USDA Natural Resources
Conservation Service

Ecological site R022BI203CA
Moderately Deep Fragmental Slopes

Accessed: 05/05/2024

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 10 to 50 Landform: Mountain slope
Soils: moderately deep, well drained soils that formed in tephra and colluvium over residuum from hydrothermally altered rock. A Cr horizon begins at 15 inches and indurated bedrock is encountered at 20-40 inches.
Temp regime: Frigid
MAT: 38 to 42 degrees F (3.3 to 5.5 degrees C).
MAP: 63 to 119 inches (2,515 to 2,870 mm).
Soil texture: Gravelly ashy loam
Surface fragments: 40 to 65 percent gravel and cobbles.
Vegetation: High cover of woolly mule-ears (*Wyethia mollis*) and/or arrowleaf balsamroot (*Balsamorhiza sagittata*) with other forbs and grasses.

Note: The soils formed from the hydrothermally altered parent material are higher in clay content and have lower pH than other soils in Lassen Volcanic National Park.

Associated sites

F022BI113CA	**Frigid Very Deep Loamy Slopes** This is an open red fir forest found on very deep hydrothermally altered soils.
R022BI209CA	**Loamy Seeps** This site is associated with wet seeps and springs in drainages and valley bottoms.

Table 1. Dominant plant species

Tree	(1) *Abies magnifica*
Shrub	Not specified
Herbaceous	(1) *Wyethia mollis* (2) *Balsamorhiza sagittata*

Physiographic features

This ecological site is found on convex mountain side slopes in hydro-thermally altered areas within Brokeoff Volcano at elevations between 5,680 and 8,570 feet. Slopes range from 10 to 80 percent, but are usually between 10 to 50 percent.

Table 2. Representative physiographic features

Landforms	(1) Mountain slope
Flooding frequency	None
Ponding frequency	None
Elevation	1,731–2,612 m
Slope	10–80%
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 (2,515 to 2,870 mm). The mean annual temperature ranges from 38 to 42 degrees F (3.3 to 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

This ecological site is not associated with wetland or riparian water features.

Soil features

The Brokeoff series associated with this site consists of moderately deep, well drained soils that formed in tephra and colluvium over residuum from hydrothermally altered volcanic rock. Acidic steam and water of various temperatures and pH have altered the mineralogy of the rock to produce minerals that have weathered into soils with significantly higher amounts of clay and a lower pH than those soils in the rest of the Park. The pH was sampled in the field at 4.8 at depths from 0 to 2 inches, and 5.0 to 5.2 in the lower horizons. A lab pit from deeper

soils with similar chemistry had pH ranges from 4.7 to 5.1. These soils are very strongly acidic to neutral, and may have high levels of aluminum and manganese. Aluminum +++ becomes soluble in acidic soils, and impairs root growth, reducing the plants ability to access water. Plants may show symptoms of Phosphorus (P), calcium (Ca), and magnesium (Mg), deficiencies due to the high pH. Manganese toxicity is also associated with acidic soils. The symptoms of manganese toxicity are reduced shoot growth, discoloring and chlorosis of leaves.

The surface texture is a gravelly ashy loam with 18 percent clay and 30 percent gravel. Subsurface textures are gravelly ashy loam, very gravelly clay loam, and extremely gravelly loam. Percent gravel ranges from 30 to 40 and percent cobbles ranges from 2 to 20 increasing with depth. At 15 to 37 inches in depth is a Cr horizon of cobbles with 98 percent rock fragments that include gravels, cobbles and stones. Indurated bedrock is encountered at 37 inches in the modal pit and ranges from 20 to 40 inches. This soil is fragmental with a high percentage of gravels and cobbles.

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 %
118 Brokeoff / 5
119 Brokeoff / 25

Table 4. Representative soil features

Family particle size	(1) Loamy
Drainage class	Well drained
Permeability class	Not specified
Soil depth	51–102 cm
Surface fragment cover <=3"	34–45%
Surface fragment cover >3"	6–20%
Available water capacity (0-101.6cm)	1.98–5.92 cm
Soil reaction (1:1 water) (0-101.6cm)	4.8–6.7
Subsurface fragment volume <=3" (Depth not specified)	25–48%
Subsurface fragment volume >3" (Depth not specified)	0–5%

Ecological dynamics

This ecological site is heavily dominated by woolly mule-ears (*Wyethia mollis*), although it may be replaced by arrowleaf balsamroot (*Balsamorhiza sagittata*) in some areas. Other common plants include bluntlobe lupine (*Lupinus obtusilobus*), mountain monardella (*Monardella odoratissima*), squirreltail (*Elymus elymoides*) and blue wildrye (*Elymus glaucus*). There are very few trees on this site.

The soils are unique to this area because of a 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. Deposition can sometimes be seen as a yellow coating on the snow, which can affect surface pH and mineralogy. Hydrogen sulfide (H2S), Carbon dioxide (CO2), hydrogen gas (H2), nitrogen (N), and helium (He) are some of the chemicals found in the thermal springs, which react with oxygen and other elements to form a variety of chemicals which may be found in the steam deposits.

The soil chemistry alone does not inhibit tree growth however, as trees are growing in similar conditions nearby. The trees nearby are not growing in a normal forest-like structure. They tend to stay open with multiple age classes, possibly indicating some response to low pHs, aluminum or manganese toxicity. Another factor may be the droughtiness of the Brokeoff soils. The Cr layer begins at 15 inches, with 98 percent rock fragments and indurated

bedrock occurring between 20 to 40 inches. Even with its finer textures this soil has a limited available water holding capacity. It is this low available water capacity, due to high rock fragments and moderately deep soils over indurated bedrock, which inhibits tree growth. Additionally, woolly mule-ears can interfere with conifer establishment through competition for water and/or allelopathy.

Woolly mule-ears (*Wyethia mollis*) can grow in a variety of soils but tend to be most aggressive in heavy clay soils, making it well adapted to this site. It does well on the moderate to steep slopes characterizing this site (Matthews 1993). Woolly mule-ears (*Wyethia mollis*) and arrowleaf balsamroot (*Balsamorhiza sagittata*) are tolerant of drought conditions and both can be found throughout the successional process.

There is a strong possibility that fire will create a disturbance in this landscape. In late summer and fall, when woolly mule-ears (*Wyethia mollis*) and arrowleaf balsamroot (*Balsamorhiza sagittata*) dry out, there is an abundance of available fuel, which increases the chance of fire. When woolly mule-ears (*Wyethia mollis*) cures it is covered with a resin that makes it rather flammable (Matthews 1993), further increasing the likelihood of fire. Arrowleaf balsamroot has a “high fire resistance rating” and following a fire it will sprout from the caudex, but growth increases slowly until seed production (McWilliams 2002). There is some indication that woolly mule-ears (*Wyethia mollis*) will resprout after a fire (Matthews 1993).

In the short term, a fire on this site will create a patchy pattern on the landscape by decreasing the amount of large forbs like woolly mule-ears and arrowleaf balsamroot, and increasing the amount of grasses.

State and transition model

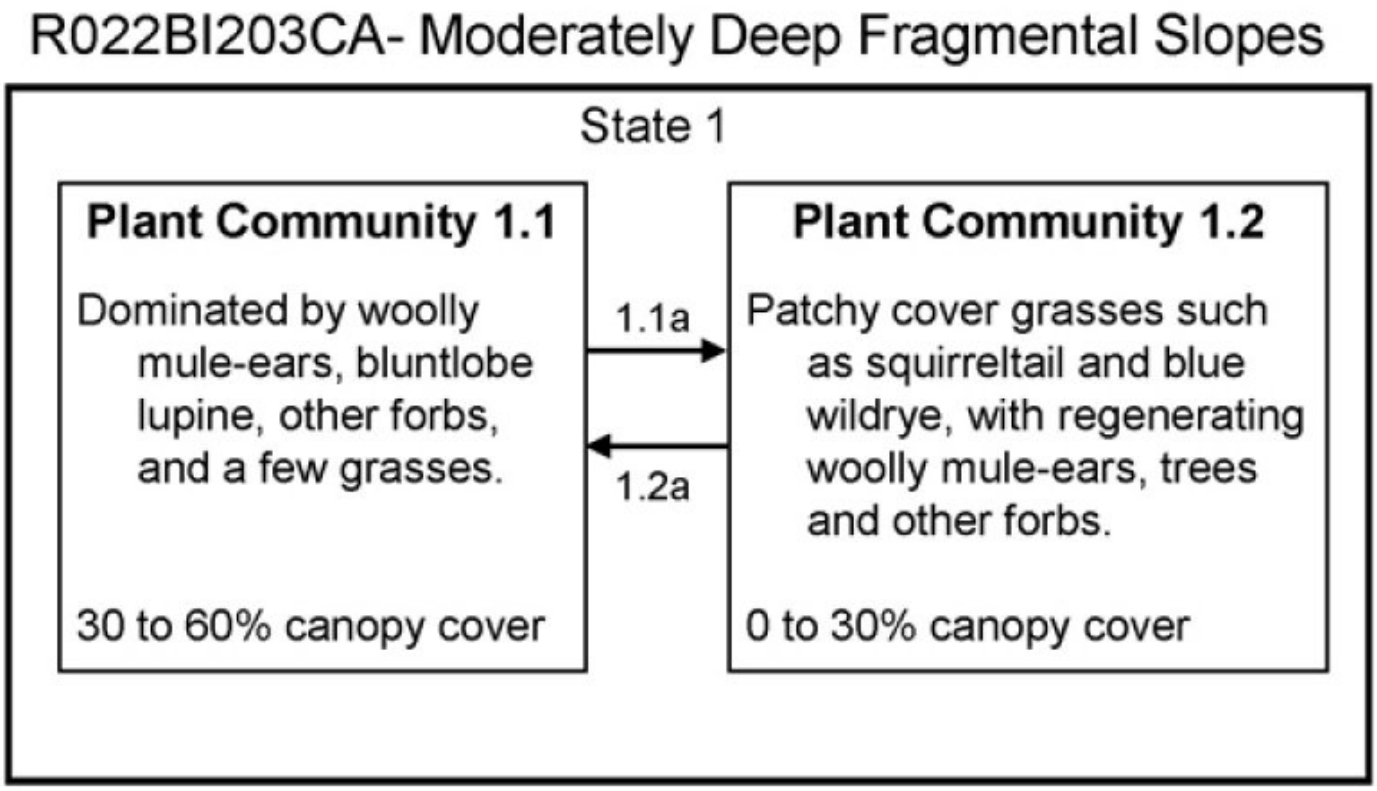

Figure 3. Moderately Deep Fragmental Slopes Model

State 1
Natural State

This state represents the natural condition for this ecological site.

Community 1.1
Robust forbs, scattered trees, and a few grasses

Figure 4. Moderately Deep Fragmental Slopes

Plant community 1.1 is the reference plant community for this site and is chiefly made up of vigorous forbs like woolly mule-ears (*Wyethia mollis*), arrowleaf balsamroot (*Balsamorhiza sagittata*) and bluntlobe lupine (*Lupinus obtusilobus*). Total canopy cover ranges from 30% and 50%, depending on the location.

Forest overstory. The overstory canopy includes western white pine (Pinus monticola) and California red fir (Abies magnifica). Trees growing here make <10% total canopy cover with <5% seedling recruitment into the understory.

Forest understory. Woolly mule-ears (Wyethia mollis) and arrowleaf balsamroot (Balsamorhiza sagittata) are most common, but seem to be exclusive of each other. Bluntlobe lupine (Lupinus obtusilobus), mountain monardella (Monardella odoratissima), California stickseed (Hackelia californica), Sierra stickseed (Hackelia nervosa), dusky onion (Allium campanulatum), naked buckwheat (Eriogonum nudum), western sweetroot (Osmorhiza occidentalis), mountain tarweed (Madia glomerata) and hairy brakenfren (Pteridium aquilinum var. pubescens) are additional forbs that may grow on this site.

Grasses make up a very small amount of the overall cover, but species include squirreltail (Elymus elymoides), blue wildrye (Elymus glaucus), western needlegrass (Achnatherum occidentale) and California brome (Bromus carinatus). Scattered shrubs growing here include whitethorn ceanothus (Ceanothus cordulatus), roundleaf snowberry (Symphoricarpos rotundifolius), Sierra gooseberry (Ribes roezlii) and rubber rabbitbrush (Ericameria nauseosa ssp. nauseosa var. speciosa).

Table 5. Annual production by plant type

Plant Type	Low (Kg/Hectare)	Representative Value (Kg/Hectare)	High (Kg/Hectare)
Forb	392	703	1098
Grass/Grasslike	1	27	62
Tree	3	34	53
Total	**396**	**764**	**1213**

Table 6. Soil surface cover

Tree basal cover	0-1%
Shrub/vine/liana basal cover	0%
Grass/grasslike basal cover	0-2%
Forb basal cover	5-10%
Non-vascular plants	0%
Biological crusts	0%
Litter	40-55%

Surface fragments >0.25" and <=3"	34-45%
Surface fragments >3"	6-20%
Bedrock	0%
Water	0%
Bare ground	22-50%

Table 7. Canopy structure (% cover)

Height Above Ground (M)	Tree	Shrub/Vine	Grass/ Grasslike	Forb
<0.15	–	–	5-10%	10-20%
>0.15 <= 0.3	–	–	0-8%	20-40%
>0.3 <= 0.6	0-1%	–	–	5-15%
>0.6 <= 1.4	1-8%	–	–	–
>1.4 <= 4	1-6%	–	–	–
>4 <= 12	0-1%	–	–	–
>12 <= 24	2-6%	–	–	–
>24 <= 37	2-5%	–	–	–
>37	–	–	–	–

Community 1.2
Patchy forbs with scattered trees and a few grasses

Plant community 1.2 is representative of how this landscape responds after a fire. Most of the woolly mule-ears (*Wyethia mollis*) and arrowleaf balsamroot (*Balsamorhiza sagittata*) would be top killed by a fire. By removing this vegetation, competition for space and resources is reduced. Squirreltail (*Elymus elymoides*) and blue wildrye (*Elymus glaucus*) will take advantage of this opportunity and regenerate quickly. Due to its relatively small size and low density, squirreltail (*Elymus elymoides*) is top killed by fire and will resprout from its root crown (Simonin 2001). Immediately following a disturbance such as fire, blue wildrye (*Elymus glaucus*) will increase dramatically, but it is a relatively short lived perennial and “will decrease in abundance and vigor after three to four years” (Johnson 1999). California brome (*Bromus carinatus*) has been a pioneering species on a variety of sites following low intensity fire. It is a prolific seed producer and responds well to disturbance but will decline over time (Tollefson 2006). It is expected that these grass species will be very abundant following a fire or other disturbance, but they will decrease relatively quickly, to allow for the regeneration of the previous plant community. Roundleaf snowberry (*Symphoricarpos rotundifolius*) is sparsely present in plant community 1.1 but would likely increase after a fire. It is described as having “high resistance to fire” and characterized as a “survivor”. It is commonly one the first species to re-colonize after fire as it is generally only top killed and regenerates from rhizomes (McWilliams 2000). Hairy brackenfern (*Pteridium aquilinum* var. pubescens) and field horsetail (*Equisetum arvense*) represent a small percentage of the total groundcover but respond favorably to fire. Field horsetail is adapted to severe fire, has deep rhizomes and regenerates quickly (Sullivan 1993). Hairy brackenfern has evolved with fire and, after fire, new sprouts are more vigorous (Crane 1990) than previous growth. In the short term, these adaptations may allow these species to increase in total biomass.

Forest overstory. The overstory canopy includes western white pine (Pinus monticola) and California red fir (Abies magnifica). Trees growing here make <10% total canopy cover with <5% seedling recruitment into the understory.

Forest understory. The understory of plant community 1.2 will be dominated by grasses like blue wildrye (Elymus glaucus) and california brome (Bromus carinatus). Total ground cover will be between 10-25 percent.

Pathway 1.1a
Community 1.1 to 1.2

1.1a- A low intensity ground fire could easily burn across this site, removing existing vegetation and leaving

opportunity for regeneration. Grasses would be the first to return, dominating the site until shrubs and forbs become more abundant. The majority of species growing here, including less abundant species, are well adapted to and even more vigorous after fire.

Pathway 1.2a
Community 1.2 to 1.1

1.2a – With time this site will move back toward plant community 1.1. Woolly mule-ears and arrowleaf balsamroot will increase and gradually shade out less competitive species. Species that are abundant in plant community 1.2 will remain in plant community 1.1 but in smaller quantities. Trees will remain a small percentage of the plant community but should fire remove competitive growth, seedlings will have a greater chance of establishing.

Additional community tables

Table 8. Community 1.1 plant community composition

Group	Common Name	Symbol	Scientific Name	Annual Production (Kg/Hectare)	Foliar Cover (%)
Grass/Grasslike					
1	**native grasses**			1–62	
	squirreltail	ELEL5	*Elymus elymoides*	1–20	1–6
	blue wildrye	ELGL	*Elymus glaucus*	0–17	0–5
	California brome	BRCA5	*Bromus carinatus*	0–13	0–3
	western needlegrass	ACOC3	*Achnatherum occidentale*	0–11	0–4
Forb					
2	**native forbs**			392–1098	
	woolly mule-ears	WYMO	*Wyethia mollis*	168–673	15–60
	arrowleaf balsamroot	BASA3	*Balsamorhiza sagittata*	11–168	2–15
	bluntlobe lupine	LUOB	*Lupinus obtusilobus*	0–135	0–12
	mountain monardella	MOOD	*Monardella odoratissima*	6–36	2–8
	California stickseed	HACA	*Hackelia californica*	0–18	0–5
	hairy brackenfern	PTAQP2	*Pteridium aquilinum var. pubescens*	0–13	0–5
	sweetcicely	OSBE	*Osmorhiza berteroi*	0–10	0–3
	silverleaf phacelia	PHHA	*Phacelia hastata*	0–9	0–2
	Brewer's aster	EUBR12	*Eucephalus breweri*	0–9	0–2
	naked buckwheat	ERNU3	*Eriogonum nudum*	0–8	0–3
	mountain tarweed	MAGL2	*Madia glomerata*	0–7	0–2
Tree					
3	**native trees**			3–53	
	California red fir	ABMA	*Abies magnifica*	3–50	5–15
	western white pine	PIMO3	*Pinus monticola*	0–2	0–1

Animal community

This site can provide good foraging resource early in the growing season, for species like deer. When ground cover is high small mammals and rodents will use the site for shelter, therefore it can also be a good hunting ground for predatory birds.

Grazing animals will eat the leaves of woolly mule-ears (*Wyethia mollis*) and arrowleaf balsamroot (*Balsamorhiza sagittata*) in the early spring, but they quickly dry and become undesirable later in growing season. Grazers will also

eat sunflower-like flower heads before the seeds ripen (McWilliams, 2002). Blue wildrye (*Elymus glaucus*) also provides fair forage value along with being a deep rooted drought tolerant perennial (Johnson, 1999).

Hydrological functions

This site is in hydrologic soil group b.

Recreational uses

This area provides scenic vistas.

Other information

Native Americans fermented the roots of woolly mule-ears (*Wyethia mollis*) in a pit with hot stones to make a sweet flavored food. Arrowleaf balsamroot (*Balsamorhiza sagittata*) was used by many Native American tribes for food and medicine. The young shoots were eaten in spring. The large tap root, bud stalks and seeds were eaten as well. It was used to treat a variety of ailments including stomachache, headache, wounds, insect bites, swellings, tuberculosis and whooping cough (McWilliams, 2002). Arrowleaf balsamroot is still valued for food and medicinal uses.

Inventory data references

There are two NRCS soil pits for this site with vegetation data.

789317
789175- Site location

Type locality

Location 1: Shasta County, CA	
Township/Range/Section	T30 N R4 E S15
UTM zone	N
UTM northing	4479536
UTM easting	624772
General legal description	The site is about 3,800 feet north-northeast from the Sulfur Works parking lot on Highway 89.

Other references

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Tollefson, Jennifer E. 2006. *Bromus carinatus*. In: Fire Effects Information System. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Science Laboratory. [Available online: http://www.fs.fed.us/database/feis/]

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:**

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

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

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

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

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

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

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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):**

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:**