10270

Mediterranean California Dry-Mesic Mixed-Conifer Forest and Woodland

BpS Model/Description Version: Aug. 2020

|  |  |  |  |
| --- | --- | --- | --- |
| **Modelers** |  | **Reviewers** |  |
| Darren Borgias | dborgias@tnc.org | Diane White, Charley Martin, Ed Reilly | dewhite01@fs.fed.us |
| Tim Bradley | tim\_bradley@nps.gov | Hugh Safford/Dave Schmidt | hughsafford@fs.fed.us |
| Steve Norman | snorman@fs.fed.us | anonymous |  |

Reviewers: Darren Borgias, Clint Emerson, Lyndia Hammer, Patricia Hochhalter, Kerry Metlen, Jena Volpe, Carl Skinner

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 standsare 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 |

References

Atzet, T., D.E. White, L.A. McCrimmon, P.A. Martinez, P.R. Fong and V.D. Randall. 1996. Field guide to the forested plant associations of Southwestern Oregon. Portland, OR: USDA For. Serv. Tech. Pap. R6-NR-ECOL-TP-17-96. Available: http://ecoshare.info/2010/11/10/field-guide-to-the-forested-plant-associations-of-southwestern-oregon/.

Beaty R. M. and A. H. Taylor. 2001. Spatial and temporal variation of fire regimes in a mixed conifer forest landscape, Southern Cascades, California, USA. Department of Geography, The Pennsylvania State University, University Park, PA, USA. Journal of Biogeography 28: 955-966.

Bekker, M.F. and A.H. Taylor. 2001. Gradient Analysis of Fire Regimes in Montane Forests of the Southern Cascade Range, Thousand Lakes Wilderness, California, USA. Plant Ecology 155: 15-28.

Bigelow, S.W., M.P. North and C.F. Salk. 2011. Using light to predict fuels-reduction and group-selection effects on succession in Sierran mixed-conifer forest. Canadian Journal of Forest Research 41: 2051-2063.

Brown, James K. and Jane Kapler Smith, eds. 2000. Wildland fire in ecosystems: effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station. 257 pp.

Caprio, A.C. and T.W. Swetnam. 1995. Historic fire regimes along an elevational gradient on the west slope of the Sierra Nevada, California. In: Brown, James K., Robert W. Mutch, Charles W. Spoon and Ronald H. Wakimoto, technical coordinators. 1995. Proceedings: Symposium on Fire in Wilderness and Park Management: Past Lessons and Future Opportunities. 1993 March 30-April 1. Missoula, MT. Gen. Tech. Rep. INT-GTR-320. Ogden, UT: USDA Intermountain Research Station.

Comfort, E., C.J. Dunn, J.D. Bailey, J.F. Franklin and K.N. Johnson. In press. Disturbance history and composition shifts in a coupled human-ecological system of Southwest Oregon, U.S.A.

Frost, Evan J. and Rob Sweeney. 2000. Fire Regimes, Fire History and Forest Conditions in the Klamath-Siskiyou Region: An Overview and Synthesis of Knowledge. Wildwood Environmental Consulting. Prepared for the World Wildlife Fund, Klamath-Siskiyou Ecoregion Program, Ashland, OR. December 2000

Kilgore, B.M. and D. Taylor. 1979. Fire history of a sequoia-mixed conifer forest. Ecology 60(1) 1979: 129-142.

Lauvaux, C.A., C.N. Skinner and A.H. Taylor. 2016. High severity fire and mixed conifer forest-chaparral dynamics in the southern Cascade Range, USA. Forest Ecology and Management 363: 74-85.

McKelvey, K.S. et al. 1996. An Overview of Fire. In: The Sierra Nevada Sierra Nevada Ecosystem Project: Final report to Congress, vol. II. Assessments and scientific basis for management options. Davis, CA: University of California, Centers for Water and Wildland Resources.

Messier, M.S., J.P.A. Shatford, D.E. Hibbs. 2012. Fire exclusion effects on riparian forest dynamics in southwestern Oregon. Forest Ecology and Management 264: 60-71.

Metlen, K. L., D. Borgias, and C. Skinner. 2016. Historical fire frequency in the Rogue Basin. Page Appendix in D. Thorpe, editor. Boot Prints: A centennial summary of activities and events of Oregon’s Department of Forestry in Jackson and Josephine Counties. Oregon Department of Forestry Southwest Oregon District, Central Point, OR.

NatureServe. 2007. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. Data current as of 10 February 2007.

Poage, N.J., P.J. Weisberg, P.C. Impara, J.C. Tappeiner and T.S. Sensenig. 2009. Influences of climate, fire, and topography on contemporary age structure patterns of Douglas-fir at 205 old forest sites in western Oregon. Canadian Journal of Forest Research 39: 1518-1530.

Sensenig, T.S. 2002. Development, fire history and current and past growth of old-growth and young-growth forest stands in the Cascade, Siskiyou, and mid-coast mountains of southwestern Oregon. PhD thesis. Oregon State University, Corvallis, OR. 180 pp.

Sensenig, T., J.D. Bailey and J.C. Tappeiner. 2013. Stand development, fire and growth of old-growth and young forests in southwestern Oregon, USA. Forest Ecology and Management 291: 96-109.

Skinner, C.N. and C. Chang. 1996. Fire Regimes, Past and Present. In: The Sierra Nevada Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, Assessments and scientific basis for management options. Davis, CA: University of California, Centers for Water and Wildland Resources.

Taylor, A. H. 2000. Fire regimes and forest changes in mid and upper montane forests of the southern Cascades, Lassen Volcanic National Park, California, U.S.A. Journal of Biogeography 27: 87-104.

Taylor, A.H. and C.N. Skinner. 1998. Fire history and landscape dynamics in a late-successional reserve, Klamath Mountains, California, USA. Forest Ecology and Management 111: 285-301.

Taylor, A.H. and C.N. Skinner. 2003. Spatial patterns and controls on historical fire regimes and forest structure in the Klamath Mountains. Ecological Applications 13: 704-719.

Van de Water, K.M. and H.D. Safford. 2011. A summary of fire frequency estimates for California vegetation before Euro-American settlement. Fire Ecology 7(3): 26-58. doi: 10.4996/fireecology.0703026.