10270
Mediterranean California Dry-Mesic Mixed-Conifer Forest and Woodland

BpS Model/Description Version: Aug. 2020

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Vegetation Type
Forest and Woodland

Map Zones
2, 3, 7

Model Splits or Lumps

North Pacific Dry Douglas Fir(-Madrone) Forest and Woodland (BpS 10350) is lumped into this BpS in the Klamath ecoregion.

Geographic Range
This type occurs in the Klamath-Siskiyou region (California and Oregon) and may extend to the west side of Mount Shasta and the upper Sacramento River. It also occurs in the southwest Oregon Cascades up to the southern end of the Willamette Valley. This particular model and description applies within the Pacific Northwest Coast, West Cascades, Klamath Mountains, and California North Coast ecoregions.

Biophysical Site Description
This type occurs on all aspects in lower montane zones (600-1,800m in northern California and southern Oregon; 1,200-2,150m in southern California). It occurs in a variety of topo-edaphic positions, such as upper slopes at higher elevations, canyon side slopes, ridgetops, and south- and west-facing slopes that burn relatively frequently.

Vegetation Description
Mixed-conifer forests must have at least two co-dominating species and typically have three or more species. *Pseudotsuga menziesii*, *Pinus ponderosa*, and *Calocedrus decurrens* (CADE27) are the most common conifers. Other conifers that are occasionally present include *Pinus jeffreyi*, *P. attenuata*, and *P. lambertiana*. *P. lambertiana* can be significant in Oregon. One reviewer suggested that *Chamaecyparis lawsoniana* and *Picea breweriana* can be present in this system.

Common sub-canopy trees include *Quercus kelloggii* and *Q. chrysolepis*. *Arbutus menziesii* commonly occurs at the northern end of the BpS range.

Understory shrubs include *Toxicodendron diversilobum*, *Ceanothus intergerrinus*, *C. velutinus*, *Arctostaphylos viscida*, *Chrysolepis chrysophylla*, *Ribes* spp., *Berberus aquifolium*, and *Symphoricarpos mollis*. In Oregon, *Holodiscus discolor* and *Berberis* spp. can occur. Herbaceous species are varied, but often include *Festuca californica*, *Elymus glaucus*, and *Whipplea modesta* (important in Oregon).

Southwest Oregon Plant Association Groups (SWOPAG, Atzet et al. 1996) included in this type are:

SWOPAG	Blue Book Plant Association	P/A Blue Book PAG Name
1407	PSME-CADE27/BEPI2	Douglas-fir/Poison Oak-warm, often low elevation
1407	PSME-PIPO/RHDI6	Douglas-fir/Poison Oak-warm, often low elevation
1407	PSME-QUKE/RHDI6	Douglas-fir/Poison Oak-warm, often low elevation
1407	PSME/DRY SHRUB	Douglas-fir/Poison Oak-warm, often low elevation
1407	PSME/HODI/WHMO-SWO	Douglas-fir/Poison Oak-warm, often low elevation
1408	PSME-ABCO/SYMO	Douglas-fir-Canyon Live Oak-cool, dry - SWO
1408	PSME-QUCH2-LIDE3	Douglas-fir-Canyon Live Oak-cool, dry - SWO
1408	PSME-QUCH2/BENE2	Douglas-fir-Canyon Live Oak-cool, dry - SWO
1408	PSME-QUCH2/RHDI6	Douglas-fir-Canyon Live Oak-cool, dry - SWO
1408	PSME/ACCI-BENE2	Douglas-fir-Canyon Live Oak-cool, dry - SWO
1408	PSME/ARNE-SWO	Douglas-fir-Canyon Live Oak-cool, dry - SWO
1408	PSME/BENE2/POMU	Douglas-fir-Canyon Live Oak-cool, dry - SWO
1411	PSME-CADE27	Douglas-fir-Ultramafic - SWO
1411	PSME-CADE27-PIJE	Douglas-fir-Ultramafic - SWO
1411	PSME/QUVA	Douglas-fir-Ultramafic - SWO

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
PSME	*Pseudotsuga menziesii*	Douglas-fir
PIPO	*Pinus ponderosa*	Ponderosa pine
CADE27	*Calocedrus decurrens*	Incense cedar
QUKE	*Quercus kelloggii*	California black oak
PILA	*Pinus lambertiana*	Sugar pine

Species names are from the NRCS PLANTS database. Check species codes at http://plants.usda.gov.

Disturbance Description

The pre-settlement fire regime of dry mixed-conifer forests is characterized by frequent low- and mixed-severity fires (Taylor and Skinner 1998). Replacement fire was uncommon, but provided an opportunity for tree recruitment (Taylor and Skinner 1998). This fire regime contributed to

the diverse multi-age stand structure that characterizes this BpS (Taylor and Skinner 1998; Taylor and Skinner 2003). Fire regimes may be similar to mesic mixed-conifer type (BpS 1028).

A sample of relevant fire history studies summarized in the following list suggests pre-settlement mean fire return intervals (FRIs) may have varied from 1.6-29yrs.

- Messier et al. (2012) studied riparian mixed-conifer forests at sites in the Rogue River Basin and found patterns similar to those found in the uplands: pulsed patterns of recruitment prior to 1900 and evidence of a frequent mixed-severity fire regime. Around 1900, a continuous recruitment pattern emerged and a shift in species dominance toward more shade-tolerant white fir was observed.

- In the Middle Applegate Watershed for eight sites representing oak woodlands, mixed-evergreen forests, and, at higher elevations, mixed-conifer forests, Comfort et al. (in press) reported pre-settlement mean FRIs of 3.5-13yrs from 157 cross-dated fire scars. The longest fire-free period they recorded was 28yrs.

- Sensenig et al. (2013) field-counted (rather than cross-dated) fire scars at six dry mixed-conifer sites in the Siskiyous of southwest Oregon to understand stand-level fire regimes from 1700-1900. Their most conservative estimate of the mean FRI at these sites varied from 19-29yrs, with a range of 10-76yrs.

- Metlen et al. (2016) found mean FRIs between 7yrs and 16yrs, and a median of 8yrs using cross-dated fire scar samples from Douglas-fir dry sites in the western Rogue Basin (Big Butte, Coggins, Elliott, Evans, Star, and Trail sites). Across these sites, FRIs largely ranged between 2yrs and 28yrs.

- Taylor and Skinner (2003) report a pre-settlement (1628-1850) composite FRI of 1.6yrs for fires recorded at any of their burned sites and up to 10.3yrs for fires recorded at 15 or more mixed-conifer sites in the south-central Klamath Mountains. For the same time period, they report a 20-yr fire rotation. They found more variability in FRIs on north-facing slopes compared to south-facing. Seventy-six percent of fires burned from midsummer through fall, and although they found some evidence of high-severity fire, the age class structure within the study area suggested that low- and moderate-severity fires were more common.

- Taylor and Skinner (1998) report a pre-settlement (1626-1849) median FRI of 14.5yrs, with a range of 6-116yrs for a mixed-conifer study area in the northern Klamath Mountains. They found that 85% of fires in the area burned during the summer and fall, and that south- and west-facing slopes burned more frequently than other aspects. They also found that upper south- and west-facing slopes appeared to burn with mostly high severity, contrasting with north- and east-facing slopes that were generally dominated by mostly low-severity fires.

- In Lassen National Park, California, Taylor (2000) reported a pre-settlement (before 1850) mean composite FRI of 4.9yrs for Jeffery pine (typically mixed with ponderosa

pine and white fir) forest sites. They found that east- and south-facing slopes burned more often than west aspects and that 67% of fires occurred during the dormant season.

- In the Cub Creek Research Natural Area in Lassen National Forest, Beaty and Taylor (2001) reported a highly variable fire regime for mixed-conifer forests. The pre-settlement (before 1850) mean composite FRI was 7.7yrs (range, 2-15yrs). More than 69% of upper slopes burned with high severity. Middle-slope positions had a mix of fire severities; lower slopes burned predominantly with low- and moderate-severity fires. Most fires burned in the dormant season.

- In the Thousand Lakes Wilderness, California, Bekker and Taylor (2001) reported pre-settlement (before 1850) mean composite FRIs of 5.8yrs and 11.3yrs for white fir-Jeffrey pine and white fir-sugar pine forest sites, respectively. They found that high- and moderate-severity fires burned more area than low-severity fires and that fires occurred most often during the dormant season.

- In their summary of pre-settlement fire regimes for California, Van de Water and Safford (2011) report a mean FRI of 11yrs, a mean minimum FRI of 5yrs, and a mean maximum FRI of 50yrs for dry mixed conifer based on review of 38 studies.

A sharp decline in fire frequency (Taylor and Skinner 1998; Taylor and Skinner 2003; Comfort et al. in press) and changes in tree recruitment and species composition (Messier et al. 2012; Poage et al. 2009), which occurred during in the 1900s, have been noted in mixed-conifer forests and are attributed, at least in part, to fire suppression policies.

Insect/pathogen and drought-related mortality that does not cause a change in state occurs every 7-10yrs in closed states; that which causes a transition from a late-seral Closed to Open state occurs about every 100yrs. Neither disease was included in the state-and-transition simulation model. With historical fire regimes, insect outbreaks may have been much reduced compared to current conditions. Snow breakage occurs in the mid-seral closed state (Class B) about every 5yrs. Although model is aspatial, most medium- and high-severity fire may actually occur on mid- and upper slope positions (Taylor and Skinner 1998; Taylor 2000; Bekker and Taylor 2001).

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	332	2		
Moderate (Mixed)	31	26		
Low (Surface)	12	72	7	17
All Fires	8	100		

Fire interval is expressed in years for each fire severity class and for all types of fire combined (All Fires). Average FI is the central tendency modeled. Percent of all fires is the percent of all fires modeled in that severity class. Minimum and Maximum FIs show the relative range of fire intervals as estimated by model contributors, if known.

Scale Description

This forest type occurs in a small- to medium-patch-size mosaic (100-1,000ac), driven by variations in topography, historical fire patterns, and fire intensity. May occur in patchy mosaic with chaparral and oak woodland types.

Adjacency or Identification Concerns
May be adjacent to chaparral, oak woodland, and grassland types, or serpentine mixed-conifer forests at lower elevations. Upper elevations defined by ecotone with Mediterranean California Mesic Mixed-Conifer (BpS 1028). When it occurs at higher elevations, it is on south-facing slopes and ridges. The western ecotone occurs with mixed-evergreen forests (east of Happy Camp, middle end of Rogue River Canyon).

This system has a large amount of management in it. Current conditions would probably result in a high amount of mid-development stage and more closed versus open (Creasy, pers. comm.).

Issues or Problems
The Klamath region literature indicates that topographic complexity is a major driver of fire severity and contributes to disparity between this northern model variant and the same BpS found in the central Sierra Nevada and farther south. Even though a mean FRI difference may exist between northern and southern aspects, Skinner and Taylor (1998) found that the numbers were not statistically significant in their study. Difference in severity between aspects may be more important. There is a critical need to account for topography in the model because it drives the disturbance effects, and thus major transitions among succession classes.

Native Uncharacteristic Conditions
Uncharacteristic native conditions can include high density of Douglas-fir and loss of pine species due to selective logging. Some areas have been converted to hardwood types by historical logging; past, prolonged fire-free interval; and subsequent severe fire.

Lauvaux et al. (2016) suggest that climate changes likely to increase fire frequency and severity may lead to more areas of chaparral dominance on the landscape in the future where, historically, chaparral was interspersed with mixed-conifer forest. They conclude that "if the decades needed for trees to re-establish from seeds from forest at the chaparral edges exceed the new fire return interval, chaparral may emerge as an alternative stable state to forest."

Comments
Several assumptions were used in this model:

- Succession class ages were based on data from Sensenig et al. (2013). Radial growth rates for the Siskiyous were estimated using the old-growth rate for Open succession classes and the young rate for Closed succession classes (see figure 4 in Sensenig et al. [2013]).
- The Closed versus Open class canopy cover break was set at 40% based on the work of Bigelow et al. (2011), which demonstrated that thinning forest to 40% canopy cover resulted in 10-20% of the area available for pine regeneration -- a level they deemed to be sufficient to perpetuate the fine-scale regeneration mosaic of Sierra Nevada mixed-conifer forests.

During the 2016 review, reviewers (Darren Borgias, Clint Emerson, Lyndia Hammer, Patricia Hochhalter, Kerry Metlen, and Jena Volpe) suggested changes to the fire frequency, s-class age, and s-class structure definitions. Kerry Metlen and Kori Blankenship revised the state-and-transition model. Carl Skinner commented on the description.

Safford felt this system should have more replacement fires than 1031 - PIPO-PIJE. Several reviewers felt there should be a separate model for *Pinus attenuata* because it occurs in large patches and has a distinct fire regime that can be described separately from this type.

Succession Classes

Mapping Rules

Upper Layer Lifeform	Height (m)	Canopy Cover (%)									
		0-10	11-20	21-30	31-40	41 - 50	51-60	61-70	71-80	81-90	91-100
Herb	0-0.5	A	A	A	A	A	A	A	A	A	A
Herb	0.5-1.0	A	A	A	A	A	A	A	A	A	A
Herb	>1.0	A	A	A	A	A	A	A	A	A	A
Shrub	0-0.5	A	A	A	A	A	A	A	A	A	A
Shrub	0.5-1.0	A	A	A	A	A	A	A	A	A	A
Shrub	1.0-3.0	A	A	A	A	A	A	A	A	A	A
Shrub	>3.0	A	A	A	A	A	A	A	A	A	A
Tree	0-5	A	A	A	A	A	A	A	A	A	A
Tree	5-10	A	A	A	A	A	A	A	A	A	A
Tree	10-25	A	C	C	C	B	B	B	B	B	B
Tree	25-50	A	D	D	D	E	E	E	E	E	E
Tree	>50	A	D	D	D	E	E	E	E	E	E

Succession class letters A-E are described in the Succession Class Description section. Some classes use a leafform distinction where a qualifier is added to the class letter: Brdl (broadleaf), Con (conifer), or Mix (mixed conifer and broadleaf). UN refers to uncharacteristic native or a combination of height and cover that would not be expected under the reference condition. NP refers to not possible or a combination of height and cover which is not physiologically possible for the species in the BpS.

Description

Class A 11 Early Development 1 - All Structures

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSME	Pseudotsuga menziesii	Douglas-fir	Upper
PIPO	Pinus ponderosa	Ponderosa pine	Upper
PILA	Pinus lambertiana	Sugar pine	Upper

Description

These early succession stands-are comprised of grass, shrubs, and shade-intolerant tree species as seedlings, saplings, and poles. Snags are typically present. This stage can occur as small patch (10-100ac) within mixed-severity fire, or less likely as large patches from more extensive fire (100-1,000ac).

Maximum Tree Size Class
Pole 5-9" DBH

Class B 4 Mid Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIPO	Pinus ponderosa	Ponderosa pine	Upper
PSME	Pseudotsuga menziesii	Douglas-fir	Upper
CADE27	Calocedrus decurrens	Incense cedar	Upper
QUKE	Quercus kelloggii	California black oak	Middle

Description
This class is composed of pole-size to large conifers (up to 30in DBH). These stands develop as an alternate successional pathway in settings and climatic periods that support longer intervals between mixed-severity fires. They can be crowded stands of conifers along with hardwood trees in younger stages. Douglas-fir continue to recruit below ponderosa pine and adult Douglas-fir, depending on local site conditions. Depauperate understory. Ladder fuels and sub-canopy fuels can be low enough for crown fire initiation. Surface fuel moderate and complex.

Maximum Tree Size Class
Large 21-33" DBH

Class C 8 Mid Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIPO	Pinus ponderosa	Ponderosa pine	Upper
PSME	Pseudotsuga menziesii	Douglas-fir	Upper
CADE27	Calocedrus decurrens	Incense cedar	Upper
QUKE	Quercus kelloggii	California black oak	Middle

Description
This class is composed of pole-size to large conifers (up to 30in DBH). These stands develop with frequent low- and mixed-severity fires (MFRI, 7-17yrs). Open stands of predominately pines and Douglas-fir, with hardwood trees scattered throughout. *Calocedrus decurrens* can be very sparse or quite common. Douglas-fir continues to seed in under the ponderosa pine overstory. Rich herbaceous and woody understory, and native grasses and forbs are favored with frequent fires. Surface fuel light and complex.

Maximum Tree Size Class
Large 21-33" DBH

Class D 63 Late Development 1 - Open

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PIPO	Pinus ponderosa	Ponderosa pine	Upper
PSME	Pseudotsuga menziesii	Douglas-fir	Upper
CADE27	Calocedrus decurrens	Incense cedar	Upper
QUKE	Quercus kelloggii	California black oak	Middle

Description

Large conifers. These stands develop with frequent low- and mixed-severity fires. Open stands of predominately pines and Douglas-fir, with hardwood trees very patchy, in younger stages, persisting in protected sights, on knolls and noses with many scars. *Calocedrus decurrens* can be very sparse or quite common. Rich herbaceous and woody understory. Native grasses and forbs are favored with frequent fire. Surface fuel is light and complex.

Maximum Tree Size Class

Very Large >33" DBH

Class E 14 Late Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSME	Pseudotsuga menziesii	Douglas-fir	Upper
PIPO	Pinus ponderosa	Ponderosa pine	Upper
CADE27	Calocedrus decurrens	Incense cedar	Upper

Description

Old-growth, closed-canopy, large conifers. Multi-layer complex canopy structure. Crowded stands of conifers can overtop the hardwood layer. Hardwoods begin to be shaded out. Douglas-fir dominates the canopy and begins to edge out the other species. Undergrowth is highly variable, from depauperate to quite dense, depending on canopy density and local site conditions. Fire frequency in these stands may be similar to Late Open stands (Taylor and Skinner 1998). The primary difference between Class D and Class E stands is that Class E stands appear to be either in more mesic locations or lower in the canyons (Carl Skinner, pers. comm.). Ladder fuels and sub-canopy may be low enough for crown fire initiation in some stands. Surface fuel moderate to high and complex.

Maximum Tree Size Class

Very Large >33" DBH

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid1:OPN	49
Mid1:OPN	50	Late1:OPN	89
Mid1:CLS	50	Late1:CLS	209

Late1:OPN	90	Late1:OPN	999
Late1:CLS	210	Late1:CLS	999

Probabilistic Transitions

Disturbance Type	Disturbance occurs In	Moves vegetation to	Disturbance Probability	Return Interval (yrs)	Reset Age to New Class Start Age After Disturbance?	Years Since Last Disturbance
Alternative Succession	Early1:ALL	Mid1:CLS	1	1	Yes	20
Replacement Fire	Early1:ALL	Early1:ALL	0.01	100	Yes	0
Mixed Fire	Early1:ALL	Early1:ALL	0.04	25	No	0
Surface Fire	Early1:ALL	Early1:ALL	0.1	10	No	0
Alternative Succession	Mid1:OPN	Mid1:CLS	1	1	Yes	20
Replacement Fire	Mid1:OPN	Early1:ALL	0.0033	303	Yes	0
Mixed Fire	Mid1:OPN	Mid1:OPN	0.0286	35	No	0
Surface Fire	Mid1:OPN	Mid1:OPN	0.1	10	No	0
Replacement Fire	Mid1:CLS	Early1:ALL	0.0025	400	Yes	0
Surface Fire	Mid1:CLS	Mid1:CLS	0.01	100	No	0
Mixed Fire	Mid1:CLS	Mid1:OPN	0.0286	35	Yes	0
Alternative Succession	Late1:OPN	Late1:CLS	1	1	Yes	20
Replacement Fire	Late1:OPN	Early1:ALL	0.002	500	Yes	0
Mixed Fire	Late1:OPN	Late1:OPN	0.0286	35	No	0
Surface Fire	Late1:OPN	Late1:OPN	0.1	10	No	0
Replacement Fire	Late1:CLS	Early1:ALL	0.002	500	Yes	0
Surface Fire	Late1:CLS	Late1:CLS	0.02	50	No	0
Mixed Fire	Late1:CLS	Late1:OPN	0.04	25	Yes	0

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