10150

California Coastal Redwood Forest

BpS Model/Description Version: Aug. 2020

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Reviewer: Kori Blankenship

Vegetation Type

Forest and Woodland

Map Zones

2, 3, 4

Geographic Range

This type occurs in a narrow band along the coast from the Chetco River, Oregon, south to Monterey County, California, along the west side of the northern California Coast Range.

Biophysical Site Description

This type is restricted to elevations below 3,500ft. Redwood forests occur in an irregular, narrow strip, ranging in width from 8-56km (5-35mi) (Olson et al. 1990; Griffin and Critchfield 1972). Precipitation in this zone is typically more than 100cm/yr but can be more than 200cm in the northern end of the range (Sawyer et al. 2000). The tallest and largest trees are confined to moist, wind-protected canyons and lower slopes.

In the southern portion of the range, annual precipitation may be as little as 50cm, and the system is limited to coves and ravines. It is commonly found on moderately well-drained marine sediments (non-metamorphosed, siltstones, sandstones, etc.).

Vegetation Description

These are dense forests dominated by coast redwood. There are two types: an inland type that includes Douglas-fir and tanoak in dryer locations, and a wetter type in the fog zone that includes Sitka spruce and western hemlock.

Shade-tolerant understory species include *Rubus parviflorus*, *Oxalis oregana*, *Aralia californica*, *Mahonia nervosa* (= *Berberis nervosa*), *Gaultheria shallon*, and many ferns, such as *Blechnum spicant*, *Polypodium* spp.,and *Polystichum munitum*. The inland type approaches the coast in the Santa Cruz and Santa Lucia mountains where the rainfall is the lowest.

BpS Dominant and Indicator Species

|  |  |  |
| --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** |
| SESE3 | *Sequoia sempervirens* | Redwood |
| PSME | *Pseudotsuga menziesii* | Douglas-fir |
| TSHE | *Tsuga heterophylla* | Western hemlock |
| LIDE3 | *Lithocarpus densiflorus* | Tanoak |

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

Disturbance Description

Redwood forests typically burned in the summer and early fall in low- to moderate-intensity surface fires that consumed irregular patches of surface fuel and understory vegetation. The great height of the canopy and separation of surface and crown fuels resulted in a pattern in which fire rarely resulted in canopy tree mortality. Fire intervals ranged from <10yrs in interior and upland locations to 100yrs or more along the coast in the fog belt. Van de Water and Safford reported a mean fire return interval (FRI) of 23yrs (range, 10-170yrs). Native Americans were thought to have contributed to the ignitions (perhaps as much as every 5-8yrs) because lightning is relatively infrequent in the area -- especially in the fog belt.

Flooding events that undermine trees may have been a significant disturbance, but it was not modeled. Windstorms and landslides also affect this type (Lorimer et al. 2009).

Fire Frequency

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Severity** | **Avg FI** | **Percent of All Fires** | **Min FI** | **Max FI** |
| Replacement | 405 | 7 |  |  |
| Moderate (Mixed) |  |  |  |  |
| Low (Surface) | 32 | 93 |  |  |
| All Fires | 30 | 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 in the interior sub-type probably encompassed tens to thousands of acres, occurring mainly during droughts and with warm, dry east winds. Fires in the coastal fog sub-type were significantly smaller. However, in the Santa Lucia Mountains of Monterey County, the fires were large and infrequent, and essentially burned at the same frequency as adjacent upslope vegetation (mixed evergreen, mesic or dry-mesic chaparral, or southern coastal scrub).

Adjacency or Identification Concerns

Includes a variety of forest types that are dominated by coast redwood. Fire exclusion has changed the duff, fuel accumulation patterns, understory shrub cover, flammability of bark, and flammability of the fire scar cavities, which increases the level of canopy tree mortality that occurs in surface fires.

**Issues or Problems**

Coast redwood includes a wide variety of forest types dominated or co-dominated by coast redwood. It was suggested to split this type into separate models: (1) a coastal fog belt model with extremely long fire intervals and a rich variety of coastal species (Sitka spruce, western hemlock, and rhododendron) and (2) a more interior model with more frequent fire and more interior associated species (tanoak, Douglas-fir, madrone). For the current model, these two systems are combined but annotated distinctly. Stand structure is defined similarly for both types into a three-box model. The fire dynamics of the types, although distinct, both result in a landscape that is almost exclusively Class C.

Native Uncharacteristic Conditions

As a result of current management, there may be stands >10m that are open canopy (closure <30%). Likewise, taller stands (>25m) are uncharacteristic if the closure is less than about 60%.

Comments

During the 2017 model review, Kori Blankenship made minor descriptive edits, added several references, and consulted with Eamon Engber (interagency fire ecologist), and Clint Isbell (USFS fire ecologist) about the fire frequency of this type. Engber indicated that the coast redwoods likely burned more frequently than adjacent Douglas-fir/tanoak sites, with the exception of very wet coast redwood sites, which would have had much longer FRIs. The adjacent Douglas-fir/tanoak sites are covered by the Mediterranean California Mixed-Evergreen Forest -- Coastal BpS, which has a modeled FRI of 39yrs. Both ecologists agreed the FRI modeled here was reasonable, but it could be even more frequent in some parts of the redwood range. Previous review (described later) indicated that the modeled fire frequency for this type may have been too short. But, based on the relative frequency of fire in redwoods versus the adjacent mixed-evergreen BpS and the Van de Water and Safford estimate of fire frequency, Blankenship decided that the modeled fire frequency was within the bounds suggested by literature and expert opinion. Blankenship did increase the frequency of replacement fire in the Late Closed class to ensure that class A would occupy at least one percent of the landscape (the original model parameters resulted in class A occupying less than 1% of the landscape). There seems to be general agreement that certain redwood sites probably had a much less frequent FRI than indicated by this model. Future review should consider splitting these sites as suggested in the Issues and Problems section of this description.

A reviewer for map zone (MZ) 2 and MZ03 thought the FRI should have been longer for this type. For instance, the reviewer suggested that even the drier type has a longer interval than 20yrs, and the wet types are >1,000yrs, but the reviewer acknowledged these suggestions were a guess.

Additional LANDFIRE National model reviewers not listed earlier include Todd Keeler-Wolf, Hugh Safford, and Dave Schmidt.

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 | B | B | B | B | B | B | B | B | B | B |
| Tree | 25-50 | UN | UN | UN | UN | UN | UN | C | C | C | C |
| Tree | >50 | UN | UN | UN | UN | UN | UN | 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 1 Early Development 1 - All Structures

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| SESE3 | Sequoia sempervirens | Redwood | Upper |
| PSME | Pseudotsuga menziesii | Douglas-fir | Upper |
| VAOV2 | Vaccinium ovatum | California huckleberry | Lower |
| GASH | Gaultheria shallon | Salal | Lower |

Description

Early succession following creation of localized canopy gaps from fire or treefall. There is regeneration of coast redwood and other conifers, including various combinations of Douglas-fir, western hemlock, and Sitka spruce. Hardwoods include tanoak, bigleaf maple and hazelnut. Also occurring are huckleberry, salal, and swordfern shrubs. Trees are seedlings or recent sprouts.

*Maximum Tree Size Class*  
Sapling >4.5ft; <5" DBH

Class B 7 Mid Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| SESE3 | Sequoia sempervirens | Redwood | Upper |
| PSME | Pseudotsuga menziesii | Douglas-fir | Upper |
| GASH | Gaultheria shallon | Salal | Lower |
| VAOV2 | Vaccinium ovatum | California huckleberry | Lower |

Description

Small trees up to 3in in diameter include coast redwood, and other conifers including various combinations of Douglas-fir and hardwoods (including tanoak, bigleaf maple, and hazelnut) inland, and Sitka spruce and western hemlock on the coast. Shrubs in both include huckleberry, salal, and swordfern.

*Maximum Tree Size Class*  
Large 21-33" DBH

Class C 92 Late Development 1 - Closed

Indicator Species

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Scientific Name** | **Common Name** | **Canopy Position** |
| SESE3 | Sequoia sempervirens | Redwood | Upper |
| PSME | Pseudotsuga menziesii | Douglas-fir | Mid-Upper |
| VAOV2 | Vaccinium ovatum | California huckleberry | Lower |
| GASH | Gaultheria shallon | Salal | Lower |

Description

Dense forest dominated by coast redwood. Douglas-fir co-dominates in interior locations. Hardwoods including tanoak, bigleaf maple, and hazelnut inland; and spruce and hemlock on the coast. Shrubs include huckleberry, salal, and swordfern throughout. In the fog zone, salmonberry occasionally stays as the dominant understory, especially on river terraces. In the inland sub-type, the canopy can be relatively open.

A significant distinction between the dry and wet types is the frequency of surface fires. In the fog zone, surface fires may only occur every 100yrs on average, but inland they can occur every 20yrs or more frequently.

*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:CLS | 4 |
| Mid1:CLS | 5 | 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 | 0.05 | 20 | Yes | 0 |
| Replacement Fire | Mid1:CLS | Early1:ALL | 0.01 | 100 | Yes | 0 |
| Surface Fire | Mid1:CLS | Mid1:CLS | 0.05 | 20 | No | 0 |
| Replacement Fire | Late1:CLS | Early1:ALL | 0.0014 | 714 | Yes | 0 |
| Surface Fire | Late1:CLS | Late1:CLS | 0.03 | 33 | No | 0 |

References

Borchert, M., D. Segotta and M.D. Purser. 1988. Coast redwood ecological types of southern Monterey County, California. General Technical Report PSW-107. Berkeley, CA: USDA Forest Service Pacific Southwest Research Station.

Brown, J.K. and J.K. Smith, eds. 2000. Wildland fire in ecosystems. Effects of fire on flora. Gen. Tech. Rep. RMRS GTR 42 vol. 2. USDA Forest Service. 257 pp.

Finney, M. A., and R. E. Martin. 1989. Fire history in a Sequoia sempervirens forest at Salt Point State Park, California. Canadian Journal of Forest Research 19: 1451-1457.

Greenlee, J.M. 1983. Vegetation, fire history and fire potential of Big Basin Redwoods State Park, California. PhD thesis. University of California, Santa Cruz.

Greenlee, J.M. and J.H. Langenheim. 1990. Historic fire regimes and their relation to vegetation patterns in the Monterey Bay Area of California. American Midland Naturalist 124:239-253.

Griffin, J.R and W.B. Critchfield. 1972. The distribution of forest trees in California. USDA Forest Service Research Paper PSW 82. 118 pp.

Lorimer, C.G., D.J. Porter, M.A. Madej, J.D. Stuart, S.D. Veirs Jr., S.P. Norman, K.L. O’Hara and W.J. Libby. 2009. Presettlement and modern disturbance regimes in coast redwood forests: implications for the conservation of old-growth stands. Forest Ecology and Management 258: 1038-1054.

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

Olson, D. F., D.F. Roy and G. A. Walters. 1990. Sequoia sempervirens (D. Don) Endl. 541-551. In: Barnes, R.M. and B H. Honkala, eds., Silvics of North America. Vol. 1, Conifers. Agriculture Handbook 654. Washington, DC: USDA Forest Service.

Sawyer, J.O., et al. 2000. Characteristics of redwood forests. In: Noss, R.F. (ed), The Redwood Forest: History, Ecology, and Conservation of the Coast Redwoods. Island Press, Washington, D.D., USA, pp.39-79.

Stephens, S.L. and D.L. Fry. 2005. Fire history in Coast Redwood Stands in the Northeastern Santa Cruz Mountains, California. Fire Ecology 1(1): 2-19.

Stuart, J. and S. Stephens. 2005. Fire in the North Coast Bioregion. Chapter 8. In: Sugihara, N.G., J.W. van Wagtendonk, J.Fites-Kaufman, K. E. Shaffer and A.E. Thode, eds. Fire in California ecosystems. Berkeley, CA: University of California Press.

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.