Ecological site F006XB002WA
Cold Cryic Udic Mountain Slopes (Mountain Hemlock Cold Moderately Moist Shrub/Herb)

Last updated: 9/11/2023
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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): 006X–Cascade Mountains, Eastern Slope

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Stretching from northern Washington to southern Oregon, MLRA 6 encompasses the mountain slopes, foothills, elevated plateaus and valleys on the eastern slopes of the Cascade mountains. This MLRA is a transitional area between the Cascade Mountains to the west and the lower lying Columbia Basalt Plateau to the east. Situated in the rain shadow of the Cascade Crest, this MLRA receives less precipitation than portions of the cascades further west and greater precipitation than the basalt plateaus to the east. Geologically, the majority of the MLRA is dominated by Miocene volcanic rocks, while the northern portion is dominated by Pre-Cretaceous metamorphic rocks and the southern portion is blanketed with a thick mantle of ash and pumice from Mount Mazama. The soils in the MLRA dominantly have a mesic, frigid, or cryic soil temperature regime, a xeric soil moisture regime, and mixed or glassy mineralogy. They generally are moderately deep to very deep, well drained, and loamy or ashy. Biologically, the MLRA is dominated by coniferous forest, large expanses of which are dominated by ponderosa pine, Douglas-fir or lodgepole pine. Areas experiencing cooler and moister conditions include grand fir, white fir, and western larch while the highest elevations include pacific silver fir, subalpine fir and whitebark pine. Economically, timber harvest and recreation are important land uses in these forests. Historically, many of these forests would have experienced relatively frequent, low and mixed severity fire favoring the development of mature forests dominated by ponderosa pine or Douglas-fir. In the southern pumice plateau forests, less frequent, higher severity fire was common and promoted the growth of large expanses of lodgepole pine forests.

LRU notes

This ecological site typically resides on mountain slopes, at elevations of 3500 to 6000 feet, on slopes of 5 to 65 percent. The climatic conditions are moderately moist and cold, with 40 to 75 frost-free days, mean annual precipitation of 40 to 80 inches, and mean annual air temperature of 39 to 42 degrees Fahrenheit.

Classification relationships

CMS356 - Mountain hemlock/Cascade azalea-big huckleberry (TSME/RHAL-VAME) (WEN)

Ecological site concept

This ecological site typically resides on mountain slopes, at elevations of 3500 to 6000 feet, on slopes of 5 to 65 percent. The climatic conditions are moderately moist and cold, with 40 to 75 frost-free days, mean annual precipitation of 40 to 80 inches, and mean annual air temperature of 39 to 42 degrees Fahrenheit.

The soils are Andisols, specifically Humic or Xeric Vitricryands, with andic soil properties and an ashy-skeletal

particle-size class. Surface textures are typically gravelly or cobbly ashy sandy loam or ashy loamy sand. The parent material is volcanic ash mixed with colluvium and residuum from volcanic rock. The soils are dominantly well drained, and have no flooding, ponding or water table. They are typically 20 to greater than 60 inches deep to a root-restricting feature. These soils have a cryic soil temperature regime and xeric or udic soil moisture regime.

The reference community has an overstory of TSME, with potentially high cover of ABAM and a diverse understory of cold adapted shrub and herbaceous species including: RHAL2, CLUN2, MEFE, PYROL, STAM2, VAME. Seral tree species include: ABAM, ABGR, ABLA, PIEN, LAOC, PICO, CUNO and in warmer, lower elevation areas PIMO3, THPL, TSHE, PSME.

This covers the mountain hemlock areas which span the highest forests, directly below subalpine parklands. These forests have a deep, persistent snowpack and short growing season. Fires occur frequently from lightning strikes, though most fires a very small, infrequently there are large stand replacing fires approximately every 300 years. Insect and disease impact these forests on small scales including heart and butt rot, root rot, bark beetles and others. This site covers the dominant cool moist condition of the mountain hemlock at the upper elevations there may be more heath species and avalanches may be a more dominant disturbance, reoccurring in the same areas repeatedly. The harsh site conditions define the ecological site and control the vegetation community and include a heavy, persistent snowpack that causes a short growing season. The reference community is predominantly *Tsuga mertensiana*, though *Abies amabilis* can have high canopy cover, the regenerating layer always has *Tsuga mertensiana*. The understory can vary from moist (MEFE, VAAL, VAME, VAOV, SOSI, CLUN2) to drier site adapted species (XETE, VACA, RHAL2, RUPE, PYSE) and at the highest elevation (PHEM).

Associated sites

F006XA008WA	**Cryic Xeric Mountain Slopes (Subalpine fir Cold Moderately Dry Shrub/Herb)** Drier sites.

Similar sites

F006XA006WA	**Cold Cryic Udic Mountain Slopes (Pacific Silver fir Cold Moist Shrub/Herb)** Lower elevation.

Table 1. Dominant plant species

Tree	(1) *Tsuga mertensiana* (2) *Abies amabilis*
Shrub	(1) *Rhododendron albiflorum* (2) *Menziesia ferruginea*
Herbaceous	Not specified

Physiographic features

This ecological site typically resides on mountain slopes, at elevations of 3500 to 6000 feet, on slopes of 5 to 65 percent.

Table 2. Representative physiographic features

Landforms	(1) Mountains > Mountain slope
Flooding frequency	None
Ponding frequency	None
Elevation	3,500–6,000 ft
Slope	5–65%
Aspect	W, NW, N, NE, E, SE, S, SW

Climatic features

The climatic conditions are moderately moist and cold, with 40 to 75 frost-free days, mean annual precipitation of 40 to 80 inches, and mean annual air temperature of 39 to 42 degrees Fahrenheit.

Influencing water features

This site is not influenced by water from a wetland or stream.

Wetland description

N/A

Soil features

The soils are Andisols, specifically Humic or Xeric Vitricryands, with andic soil properties and an ashy-skeletal particle-size class. Surface textures are typically gravelly or cobbly ashy sandy loam or ashy loamy sand. The parent material is volcanic ash mixed with colluvium and residuum from volcanic rock. The soils are dominantly well drained, and have no flooding, ponding or water table. They are typically 20 to greater than 60 inches deep to a root-restricting feature. These soils have a cryic soil temperature regime and xeric or udic soil moisture regime. Parent material / Surface texture:

Parent Material: volcanic ash mixed with colluvium and residuum from volcanic rock
Surface Texture: gravelly or cobbly ashy sandy loam or loamy sand

Table 3. Representative soil features

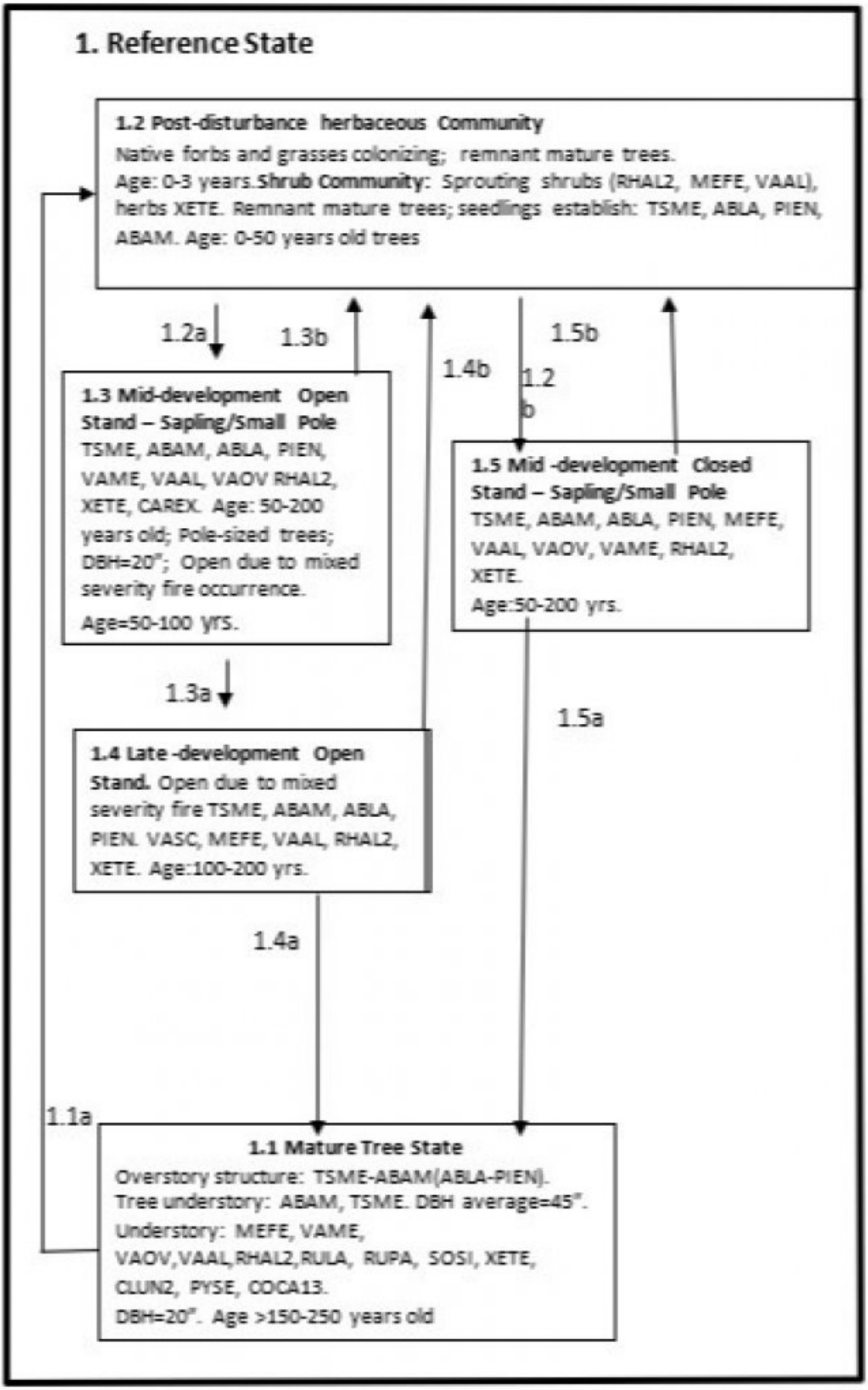
Surface texture	(1) Gravelly, cobbly, ashy sandy loam (2) Gravelly, cobbly, ashy loamy sand
Family particle size	(1) Ashy-skeletal
Drainage class	Well drained
Depth to restrictive layer	20–60 in
Soil depth	20–60 in
Surface fragment cover <=3"	0–10%
Surface fragment cover >3"	0–9%
Available water capacity (0-40in)	0.9–6.8 in

Ecological dynamics

This ecological site spans the highest elevations of closed canopy configuration forests. As such, the site conditions of cold, heavy and persistent snowpack impact vegetation growth. Diseases such as heart, root and butt rot affect tree growth and can lead to small patch disturbances, as well as windthrow, and insect damage and avalanches. Lightning strikes are common at this site, though fire is rare (rotation interval 200 to 500 years) but is severe (stand replacing fire). *Tsuga mertensiana* in the Pacific Northwest, had a fire return interval of 600 years in pre-logging conditions (FEIS, USFS, webpage). The predicted fire return interval within Wenatchee National Forest is expected to exceed 300 years, though multiple lightning strikes can cause very small patch disturbance. LANDFIRE states that North Pacific Mountain Hemlock has stand replacement fires at intervals of 500 years, mixed severity fire at 2000 years and all types of fires every 400 years. *Tsuga mertensiana* and *Abies amabilis* are present in all community phases, though *Tsuga mertensiana* eventually dominates the overstory and regeneration layers in the reference community. *Tsuga heterophylla* can occur on lower elevations and warmer sites in early and mid-development phases, while *Pinus monticola* can occur infrequently. Sites west of the Cascade crest have a more maritime climate and thus longer fire return intervals, while site east of the crest are more continental in climate and have more frequent fire.

State and transition model

State and Transition Model: Mountain Hemlock Cold Moderately Moist Shrub/Herb



1 Reference State

1.1 This phase has an overstory dominated by Mountain Hemlock and Pacific Silver Fir, with numerous lower tree canopies of both and seral species, an understory of tall shrubs, and cool, moist adapted herbaceous species. Thick tall and medium statured shrubs include: MEFE, VAME, VAAL, RULA2, RHAL2 understory of CLUN2, PYSE, TITRU, VASI, MOSS.
1.2 Pioneering herbaceous community. Immediately post-fire, on-site and windblown tree seeds establish, shrub and herbaceous plants resprout and pioneering herbaceous plants establish on mineral soil interspaces. This is a short duration community phase. Shrub Community. This plant community contains a high diversity of shrubs including MEFE, VAME, VAAL, RULA2, RHAL2). Seedlings mature to saplings.
1.3 Mid-development OPEN CANOPY community. This phase is dominated by a mix of TSME, Pacific Silver fir and seral tree species (TSHE, PIMO3) that are pole sized and are in either an open canopy due to the occurrence of mixed severity fire. Mixed severity fire creates an open canopy is created and maintained. The lower, secondary tree canopy layer is of TSME, Pacific Silver fir.
1.4 LATE-development OPEN CANOPY community. This phase is dominated by a mix of TSME, Pacific Silver fir and seral tree species (TSHE, PIMO3) that are larger than pole sized and are in an open canopy due to the occurrence of mixed severity fire. Fire would create and maintain an open canopy configuration. The lower, secondary tree canopy layer is of Pacific Silver fir.
1.5 MID-development CLOSED CANOPY community. This plant community is dominated by larger trees that is a mix of TSME and Pacific Silver fir and seral tree species in the overstory in a closed canopy configuration due to the lack occurrence of mixed severity fire. The lower tree canopy has Pacific Silver fir.
1.1a; 1.3b; 1.4b; 1.5b: Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous plants. This disturbance causes a return to the pioneering, herbaceous community with resprouting shrubs.

Plant Community Pathways

1.2a:With time, the tree seedlings and small saplings go to the mid development community and due to the occurrence of mixed severity fire the canopy is in an open configuration.
1.2b:With time, the tree seedlings and small saplings go to the mid development community grow into the closed canopy configuration.
1.3a: With time, the pole sized trees develop to large mature trees in the late development phase.
1.4a: With time, the large mature trees develop into the closed configuration of the reference phase without the occurrence of mixed severity fire.
1.5a: With time, the large mature trees develop into the closed configuration of the reference phase without the occurrence of mixed severity fire.

State 1
Reference State

Plant List Overstory Trees Mountain hemlock (*Tsuga mertensiana*) Pacific silver fir (*Abies amabilis*) Subalpine fir (*Abies lasiocarpa*) Engelmann spruce (*Picea engelmannii*) Western white pine (*Pinus monticola*) Western larch (*Larix occidentalis*) Douglas-fir (*Pseudotsuga menziesii*) Western hemlock (*Tsuga heterophylla*) Lodgepole pine (*Pinus contorta*) Whitebark pine (*Pinus albicaulis*) Understory Trees Mountain hemlock (*Tsuga mertensiana*) Pacific silver fir (*Abies amabilis*) Subalpine fir (*Abies lasiocarpa*) Western hemlock (*Tsuga heterophylla*) Understory Shrubs Cascade azalea (*Rhododendron albiflorum*) Big huckleberry (*Vaccinium membranaceum*) Sidebells pyrola (Pyrola secunda) Dwarf bramble (*Rubus lasiococcus*) Beargrass (*Xerophyllum tenax*) Low huckleberry (*Vaccinium myrtillus*) Grouse huckleberry (*Vaccinium scoparium*) Red mountain health (*Phyllodoce empetriformis*) Cascade huckleberry (*Vaccinium deliciosum*) Rusty menziesia (*Menziesia ferruginea*) Understory Herbs Broadleaf arnica (*Arnica latifolia*) W. rattlesnake plantain (Goodyera oblongfolia) Vanilla leaf (Achylys triphylla) Smoothrush woodrush (Luzula hitchcockii) Lupines (Lupin spp.) Green fescue (*Festuca viridula*) Arnica spp. (Arnica spp.) Queencup beadily (*Clintonia uniflora*) Rosy twistedstalk (Streptopus roseus) Mosses (Moss spp.)

Community 1.1
Mature Tree State

This phase has an overstory dominated by Mountain Hemlock and Pacific Silver Fir, with numerous lower tree canopies of both and seral species, an understory of tall shrubs, and cool, moist adapted herbaceous species. Thick tall and medium statured shrubs include: MEFE, VAME, VAAL, RULA2, RHAL2 understory of CLUN2, PYSE, TITRU, VASI, MOSS.

Dominant plant species

- mountain hemlock (*Tsuga mertensiana*), tree
- Pacific silver fir (*Abies amabilis*), tree
- subalpine fir (*Abies lasiocarpa*), tree
- Engelmann spruce (*Picea engelmannii*), tree
- rusty menziesia (*Menziesia ferruginea*), shrub
- thinleaf huckleberry (*Vaccinium membranaceum*), shrub
- Alaska blueberry (*Vaccinium alaskaense*), shrub
- roughfruit berry (*Rubus lasiococcus*), shrub
- Cascade azalea (*Rhododendron albiflorum*), shrub
- bride's bonnet (*Clintonia uniflora*), other herbaceous
- oneleaf foamflower (*Tiarella trifoliata var. unifoliata*), other herbaceous
- Sitka valerian (*Valeriana sitchensis*), other herbaceous
- Moss (*Moss*), other herbaceous

Community 1.2
Post-disturbance Herbaceous Community

Pioneering herbaceous community. Immediately post-fire, on-site and windblown tree seeds establish, shrub and herbaceous plants resprout and pioneering herbaceous plants establish on mineral soil interspaces. This is a short duration community phase. Shrub Community. This plant community contains a high diversity of shrubs including MEFE, VAME, VAAL, RULA2, RHAL2). Seedlings mature to saplings.

Dominant plant species

- rusty menziesia (*Menziesia ferruginea*), shrub
- thinleaf huckleberry (*Vaccinium membranaceum*), shrub
- Alaska blueberry (*Vaccinium alaskaense*), shrub
- roughfruit berry (*Rubus lasiococcus*), shrub
- Cascade azalea (*Rhododendron albiflorum*), shrub

Community 1.3
Mid-development Open Stand -Sapling/Small Pole

This phase is dominated by a mix of TSME, Pacific Silver fir and seral tree species (TSHE, PIMO3) that are pole sized and are in either an open canopy due to the occurrence of mixed severity fire. Mixed severity fire creates an open canopy is created and maintained. The lower, secondary tree canopy layer is of TSME, Pacific Silver fir.

Dominant plant species

- mountain hemlock (*Tsuga mertensiana*), tree
- Pacific silver fir (*Abies amabilis*), tree
- western hemlock (*Tsuga heterophylla*), tree
- western white pine (*Pinus monticola*), tree

Community 1.4
Late-development Open Stand

This phase is dominated by a mix of TSME, Pacific Silver fir and seral tree species (TSHE, PIMO3) that are larger than pole sized and are in an open canopy due to the occurrence of mixed severity fire. Fire would create and maintain an open canopy configuration. The lower, secondary tree canopy layer is of Pacific Silver fir.

Dominant plant species

- mountain hemlock (*Tsuga mertensiana*), tree
- Pacific silver fir (*Abies amabilis*), tree
- western white pine (*Pinus monticola*), tree
- western hemlock (*Tsuga heterophylla*), tree

Community 1.5
Mid-development Closed Stand -Sapling/Small Pole

This plant community is dominated by larger trees that is a mix of TSME and Pacific Silver fir and seral tree species in the overstory in a closed canopy configuration due to the lack occurrence of mixed severity fire. The lower tree canopy has Pacific Silver fir.

Dominant plant species

- mountain hemlock (*Tsuga mertensiana*), tree
- Pacific silver fir (*Abies amabilis*), tree

Pathway 1.1a
Community 1.1 to 1.2

Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous plants. This disturbance causes a return to the pioneering, herbaceous community with re-sprouting shrubs.

Pathway 1.2a
Community 1.2 to 1.3

With time, the tree seedlings and small saplings go to the mid-development community and due to the occurrence of mixed severity fire the canopy is in an open configuration.

Pathway 1.2b
Community 1.2 to 1.5

With time, the tree seedlings and small saplings go to the mid-development community grow into the closed canopy configuration.

Pathway 1.3b
Community 1.3 to 1.2

Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous

plants. This disturbance causes a return to the pioneering, herbaceous community with resprouting shrubs.

Pathway 1.3a
Community 1.3 to 1.4

With time, the pole sized trees develop to large mature trees in the late development phase.

Pathway 1.4a
Community 1.4 to 1.1

With time, the large mature trees develop into the closed configuration of the reference phase without the occurrence of mixed severity fire.

Pathway 1.4b
Community 1.4 to 1.2

Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous plants. This disturbance causes a return to the pioneering, herbaceous community with resprouting shrubs.

Pathway 1.5a
Community 1.5 to 1.1

With time, the large mature trees develop into the closed configuration of the reference phase without the occurrence of mixed severity fire.

Pathway 1.5b
Community 1.5 to 1.2

Rare, stand-replacement fire that kills significant number of mature trees and top-kills shrubs and herbaceous plants. This disturbance causes a return to the pioneering, herbaceous community with resprouting shrubs.

Additional community tables

Other information

Site index: Mountain Hemlock 45 – 80 100TA, Barnes 1962 (990); Subalpine fir 54 – 100 100TA, Alexander 1967 (412); Douglas-fir 50 – 60 50BA Cochcran 1979b (765); Western larch 45 50BA Cochran 1985 (261); Western white pine 35 – 40 50TA, Haig 1932 (570); Western Hemlock 80 100TA, Barnes 1962 (990); Engelmann spruce 85 100TA, Alexander 1967 (412); Lodgepole pine 80 100TA, Alexander 1966 (520); Pacific silver fir 95 100TA, Hoyer, Herman 1989 (05); Grand fir 50 50BA, Cochran 1979a (031)

Table 4. Representative site productivity

Common Name	Symbol	Site Index Low	Site Index High	CMAI Low	CMAI High	Age Of CMAI	Site Index Curve Code	Site Index Curve Basis	Citation
mountain hemlock	*TSME*	45	80	–	–	–	–	–	
western larch	*LAOC*	45	45	–	–	–	–	–	
Douglas-fir	*PSME*	50	60	–	–	–	–	–	
western white pine	*PIMO3*	35	40	–	–	–	–	–	
western hemlock	*TSHE*	80	80	–	–	–	–	–	
Engelmann spruce	*PIEN*	85	85	–	–	–	–	–	
lodgepole pine	*PICO*	80	80	–	–	–	–	–	
Pacific silver fir	*ABAM*	95	95	–	–	–	–	–	
grand fir	*ABGR*	50	50	–	–	–	–	–	

Inventory data references

This ecological site relates to the Wenatchee National Forest plant associations: mountain hemlock/Cascade azalea-big huckleberry, mountain hemlock/pink mountainheath-Cascade huckleberry, mountain hemlock/rusty menziesia-big huckleberry

Other references

Scientific Literature:
Lillybridge, Terry R., et al. "Field guide for forested plant associations of the Wenatchee National Forest." Gen. Tech. Rep. PNW-GTR-359. Portland, OR: US Department of Agriculture, Forest Service, Pacific Northwest Research Station. 335 p. In cooperation with: Pacific Northwest Region, Wenatchee National Forest 359 (1995).

Diaz, Nancy M. "Plant association and management guide for the mountain hemlock zone: Gifford Pinchot and Mt. Hood National Forests." (1997).
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LANDFIRE, 2007, Biophysical Settings Model Descriptions, LANDFIRE 1.1.0, U.S. Department of the Interior, USDA Forest service, Accessed 20 April 2020 at https://www.landfire.gov/bps-models.php

Contributors

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Approval

Kirt Walstad, 9/11/2023

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	10/12/2024
Approved by	Kirt Walstad
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:**

    ___