10430
Mediterranean California Mixed-Evergreen Forest

BpS Model/Description Version: Aug. 2020

Modelers		Reviewers	
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None	None	None	None
None	None	None	None

Vegetation Type
Forest and Woodland

Map Zone
5

Geographic Range
This type occurs along the California Coast Ranges from Napa, Sonoma, and Marin counties south to the Santa Cruz Mountains.

Biophysical Site Description
This Biophysical Setting (BpS) occurs on all aspects (moving to the northern aspects in the inner Coast Ranges) at elevations predominately along the 300- to 1,050-m elevational belt, possibly up to 1,220m. The distribution of the BpS is influenced by the maritime climate, but does not exist on the coast itself. It occurs above and inland from the redwood type throughout the outer and middle Coast Ranges on Franciscan formation soils (metasedimentary sandstones, schists, and shales) with moderate to high rainfall.

Vegetation Description
This type is characterized primarily by the absence of *Sequoia sempervirens* and secondarily by the combination of coniferous and broadleaf trees (two tiered in older stands). Characteristic trees include *Pseudotsuga menziesii* var. *menziesii*, *Quercus chrysolepis*, *Q. wislizenii*, *Lithocarpus densiflorus*, *Arbutus menziesii*, *Umbellularia californica*, *Chrysolepis chrysophylla*, and *Aesculus californica*. Species composition is primarily determined by the environmental gradients of temperature and moisture availability, and secondarily by disturbance history, which can lead to stands dominated solely by one or two of the aforementioned species, with *Umbellularia californica*, *Lithocarpus densiflorus*, or *Pseudotsuga menziesii* var. *menziesii* being the most common sole dominants. Black oak (*Quercus kelloggii*) is found on drier sites on the inland portion of the range. Both *Pseudotsuga menziesii* var. *menziesii* and *Lithocarpus densiflorus* become progressively more restricted to moister sites as you move southward and inland (e.g., both are absent from the East San Francisco Bay Hills). In these map zones, ponderosa pine can only be found in open forests adjacent to this type on approximately 2,800ha of sandy soil derived from Miocene marine sand deposits in central Santa Cruz County, California. Understory tree species include *Acer macrophyllum*. These stands can have dense or diverse shrub understories or openings with *Corylus cornuta* var. *californica*, *Vaccinium ovatum* (cover increases over time without burning, perhaps delaying succession), *Ceanothus thyrsiflorus*, *Dryopteris arguta*, *Heteromeles arbutifolia*, *Holodiscus discolor*, *Polypodium*

californicum, *Pteridium aquilinum*, *Polystichum munitum* (favored by frequent, light burning), *Symphoricarpos mollis*, and *Toxicodendron diversilobum* are common. Occasionally, shade is so intense beneath the forest canopy that completely bare ground is common where drought is an added stressor. But, as 102cm in precipitation is approached, *Polystichum munitum* can dominates the understory.

BpS Dominant and Indicator Species

Symbol	Scientific Name	Common Name
PSMEM	*Pseudotsuga menziesii var. menziesii*	Douglas-fir
LIDE3	*Lithocarpus densiflorus*	Tanoak
ARME	*Arbutus menziesii*	Pacific madrone
UMCA	*Umbellularia californica*	California laurel
PILA	*Pinus lambertiana*	Sugar pine
POMU	*Polystichum munitum*	Western swordfern

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

Disturbance Description

Extensive timber harvest has resulted in landscapes with only fragmented patches of late-seral or old-growth forests; in more extreme cases, only fragments of mid-seral forest remain. Thus, a good deal of the remainder of this forest consists of second-growth mixed-evergreen forest following Douglas-fir and tanoak logging. Some of this second-growth is in “dog-hair thickets.” Dog-hair reproduction is slow to mature because of excessive competition or available light, water, and nutrients. Logging allows more light to reach the forest floor, supporting the growth of shorter, hardwood species.

Prior to European settlement, fire was the dominant disturbance event. The vast majority of fires occurred in late summer or early fall and are possibly associated with lightning storms. However, throughout this geographic area, Native American populations were relatively large and their low-severity fire regime is thought to have modified the fire regime extensively (e.g., locally increased the frequency, especially along lower elevational areas), increasing in use around 3,000yrs ago and decreasing after Spanish settlement. Lightning fire activity typically ignited “sleeper” mixed-severity fires. Mixed-severity fires have been common (about every 60yrs), creating patches of varying age and species composition. Hardwoods typically provide the greatest cover after fire due to root-crown sprouting. Depending upon fire severity, many hardwoods may have epicormic sprouting well into the crown. Species composition, density, and inter-specific competition within stands contribute to multiple pathways following disturbance. In stands with high tanoak cover, tanoak may dominate the stand for many years before Douglas-fir can re-establish. Typically, it may take 15yrs or longer before Douglas-fir can establish and emerge through the hardwood canopy. Low-severity fires (2-12yrs) favor dominance of large, old conifers. Moderate-severity fires favor development of multi-age stands of mixed species composition. High-severity fires (200-400yrs), driven by weather, climate, and stand condition, favor development of hardwood-dominated stands. Frequent low-severity fires following a high-severity fire maintain a hardwood-dominated stand.

Other disturbance events include windstorms, slope failure, disease, herbivory, and ice storms. Mass wasting, predominately as debris flow on steep terrain, and slide-and-flow processes on moderately steep slopes lead to a high frequency of slope failure. Wind storms and slope failure are responsible for the majority of gaps in this system, with some 20% of the land area falling within canopy gaps. Although the majority of gaps in one study were <$50m^2$, the average gap size was approximately $140m^2$. Gaps formed by Douglas-fir are typically twice as large as those formed by the associated hardwood species, as are gaps on north-facing slopes when compared to those formed on south-facing slopes. Multiple disturbances are frequent in this system, making synergism between disturbance types important; approximately half the gaps in this system are created by two or more disturbance events. Fire may weaken trees, which are knocked down by an ice storm, or windthrow may damage other canopy individuals or expose adjacent individuals to stronger winds.

Fire Frequency

Severity	Avg FI	Percent of All Fires	Min FI	Max FI
Replacement	315	3	65	500
Moderate (Mixed)	66	14		
Low (Surface)	11	83	7	15
All Fires	9	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

Fires of mixed severity often are large in area due to the high number of ignition points associated with fire events. These fires included low-, moderate-, and high-severity patches, and spanned this type and adjacent types. Due to environmental and cultural-influenced changes in the disturbance regime, low-severity fires have been most restricted and thus most lacking from the system. Patch size and severity patterns can be strongly influenced by topography and species composition.

Adjacency or Identification Concerns

Surrounding types include the mixed-conifer types (upslope and/or east), chaparral (drier, rockier slopes), coastal scrub, oak woodlands/grasslands (drier, interior slopes with fine-texture soils), or redwoods (moister slopes and canyon bottoms). Species composition and stand structure change dramatically with topography, age, and disturbance history. In central California, the term "mixed-evergreen forest" as used currently is somewhat anomalous, because it often designates forests dominated solely by *Umbellularia californica* (California bay). Such bay-dominated forests are frequent around the San Francisco Bay area, where annual rainfall is between 51cm and 102cm. At the dry end of that precipitation range, bay forests are entirely confined to very shady north slopes and canyons, but they also occur on somewhat sunnier slopes as 102cm is approached. Any increase in the average precipitation and the bay is replaced by redwood forests.

Tanoak stands develop differently -- from seeds rather than sprouts. Reproduction from seed occurs mainly in the understory of mixed-hardwood and conifer stands, where a few seedlings become established each year and stocking increases slowly over time. Plants remain small for years and are susceptible to dieback, damage, and death. Without disturbance, stand development may take decades. The resulting stands are of uneven age and have variable vertical structure. If regeneration is from sprouts, growth is more dynamic. In clearcuts or burns, tanoak often form nearly pure, dense, even-age stands. With time, these thin somewhat, but remain quite dense. In most areas, propagation of tanoak is from root-crown sprouts, although occasional seedlings and seedling-sprouts eventually become trees. Currently, sudden oak disease (SOD; *Phytophthora* *ramorum*) has become established in this type and is spreading northward. SOD is often lethal to tanoak, but may affect black oak and some shrub species. Also, combinations of management activities (or other disturbances) that seriously affect site potential (tractor logging and/or salvage with plantation planting) can result in establishment of persistent chaparral.

Issues or Problems

The episodic nature of disturbance in this system indicates that disturbances are not randomly distributed with respect to prior disturbances, nor are disturbances evenly rotating throughout a forest. The mechanisms of the various disturbance types may all create intervals of repeated disturbance rather than single disturbance events. For example, slope failures destabilize adjacent areas; fires damage trees mechanically, leaving them at risk to disease, herbivory, or windthrow; wind-thrown trees may damage their neighbors while falling, leaving the neighbors exposed to stronger winds. There is both a direct and an indirect relationship between topography and the disturbance regime in this system, leading to differences in species composition, which in turn further influence the disturbance regime.

Due to environmentally and culturally influenced changes in the disturbance regime, mixed-evergreen forests may invade and replace many surrounding communities (e.g., mesic chaparral, coastal scrub, and oak woodland), especially if soil depth and humus layer development are sufficient to support trees. In addition, some shrubs found in these adjacent communities serve as nurse plants to some of the characteristic trees of this system. Therefore, one could consider each of these communities as early-seral stages for this community. Due to historical changes in the disturbance regime, this system has increased its invasion of surrounding communities and increased density of understory, potentially fueling fires of higher intensity than those occurring prior to European settlement. Due to a disparity in life span (e.g., Douglas-fir commonly live >500yrs and occasionally >1,000 yrs, and tanoak typically live 300-400yrs), a considerable range exists in the potential canopy residency time of the individual trees.

SOD will likely remain a factor in community succession. Because of the range of susceptibility of co-existing plant species (e.g., bay and tanoak), SOD-mediated competition may influence future successional patterns in these forests. Succession in the absence of fire leads to greater abundance of host species, which provide increased habitat for *P. ramorum*. This will also increase intraspecific competition where these trees are abundant, and other density-dependent effects (e.g., shading) can reduce resource allocation to plant defenses.

In prehistoric times, much of this system would have supported a range of age classes of forest, dominated by late-seral, old growth. These late-seral stands were established under a climate regime different from today's climate. For instance, atmospheric carbon levels are far greater than in prehistory. Various research also suggests that the average rainy season has compressed from an early fall-through-late spring cycle to a predominantly winter precipitation cycle. In addition to macroclimate differences, microclimate variations associated with fog collection and other self-perpetuating moisture cycling functions unique to old-growth forest would likely have been present in prehistoric times. These processes cannot be re-established.

If future climate change manifests as increases in both temperature and moisture expansion, mixed-evergreen forests will continue to establish themselves at the expense of shrubland, grassland, and, to a lesser extent, oak woodland. The expansion of forests will possibly be most notable inland along the coast. The distributions of mixed-evergreen forest and conifer forest will likely remain relatively static under drier scenarios.

Native Uncharacteristic Conditions

Due to the resprouting hardwoods, the canopy closes quickly (or nearly so) after fires. For this reason, any sizeable trees >5m in <40% canopy closure is considered an uncharacteristic condition. Mid-open and mid-closed stands get to be 25m tall, but eventually the conifers overtop them (in the late-closed stands). When this is the case, it may not be appropriate to call it a mixed-evergreen type.

Comments

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	UN	UN	UN	UN	B	B	B	B	B	B
Tree	25-50	UN	UN	UN	UN	C	C	C	C	C	C
Tree	>50	UN	UN	UN	UN	C	C	C	C	C	C

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 8 Early Development 1 - All Structures

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
LIDE3	Lithocarpus densiflorus	Tanoak	Upper
ARME	Arbutus menziesii	Pacific madrone	Upper
UMCA	Umbellularia californica	California laurel	Upper
PSMEM	Pseudotsuga menziesii var. menziesii	Douglas-fir	Low-Mid

Description
Early succession following creation of localized canopy gaps from fire or falling trees. Regenerating species include Douglas fir and hardwood species such as tanoak, bigleaf maple, hazelnut, huckleberry, and Western swordfern. Trees are seedlings or recent sprouts. Note that, during this stage, tanoak can occasionally form pure stands, but more commonly, they grow with other conifers and hardwoods.

Maximum Tree Size Class
None

Class B 28 Mid Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
LIDE3	Lithocarpus densiflorus	Tanoak	Mid-Upper
PSMEM	Pseudotsuga menziesii var. menziesii	Douglas-fir	Upper
UMCA	Umbellularia californica	California laurel	Mid-Upper
POMU	Polystichum munitum	Western swordfern	Mid-Upper

Description
DBH range, 25-51cm. This class represents a combination of two states that were combined to meet the LANDFIRE modeling rules. One potential state is composed of dense hardwood cover (60-100%) with emergent conifers. The other state has a hardwood-dominated canopy (51-60% cover) potentially including mature stands of well-developed hardwoods (i.e., tanoak, interior live oak, and black oak). Conifer can present at very low densities.

Maximum Tree Size Class
Medium 9-21" DBH

Class C 64 Late Development 1 - Closed

Indicator Species

Symbol	Scientific Name	Common Name	Canopy Position
PSMEM	Pseudotsuga menziesii var. menziesii	Douglas-fir	Upper
LIDE3	Lithocarpus densiflorus	Tanoak	Middle
ARME	Arbutus menziesii	Pacific madrone	Middle
UMCA	Umbellularia californica	California laurel	Middle

Description
Late to old-growth forests. Tree DBH, generally >76cm for larger species. Conifers have a height difference from Class B.

This class can maintain in a late closed condition. During this stage, these stands consist of primarily two differing structures. One is an open Douglas-fir canopy over a more continuous lower stratum of tanoak, Pacific madrone, and other hardwoods. The other is essentially an uneven-age Douglas-fir and tanoak forest, with both species -- and perhaps other hardwoods -- reproducing in various-size gaps at different times and forming an irregular canopy of varying age and species composition.

<u>*Maximum Tree Size Class*</u>
Very Large >33" DBH

Model Parameters

Deterministic Transitions

From Class	Begins at (yr)	Succeeds to	After (years)
Early1:ALL	0	Mid1:CLS	29
Mid1:CLS	30	Late1:CLS	49
Late1:CLS	50	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
Replacement Fire	Early1:ALL	Early1:ALL	0.005	200	Yes	0
Replacement Fire	Mid1:CLS	Early1:ALL	0.003	333	Yes	0
Insects or Disease	Mid1:CLS	Mid1:CLS	0.005	200	No	0
Mixed Fire	Mid1:CLS	Mid1:CLS	0.0167	60	No	0
Surface Fire	Mid1:CLS	Mid1:CLS	0.1	10	No	0
Insects or Disease	Late1:CLS	Mid1:CLS	0.0025	400	Yes	0
Insects or Disease	Late1:CLS	Late1:CLS	0.0025	400	No	0
Replacement Fire	Late1:CLS	Early1:ALL	0.003	333	Yes	0
Mixed Fire	Late1:CLS	Mid1:CLS	0.0167	60	Yes	0
Surface Fire	Late1:CLS	Late1:CLS	0.1	10	No	0

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