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Mediterranean California Mixed-Evergreen Forest -- Coastal

BpS Model/Description Version: Aug. 2020

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Vegetation Type

Forest and Woodland

Map Zones

2, 3

Model Splits or Lumps

The Mediterranean California Mixed Evergreen Forest is a major Biophysical Setting (BpS) from southwest Oregon through northwest California that spans broad environmental gradients in precipitation, temperature, and topography. Throughout its range, precipitation generally decreases and temperature generally increases north to south and west to east. The average annual rainfall varies from >120in/yr to 40in/yr (Jimerson et al. 1996; Atzet et al. 1996) and mean monthly temperatures can be as low as 30°F at upper elevation inland locations in the winter to 72°F in the summer (Jimerson et al. 1996).

To address some of this variability, LANDFIRE has split the Mediterranean California Mixed-Evergreen BpS into a Coastal type and an Interior type, acknowledging that even these two variants encompass a broad range of climate and site potentials. Atzet et al. (1996) and Jimerson et al. (2006) recognized a similar distinction in their plant association guides for southwest Oregon and northwest California. Atzet et al. distinguished a group of drier, cooler, inland tanoak associations from the wetter, warmer coastal tanoak associations. Jimerson et al. recognized a warmer, drier Douglas-fir sub-series and a cooler, wetter tanoak sub-series.

The Coastal/Interior split is used to represent differences in species composition, successional rates, and fire regimes, primarily due to fire and climatic (precipitation and frost) limitations on tanoak survival and competitive edge. The Coastal type occupies an area with more maritime influence generally found west of the Coast Range crest or in inland coves on northerly aspects (typically <2,000feet in elevation in southwest Oregon [Atzet et al. 1996]). The Interior type is generally found east of the Coast Range crest and at higher elevations, where the maritime influence diminishes and sites are relatively drier.

Geographic Range

This BpS occurs in southwest Oregon and northwest California generally west of the Coast Range crest. The distribution of the BpS is influenced by the maritime climate, but it does not exist on the coast itself. In California, it occurs inland from the redwood type throughout the outer and middle Coast Ranges; in Oregon, it occurs inland of the Sitka spruce type.

Biophysical Site Description

This BpS occurs near the coast, where the marine influence limits severe frosts and reduces summer evapotranspirational demand (Atzet et al. 1996). Annual temperatures range from 45-53°F (average, 49°F), annual precipitation ranges from 60-120in (average, 95in [Jimerson et al. 1996]), soil types are sedimentary (often sandstone), generally 37-52in deep (although more shallow on the Dothan sandstones), and elevation ranges from 1,000-3,500ft (typically <2,000ft in elevation in southwest Oregon [Atzet et al. 1996]). It is found on all aspects and generally at mid- and lower slope positions (Atzet et al. 1996).

Vegetation Description

This type is characterized by the combination of coniferous and broadleaf evergreen trees. Characteristic trees include *Pseudotsuga menziesii*, *Quercus chrysolepis*, *Lithocarpus densiflorus*, *Arbutus menziesii*, *Umbellularia californica*, *Chrysolepis chrysophylla*, and *Tsuga heterophylla*. Species composition is determined primarily by the environmental gradients of temperature and moisture availability. On wetter sites, western hemlock tends to be a co-climax species with tanoak, whereas on drier sites, Douglas-fir is a co-climax species with tanoak. In northwest California and southwest Oregon, *Chamaecyparis lawsoniana* (Port Orford Cedar) is a common riparian conifer associate, especially in the western third of the Coast Range crest. Evergreen huckleberry and western swordfern are usually present. Other associates are Pacific rhododendron, salal, and dwarf Oregongrape.

Southwest Oregon Plant Associations (Atzet et al. 1996) included in this type are:

SWOPAG	Plant Association	PAG Name
1502	LIDE3-ACMA3-QUCH2/POMU	Tanoak-Bigleaf Maple-Canyon Live Oak/Western Swordfern
1503	LIDE3-CHLA/GASH	Tanoak/Salal
1503	LIDE3-PSME/GASH-BENE2	Tanoak/Salal
1504	LIDE3-PSME/GASH-RHMA3	Tanoak/Evergreen Huckleberry
1504	LIDE3-PSME/GASH-VAOV2	Tanoak/Evergreen Huckleberry
1504	LIDE3-TSHE/VAOV2-RHDI6	Tanoak/Evergreen Huckleberry
1504	LIDE3-TSHE/VAOV2/POMU	Tanoak/Evergreen Huckleberry
1504	LIDE3-TSHE/VAOV2/POMU-RIP	Tanoak/Evergreen Huckleberry
1504	LIDE3/VAOV2-RHMA3-GASH	Tanoak/Evergreen Huckleberry
1521	LIDE3-PIMO3/QUVA/XETE	Tanoak-Ultramafic
1701	PIMO3-LIDE3/QUVA/XETE	Western White Pine - SWO

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
LIDE3	<i>Lithocarpus densiflorus</i>	Tanoak
PSME	<i>Pseudotsuga menziesii</i>	Douglas-fir
TSHE	<i>Tsuga heterophylla</i>	Western hemlock
CHLA	<i>Chamaecyparis lawsoniana</i>	Port Orford Cedar
VAOV2	<i>Vaccinium ovatum</i>	Evergreen huckleberry
GASH	<i>Gaultheria shallon</i>	Salal
MANE2	<i>Mahonia nervosa</i>	Dwarf Oregongrape
RHMA3	<i>Rhododendron macrophyllum</i>	Pacific rhododendron

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

Disturbance Description

Fire is the dominant disturbance event, but other disturbances include flooding, windthrow, ice storms, and insects and disease (Jimerson et al. 1996). Hardwoods typically provide the greatest cover after fire due to root-crown sprouting. Depending on fire severity, many hardwoods may have epicormic sprouting well into the crown. Species composition, density, and inter-species competition within stands contribute to multiple pathways following disturbances. In stands with high tanoak cover, tanoak may dominate the stand for many years before conifers can re-establish. Typically, it may take 15yrs or longer before Douglas-fir can establish and emerge through the hardwood canopy.

Within the mixed-evergreen forest, fire frequency and severity were highly variable, with more coastal forests generally burning less frequently than interior sites (Fryer 2008; Atzet and Wheeler 1982). Lightning ignitions were probably limited in this BpS; Native American burning was likely an important ignition source (Fryer 2008). Mixed- and high-severity fires have been common, creating patches of varying age and species composition. Jimerson et al. (1996) describe coastal tanoak plant associations in northwest California as having a fire regime characterized by infrequent, high-severity fire events that tend to occur during extended drought. They note that fires that occurred in non-drought years tended to be smaller (<10ac) and low intensity.

Fire histories specific to coastal mixed-evergreen forests are limited, but suggest mean fire return intervals (FRIs) ranging from 7-40yrs:

- In their summary of pre-settlement fire regimes for California, Van de Water and Safford (2011) report a mean FRI of 29yrs, a mean minimum FRI of 15yrs, and a mean maximum FRI of 80yrs for mixed-evergreen forests based on review of 21 studies (they did not distinguish Coastal vs. Interior mixed evergreen).
- Local ecology plot data (southwest Oregon USDA Forest Service) show 250-yr average stand age, suggesting a mean stand-replacement FRI of 250yrs. Mixed-severity fire ranges from 15-40yrs. Surface fire may be locally common (due to aspect, topography, etc.), but is generally uncommon due to moist weather (humidity, fog) conditions that allow fuel buildup, resulting in mixed-severity fire. Mixed-severity fire maintained tanoak as a principal canopy intermediate. Stand-replacement fire often results in rapid

resprouting, and tanoak dominated sites for a decade or longer. Mixed-severity fire results in all-size conifer mortality in higher intensity portions of fires.

- White et al. (1997) reported highly variable fire frequency in tanoak series plots in the Siskiyou National Forest and the Klamath Province portion of the Rogue River National Forest. They reported mean FRIs of 7yrs for the LIDE3/VAOV2-RHMA3-GASH, 14yrs for the LIDE3-TSHE/VAOV2/POMU, and 23yrs for LIDE3-CHLA/GASH plant associations. The occurrence of disturbance events in this study was inferred from the presence of pioneer species on a plot rather than by fire scar analysis.

In the Klamath-Siskiyou mountains, White et al. (2003) found that fires are burning more area and have larger patches of high-severity fire today than they had historically, but Miller et al. (2012) found no significant trend in fire severity in national forests in northwest California.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	217	18		
Moderate (Mixed)	59	66		
Low (Surface)	247	16		
All Fires	39	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

Pre-settlement fires were of long duration (months) and from 100-10,000ac (fifth field watershed size analysis area [Agee 1993]).

Adjacency or Identification Concerns

Currently, sudden oak death (SOD; *Phytophthora ramorum*) has become established in the southern portions of the range of the type and is spreading northward. SOD is often lethal to tanoak, but may affect black oak and some shrub species. Also, activities that result in reduced site potential (high grading and/or salvage with plantation planting) can result in establishment of persistent chaparral.

To the west, this BpS is adjacent to California Coastal Redwood Forest and North Pacific Hypermaritime Sitka Spruce Forest. It forms a mosaic with North Pacific Maritime Mesic-Wet Douglas-fir-Western Hemlock forest to the north and is adjacent to Mediterranean California Mixed-Evergreen Forest -- Interior BpS and mixed-conifer BpSs to the east.

Issues or Problems

There was little fire history information available to support the development of this state-and-transition model. Available information suggested considerable variability in the fire frequency and severity in this system across space and time, which probably contributed to a wider range of variation than suggested by the mean succession class percentages reported here.

Native Uncharacteristic Conditions

Due to resprouting hardwoods, the canopy closes quickly (or nearly so) after fires. For this reason, any sizeable trees >5m that are in <40% canopy closure would not have been a persistent condition on the landscape. Mid-open and mid-closed stands get to be 25m tall, but eventually the conifers overtop them (in the late-closed stands).

Comments

Several assumptions were made when creating the Mediterranean California Mixed-Evergreen Forest -- Coastal and Interior models.

1. The state-and-transition models for these types incorporate the “precocious development model” presented by Donato et al. (2012) by specifying that the dominant development pathway is open and that stands reach, relatively quickly, the competitive exclusion and overstory development phases. The inclusion of more frequent high-severity, fire-maintaining early stands and the alternative closed development pathways are used to incorporate the ideas of Odion et al. (2010), which suggest that feedback loops promote self-maintaining, pyrogenic shrubby conditions and less-pyrogenic, closed-canopy conifer-dominated systems.
2. We assumed that closed stands would grow more slowly than open stands for both BpSs, and that overall growth rates would be faster near the coast than at more interior locations.
 - a. For Interior, we developed growth rates based on data from the Sensenig et al. (2013) Mid-Coast sites using the old-growth rate for Open Succession Classes and the young rate for Closed Succession Classes (see figure 4, Sensenig et al. 2013).
 - b. For Coastal, we developed growth rates from Forest Vegetation Simulator (FVS) results and stand exam data from several stands in a coastal Douglas-fir/tanoak co-climax association provided by Steve Boyer (Gold Beach Ranger District Silviculturist). The transition from early to mid-development was set at 30yrs based on an FVS run that showed that, after a clearcut (stand-replacement event), it took about 30yrs to reach 9in in quadratic mean diameter (QMD), the minimum DBH for mid-development stands in the model. Stand exam data from five thinned stands showed that, by about 67yrs of age, the QMD was 22.2in, which we translated into a transition from mid to late open at 70yrs in the model. Stand exam data from three un-thinned stands showed that, by about 66yrs of age, the QMD was 15.0in. Growth rates for these stands estimated from FVS showed that it would take another 30-40yrs to grow another 5.4in to reach about 21in QMD, the minimum DBH for late-development closed stands in the model, suggesting a transition from mid to late closed between 96yrs and 106yrs. Given that this site was very productive, we estimated the transition from mid to late closed at 120yrs in the model to account for a broader range of site productivity found across the range of the BpS.
3. We assumed that fires would burn more frequently in Interior sites than in Coastal sites because they are drier and more prone to natural lightening ignitions (Rorig and Furguson 1999 provide data showing lightning caused fires in the northwest from 1986-1993). We further assumed that Interior fire regimes would be characterized predominantly by low mixed-severity fire whereas coastal sites, which are typically wetter and have greater biomass, would experience less frequent but higher severity fire events.

4. We assumed that insects/disease in Interior and wind events in Coastal could open stands periodically, but we have no information to support the probabilities used for these transitions in the model.
5. To set the threshold for the canopy cover break that would represent Open versus Closed classes, we tried to identify a canopy cover level at which early-seral species could no longer regenerate successfully. For the Mediterranean California Mixed-Conifer BpSs in southern Oregon and northern California, a 40% break was used based on the work of Bigelow et al. (2011), which demonstrated that thinning forest to 40% canopy cover was sufficient to perpetuate the growth and development of early-seral species in Sierra Nevada mixed-conifer forests. Observations from the Gold Beach Ranger District, Rogue River-Siskiyou National Forest on Mixed-Evergreen – Coastal BpS sites suggested that Douglas-fir will regenerate in stands that were thinned to between 40% and 60% canopy cover, but that the fir growth stagnated in stands thinned only to 60% (Stephen Boyer and Matthew Timchak, pers. comm.). This suggested that the Open/Closed Class break should probably be less than 60%. We chose 40% for consistency with the mixed-conifer BpSs.

During the 2016 review, reviewers (Darren Borgias, Clint Emerson, Lyndia Hammer, Patricia Hochhalter, Kerry Metlen, and Jena Volpe) decided to split the Mediterranean Mixed-Evergreen BpS into an Interior type and a Coastal type. The Coastal type was initiated from the Rapid Assessment PNVG model R#TAOAcO-Oregon Coastal Tanoak, with contributions from Diane White, Edward Reilly, Charley Martin, Jim Merzenich, and Tom Atzet, but substantial changes were made to the state-and-transition model by Kori Blankenship. This model and description were informed by conversations with Stephen Boyer, Joe Fontaine, Clint Isbel, Bill Kuhn, and Matthew Timchak.

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	C	C	C	C	B	B	B	B	B	B
Tree	10-25	C	C	C	C	B	B	B	B	B	B
Tree	25-50	D	D	D	D	E	E	E	E	E	E
Tree	>50	D	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

Description

Indicator Species

Description

Maximum Tree Size Class

Indicator Species

Description

Maximum Tree Size Class

Class C	15	Mid Development 1 - Open
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSME	Pseudotsuga menziesii	Douglas-fir	Upper
LIDE3	Lithocarpus densiflorus	Tanoak	Mid-Upper
VAOV2	Vaccinium ovatum	Evergreen huckleberry	Lower
GASH	Gaultheria shallon	Salal	Lower

Description

Open conditions maintained by mixed-severity fire. Douglas-fir gradually assumes dominance as age increases. Patches of dominant tanoak are present and can eventually form a dense sub-canopy below the firs. Other hardwoods include California laurel (UMCA), Pacific madrone (ARME), and chinquapin (CACH6).

Maximum Tree Size Class

Medium 9-21" DBH

Class D	30	Late Development 1 - Open
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSME	Pseudotsuga menziesii	Douglas-fir	Upper
TSHE	Tsuga heterophylla	Western hemlock	Upper
LIDE3	Lithocarpus densiflorus	Tanoak	Middle
VAOV2	Vaccinium ovatum	Evergreen huckleberry	Lower

Description

Open conditions maintained by mixed-severity fire. Douglas-fir is dominant. Hardwoods often reach tree form. Patches of dominant tanoak are present and can form a dense sub-canopy below the firs. Other hardwoods include California laurel (UMCA), Pacific madrone (ARME), and chinquapin (CACH6).

Maximum Tree Size Class

Very Large >33" DBH

Class E	27	Late Development 1 - Closed
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Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSME	Pseudotsuga menziesii	Douglas-fir	Upper
TSHE	Tsuga heterophylla	Western hemlock	Upper
LIDE3	Lithocarpus densiflorus	Tanoak	Middle
GASH	Gaultheria shallon	Salal	Lower

Description

With less-frequent fire or lower intensity fire, closed conditions occur. Douglas-fir is dominant. Hardwoods often reach tree form.

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	29
Mid1:OPN	30	Late1:OPN	69
Mid1:CLS	30	Late1:CLS	119
Late1:OPN	70	Late1:OPN	999
Late1:CLS	120	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	29
Surface Fire	Early1:ALL	Early1:ALL	0.004	250	No	0
Replacement Fire	Early1:ALL	Early1:ALL	0.009	111	Yes	0
Mixed Fire	Early1:ALL	Early1:ALL	0.0167	60	No	0
Alternative Succession	Mid1:OPN	Mid1:CLS	1	1	Yes	39
Surface Fire	Mid1:OPN	Mid1:OPN	0.004	250	No	0
Replacement Fire	Mid1:OPN	Early1:ALL	0.004	250	Yes	0
Mixed Fire	Mid1:OPN	Mid1:OPN	0.0167	60	No	0
Surface Fire	Mid1:CLS	Mid1:CLS	0.004	250	No	0
Replacement Fire	Mid1:CLS	Early1:ALL	0.004	250	Yes	0
Wind or Weather or Stress	Mid1:CLS	Mid1:OPN	0.005	200	Yes	0
Mixed Fire	Mid1:CLS	Mid1:OPN	0.0167	60	Yes	0
Alternative Succession	Late1:OPN	Late1:CLS	1	1	Yes	39
Surface Fire	Late1:OPN	Late1:OPN	0.004	250	No	0
Replacement Fire	Late1:OPN	Early1:ALL	0.004	250	Yes	0
Mixed Fire	Late1:OPN	Late1:OPN	0.0167	60	No	0
Surface Fire	Late1:CLS	Late1:CLS	0.004	250	No	0
Replacement Fire	Late1:CLS	Early1:ALL	0.004	250	Yes	0
Wind or Weather or Stress	Late1:CLS	Late1:OPN	0.005	200	Yes	0

Mixed Fire	Late1:CLS	Late1:OPN	0.0167	60	Yes	0
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