## Sierran Mixed Conifer (SMC)

### General Information

### Variants

Sierran Mixed Conifer Mesic (SMCM)

Sierran Mixed Conifer Xeric (SMCX)

Sierran Mixed Conifer with Aspen (SMC-ASP)

### Crosswalks

SMC:

* Existing Vegetation Regional Dominance Type 1: Mixed Conifer – Fir OR Mixed Conifer – Pine
* Existing Vegetation Regional Dominance Type 2: Any

SMCM:

* Presettlement Fire Regime Type: Moist Mixed Conifer
* BpS Model: 0610280 Mediterranean California Mesic Mixed Conifer Forest and Woodland
* Additional biophysical settings TBD.

SMCX:

* Presettlement Fire Regime Type: Dry Mixed Conifer
* BpS Model: 0610270 Mediterranean California Dry-Mesic Mixed Conifer Forest and Woodland
* Additional biophysical settings TBD.

SMC-ASP:

* This type is created by overlaying the NRIS TERRA Inventory of Aspen on top of the EVeg layer. Where it intersects with either SMCM or SMCX it is assigned to SMCM-ASP.

### Vegetation Description

**Sierran Mixed Conifer (SMC)** The Sierran mixed conifer (SMC) landcover type includes an assemblage of conifer and hardwood species that forms a multilayered forest. Historically, burning and logging have caused wide variability in stand structure, resulting in both even-aged and uneven-aged stands. Old-growth stands where fire has been excluded are often two-storied, with the overstory comprised of mixed conifer and the understory dominated by *Abies concolor* and *Calocedrus decurrens*. Forested stands form closed, multilayered canopies with nearly 100 percent overlapping cover. When openings occur, shrubs are common in the understory. Closed canopy stand distribution is both extensive and patchy depending on scale, site, slope, soils, microclimate, and history. (WHR)

Five conifers and one hardwood typify the SMC forest: *Abies concolor*, *Pseudotsuga menziesii*, *Pinus ponderosa*, *Pinus lambertiana*, *Calocedrus decurrens*, and *Quercus kelloggii*. *Lithocarpus densiflora* and *Acer macrophyllum* are occasional associates. *Abies concolor* tends to be the most ubiquitous species (though most often a minor overstory component) because it tolerates shade and has the ability to survive long periods of suppression in brush fields. *Pseudotsuga menziesii* dominates the species mix in the north. *Pinus ponderosa* dominates at lower elevations and on south slopes. *Pinus jeffreyi* commonly replaces *Pinus ponderosa* at high elevations, on cold sites, or on ultramafic soils. *Abies magnifica* is a minor associate at the highest elevations. *Pinus lambertiana* is found throughout the SMC type. *Quercus kelloggii* is a minor, but widespread, component in SMC stands. Though it does best on open sites, it is maintained under adverse conditions such as shade, ridge tops, and south slopes where conifers may regenerate in its shade. (WHR) In some locations, *Populus tremuloides* is also a component of the stand and, when present, typically dominates during the early seral stages following disturbance.

*Ceanothus integerrimus*, *Arctostaphylos* spp., *Chrysolepis* spp., *Lithocarpus densiflora*, *Prunus emarginata*, *Ceanothus prostratus*, *Ceanothus cordulatus*, *Ribes* spp., *Rosa* spp., and *Chamaebatia foliolosa* are common shrub species in the SMC understory. Grasses and forbs associated with this type include *Bromus carinatus* var. *marginatus*, *Carex* spp., *Cirsium vulgare*, *Iris* spp., *Juncus* spp., and *Achnatherum* spp. In all, over 100 species of grasses, forbs and shrubs contribute to the flora of SMC. (WHR)

**Mesic/Fir/Productive Modifer** This variant is the higher elevation and often more moisture-deficient counterpart of the Sierran Mixed Conifer Xeric landcover type. Three major species define this mixed conifer type: *Abies concolor*, *Pinus jeffreyi*, and/or *P. contorta* ssp. *murrayana*. At lower elevations the Mixed Conifer Pine Alliance associates such as *Pseudotsuga menziesii* and *P. ponderosa* may occur in trace amounts. As elevations begin to increase, *A. magnifica* becomes more prominent. Other associates at all elevations may include *P. lambertiana* and *Calocedrus decurrens*. Upper elevation and Great Basin shrubs are often found on or next to these locations, including *Arctostaphylos patula*, *Quercus vaccinifolia*, *Cercocarpus ledifolius*, *Ceanothus velutinus*, *Alnus incana* ssp. *tenuifolia*), *Artemisia* *tridentata* ssp. *vaseyana*, and *Purshia tridentata*. *Q. kelloggii*, *Salix* spp. and *Populus tremuloides* are also likely to occur on these sites. (CalVeg description for Mixed Conifer – Fir Alliance)

**Xeric/Pine/Unproductive Modifier** This variant is defined by the presence of conifer species such as *Pinus ponderosa*, *Calocedrus decurrens*, *Pseudotsuga menziesii*, *Abies concolor*, and *Pinus lambertiana*, and the absence or only trace amounts of *Pinus jeffreyi*. Any one of these species may become locally dominant over small areas but dominance is shared by more than two species in this type. The pines normally are prominent on south and west facing slopes, *Pseudotsuga menziesii* and *Abies concolor* on north and east slopes, and *Calocedrus decurrens* as a secondary component of all slopes.

At lower elevations this Alliance may be found on north aspects and others such as the Gray Pine, Ponderosa Pine, Douglas-Fir - Pine, Black Oak, Tanoak, and Canyon Live Oak Alliances are more likely to be present on south, east and west facing aspects. At higher elevations this Alliance may typically occur on south, east and west aspects and the White Fir or Mixed Conifer - Fir Alliances on north aspects. Riparian habitats may be occupied by this Alliance in association with such Alliances as White Alder, Maple, and Willow.

At lower elevations, *Pinus sabiniana*, *Lithocarpus densiflorus* and *Quercus kelloggii* may become common associates. Understory shrubs within this Alliance include *Ceanothus integerri*mus and *Arctostaphylos viscida* on lower sites and *Arctostaphylos patula* at higher elevations. (CalVeg description for Mixed Conifer – Pine Alliance)

**Serpentine Soils Modifier** Low to moderate elevations in ultramafic and serpentinized areas often produce soils low in essential minerals such as calcium and magnesium or have excessive accumulations of heavy metals such as nickel and chromium. These sites vary widely in the degree of serpentization and effects on their overlying plant communities. Small stunted *Pinus monticola*, *P. contorta* ssp. *murrayana* and *P. jeffreyi* occur in combinations or in nearly pure open stands. Other common tree associates on ultramafics include *Pseudotsuga menziesii* and *Calocedrus decurrens*. Hardwoods are often sparse, but shrubs such as *Arctostaphylos nevadensis*, *A. viscida*, *Quercus vaccinifolia*, *Q. garrayana* var. *breweri*, *Rhamnus californica*, *Lithocarpus densiflorus* var. *echinoides*, *Rhododendron occidentale*, *Garrya buxifolia* and *Ceanothus pumilus* may occur on these sites. This type has been mapped at various spatial densities within twenty-two subsections at elevations less than about 7000 feet (2135 m).

**Aspen Variant** When *Populus tremuloides* co-occurs with SMC, it is typically found in smaller patches, often less than 2 ha (5 acres) in size. It is associated only with SMCM. Mature stands in which *P. tremuloides* are still dominant are usually relatively open. Average canopy closures of stands in eastern California range from 60 to 100 percent in young and intermediate-aged stands and from 25 to 60 percent in mature stands. The open nature of the stands results in substantial light penetration to the ground. (WHR)

### Distribution

**Sierran Mixed Conifer** SMC generally forms a vegetation band ranging from 770 to 1230 m (2500 to 4000 ft). It dominates the western middle elevation slopes of the Sierra Nevada. Soils supporting SMC are varied in depth and composition, and are derived primarily from Mesozoic granitic, Paleozoic sedimentary and volcanic rocks, and Cenozoic volcanic rocks. Serpentine soils, found primarily in the northern mixed conifer zone, support a number of endemic plants. Fissures and cracks in granitic parent material often support forest growth, even where soil development is shallow. (WHR)

**Mesic/Fir/Productive Modifer** Favorable slopes, primarily north and east aspects throughout the geographic range.

**Xeric/Pine/Unproductive Modifier** Occurs on south and west-facing aspects (BPS)

**Serpentine Soils Modifier**

**Aspen Variant** Sites supporting *P. tremuloides* are associated with added soil moisture, i.e., azonal wet sites. These sites are often close to streams and lakes. Other sites include meadow edges, rock reservoirs, springs and seeps. Terrain can be simple to complex. At these lower elevations, topographic conditions for this type tends toward positions resulting in relatively colder, wetter conditions within the prevailing climate, e.g., ravines, north slopes, wet depressions, etc. (BPS)

**Disturbances**

### Wildfire

**Sierran Mixed Confier** Wildfires are common and frequent; mortality depends on vegetation vulnerability and wildfire intensity. Low-mortality fires kill small trees and consume above-ground portions of shrubs and herbs, but do not kill large trees or below-ground organs of most shrubs and herbs which promptly re-sprout. High-mortality fires kill trees of all sizes and may kill many of the shrubs and herbs as well. However, high-mortality fire typically kills only the above-ground portions of the shrubs and herbs; consequently, most shrubs and herbs promptly re-sprout from surviving below-ground organs.

**Mesic/Fir Variant** For moist mixed conifer forests, Van de Water and Safford found a mean fire return interval of 16 years, median of 12 years, mean min interval of 5 years and mean max of 80 years. Westside mixed conifer types examined by Skinner and Chang found a median fire return interval of 22 years, with a minimum of 3 years and a maximum of 44 years.

Within the cover type, the early development stage is the least susceptible to fire. The open classes are the most susceptible, and LDO is slightly more so than MDO. The closed classes are less susceptible but have a higher probability of experiencing high mortality fire than the other classes.

**Xeric/Pine Variant** For dry mixed conifer forests, Van de Water and Safford found a mean fire return interval of 11 years, median of 9 years, mean min interval of 5 years and mean max of 50 years. Westside mixed conifer types examined by Skinner and Chang found a median fire return interval of 22 years, with a minimum of 3 years and a maximum of 44 years. Mixed aspen stands experience a longer return interval, on average.

Within SMCX forests, the early-development condition is the least susceptible to fire. The mid-development open-canopy condition is slightly less susceptible to fire than the corresponding open-canopy condition, although it is also relatively more likely to experience high mortality fire than the open condition. In general, the open-canopy conditions are more susceptible than the closed-canopy conditions, and the late-development open-canopy condition is slightly more susceptible than the mid-development open-canopy condition. Within this cover type, the late-development closed-canopy condition is relatively less susceptible to fire than every class except the early-development conditoin, however, it experiences a much higher frequency of high mortality events relative to low mortality than any other condition.

**Serpentine Soils Modifier**

**Aspen Variant** Sites supporting *P. tremuloides* are maintained by disturbances that allow regeneration from below-ground suckers, such as stand-replacement fires. Upland clones are impaired or eliminated by conifer ingrowth and overtopping and to a lesser extent by disturbances such as ill-timed grazing. If aboveground *P. tremuloides* on upland sites disappears completely (site overtaken by conifers) due to prolonged absence of disturbance, then restoration to a *P. tremuloides* condition is not a viable pathway. In a reference condition scenario, a few stands will advance toward conifer dominance, but in the current landscape scenario where fire has been reduced from reference conditions there are many more conifer-dominated mixed aspen stands. (BPS)

Table 1. SMC, SMC-ASP Fire return intervals (years) and percentage of high versus low mortality fires in relation to soil type modifier and the presence of *Populus tremuloides* (Aspen). Numbers for SMC on productive soils were derived from BpS model 0610280 and Van de Water and Safford (2011). Numbers for SMC on unproductive soils were derived from BpS model 0610270 and Van de Water and Safford (2011). Numbers for SMC-ASP were derived from BpS model 0610610 and Van de Water and Safford (2011).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Variant | Modifier | Fire Intensity | Average | Min | Max | % of Fires |
| SMC | Productive | High Mortality | 106 |  |  | 16 |
| Low Mortality | 20 |  |  | 84 |
| All Fires | 17 | 5 | 80 |  |
| Unproductive | High Mortality | 97 |  |  | 12 |
| Low Mortality | 13 |  |  | 88 |
| All Fires | 12 | 5 | 60 |  |
| Serpentine | High Mortality |  |  |  |  |
| Low Mortality |  |  |  |  |
| All Fires |  |  |  |  |
| SMC-ASP | n/a | High Mortality | 99 |  |  | 37 |
| Low Mortality | 58 |  |  | 63 |
| All Fires | 37 | 5 | 90 |  |







### Other Disturbance

Other disturbances are not currently modeled, but may, depending on the condition affected and mortality levels, reset patches to early development, maintain existing stages, or shift/accelerate succession to a more open stage. All of the tree species associated with this vegetation type are susceptible to a wide variety of pathogens and insects.

### Vegetation Condition Classes

### Sierran Mixed Conifer Variant

### Early Development (ED)

##### Description Grasses, forbs, low shrubs, and sparse to moderate cover of tree seedlings/saplings with an open canopy. This condition is characterized by the recruitment of a new cohort of early successional, shade-intolerant tree species into an open area created by a stand-replacing disturbance. (CO Model)

After disturbance, succession proceeds from an ephemeral herb to perennial grass-herb. This stage is generally only about 2 years long, during which *Galium* spp., *Goodyera* spp., *Bromus carinatus* var. *marginatus*, and *Achnatherum* spp. establish. The shrub-seedling-sapling stage is next; species present may include *Arctostaphylos* spp., *Ceanothus* spp., *Prunus* spp., *Ribes* spp., and *Chamaebatia foliolosa*, as well as the tree species typical of the cover type. (WHR)

In some cases, tree seedlings may develop a nearly continuous canopy and succeed relatively quickly to mid-development conditions. In other cases, such as on unproductive soils, chaparral conditions may dominate and persist for long periods of time. Shrub species may include *Arctostaphylos patula*, *Quercus vaccinifola*, and *Ceanothus* spp. (BPS)

##### Succession Transition

##### Mesic/Fir/Productive Modifier In the absence of disturbance, this class will begin transitioning to a mid development stage after 50 years, and the transition will be to either MDC or MDO, although the transition to MDC is twice as likely as transition to MDO. After 70 years, all stands will have succeeded to either MDC or MDO.

##### Xeric/Pine/Unproductive Modifier Transition to the MD conditions may be substantially delayed. Thus, in the absence of disturbance, this class will begin transitioning to either MDC or MDO after 80 years and may be delayed in the ED stage for as long as 150 years. Moreover, given that a patch will succeed, the probability of transitioning to MDO is 0.8 and to MDC is 0.2.

##### Serpentine Modifier

##### Wildfire Transition High mortality wildfire (100% of fires) recycles the patch through the Early Development stage. Low mortality wildfire is not modeled for this stage.

##### Mesic/Fir/Productive Modifier

##### Xeric/Pine/Unproductive Modifier

##### Serpentine Modifier

##### Mesic/Fir/Productive Modifier

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**Serpentine Modifier**

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##### Xeric/Pine/Unproductive ModifierH

##### Serpentine Modifier

### Mid Development - Open (MDO)

##### Description Heterogeneous ground cover of grasses, forms, and shrubs.Trees present are pole to medium sized conifers with canopy cover less than 50%. (BPS)

##### Mesic/Fir/Productive Modifier *Abies concolor, Pinus ponderosa, Pseudotsuga menziesii,* and *Pinus lambertiana* are likely components. (BPS)

##### Xeric/Pine/Unproductive Modifier *Pinus ponderosa*, *Pinus lambertiana*, and *Quercus kelloggii* are likely components. (BPS)

##### Serpentine Modifier

##### Succession Transition

##### Mesic/Fir/Productive Modifier In the absence of low mortality disturbance, MDO will begin transitioning to MDC after 30 years. Succession to LDO takes place after 50 years since entering a middle development stage.

##### Xeric/Pine/Unproductive Modifier Succession to LDO takes place variably beginning at 70 years since transition to middle development, and all patches succeed by 100 years.

**Serpentine Modifier**

##### Wildfire Transition

##### Mesic/Fir/Productive Modifier High mortality wildfire (9.5% of fires) returns the patch to Early Development. Low mortality fire (90.5%) maintains the MDO condition and allows for succession to LDO. On unproductive soils, …

##### Xeric/Pine/Unproductive Modifier High mortality wildfire (8.6% of fires) returns the patch to Early Development. Low mortality fire (91.4%) maintains the MDO condition and allows for succession to LDO.

##### Serpentine Modifier

### Late Development – Open (LDO)

##### Description Moderate to dense ground cover of grasses, forbs, and low shrubs; low density (less than 50% canopy cover) of large trees. Occurring in small to moderately-sized patches on southerly aspects and ridge tops. Upper canopy trees may be very large, but overall size classes vary with a patchy distribution and open canopy. This condition develops when low-mortality disturbance is fairly frequent; it persists as long as low-mortality fires continue to occur periodically. (BPS, CO Model)

##### Mesic/Fir/Productive Modifier Mature trees include *Abies concolor, Pinus ponderosa, Pseudotsuga menziesii,* and *Pinus lambertiana*. (BPS)

##### Xeric/Pine/Unproductive Modifier Mature trees include *Pinus ponderosa*, *Pinus lambertiana*, and *Quercus kelloggii*. (BPS)

**Serpentine Modifier**

##### Succession Transition

##### Mesic/Fir/Productive Modifier In the presence of low mortality disturbance, this class can self-perpetuate, but after 35 years with no fire, this class will begin transitioning to LDC.

##### Xeric/Pine/Unproductive Modifier Patches occurring on low productivity soils do not succeed to closed (or, don’t succeed until some high number of years without fire - 150? )

**Serpentine Modifier**

##### Wildfire Transition

##### Mesic/Fir/Productive Modifier High mortality wildfire (3.6% of fires) returns the patch to early development. Low mortality wildfire (90.5%) maintains LDO. BpS model says that mixed severity fire ”rarely” resets patch to early development. For now I have modeled that as a 5% chance of this high mortality event.

##### Xeric/Pine/Unproductive Modifier High mortality wildfire (2.5% of fires) returns the patch to early development. Low mortality wildfire (97.5%) maintains LDO. BpS model says that mixed severity fire ”rarely” resets patch to early development. For now I have modeled that as a 5% chance of this high mortality event.

**Serpentine Modifier**

### Late Development – Closed (LDC)

##### Description Overstory of large and very large trees with canopy cover over 50%. Trees present likely include *Abies concolor*, *Pinus ponderosa*, *Pseudotsuga menziesii*, and *Pinus lambertiana*. Occurring in small to moderately-sized patches on north aspects and lower slope positions. Understory characterized by medium and smaller-sized shade-tolerant conifers. (BpS)

Areas with aspen are now dominated by conifer species. Some decadent aspen remain but their influence on the site is much decreased. OR Aspen continue to persist in open areas, but become decadent as the stand ages and these gaps close.

##### Succession Transition In the absence of disturbance, this class will maintain, regardless of soil characteristics.

##### Wildfire Transition

##### Mesic/Fir/Productive Modifier High mortality wildfire (31.2% of fires) will return the patch to Early Development. Low mortality wildfire (68.8%) usually has little effect, although at some unknown rate – BPS doesn’t have a value of the time it opens the stand up to LDO.

##### Xeric/Pine/Unproductive Modifier High mortality wildfire (34% of fires) will return the patch to Early Development. Low mortality wildfire (66%) usually has little effect, although 7.6% of the time it opens the stand up to LDO.

**Serpentine Modifier**

### Aspen Variant

### Early Development – Aspen (ED–A)

**Description** Grasses, forbs, low shrubs, and sparse to moderate cover of tree seedlings/saplings (primarily *P. tremuloides*) with an open canopy. This condition is characterized by the recruitment of a new cohort of early successional, shade-intolerant tree species into an open area created by a stand-replacing disturbance. (CO Model)

Following disturbance, succession proceeds rapidly from an herbaceous layer to shrubs and trees, which invade together. (WHR) *P. tremuloides* suckers over 6ft tall develop within about 10 years.

**Succession Transition** Unless it burns, a patch in the early stage persists for 10 years, at which point it transitions to MDC-A.

**Wildfire Transition** High mortality wildfire (100% of fires) recycles the patch through the Early Development stage. Low mortality wildfire is not modeled for this stage.

### Mid Development – Aspen (MD–A)

##### Description *P. tremuloides* trees 5-16in DBH. Canopy cover is highly variable, and can range from 40-100%. These patches range in age from 10 to 150 years and could maintain indefinitely. Some understory conifers, including *Pinus ponderosa*, *Pinus lambertiana*, and *Abies concolor* are encroaching, but *P. tremuloides* is still the dominant component of the stand.

##### Succession Transition MD-A persists for at least 100 years in the absence of fire, after which stands begin transitioning to MD-AC. At age 150 all remaining MD-A patches transition to MD-AC.

##### Wildfire Transition [Needs to be updated] High mortality wildfire (14.6% of fires) returns the patch to ED-A. Low mortality wildfire (85.4%) maintains the patch in MDO2.

**Mid Development – Aspen with Conifer (MD–AC)**

**Description** These stands have been protected from fire for at least 100 years. *P. tremuloides* trees are predominantly 16in DBH and greater. Conifers are present and overtopping the aspen. *Abies concolor* is a typical conifer that is successional to aspen, and is depicted here, but other conifers including *Pinus ponderosa* and *Pinus lambertiana* are also possible. Conifers are pole to medium-sized, and conifer cover is at least 40%.

**Succession Transition** MD-A persists for 100 years in the absence of fire, after which stands transition to LDC.

**Wildfire Transition** [Needs to be updated] High mortality wildfire (14.6% of fires) returns the patch to ED2. Low mortality wildfire (85.4%) opens the stand up to MDO2.

### Late Development – Closed (LDC)

##### Description See description of same stage under Sierran Mixed Conifer Variant. Areas with aspen are now dominated by conifer species. Some decadent aspen remain but their influence on the site is much decreased. OR Aspen continue to persist in open areas, but become decadent as the stand ages and these gaps close.

##### Succession Transition See description of same stage under Sierran Mixed Conifer Variant

##### Wildfire Transition High mortality wildfire (31.2% of fires) will return the patch to Early Development - Aspen. Low mortality wildfire (68.8%) usually has little effect, although at some unknown rate – BPS doesn’t have a value of the time it opens the stand up to LDO.

**Condition Classification**

Table 2. Cover Condition for SMC and the attributes from EVeg used to assign that condition. Each row should be read with a boolean AND across each column of a row.



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cover Condition | Overstory Tree  Diameter 1 (DBH) | Overstory Tree  Diameter 2 (DBH) | Total Tree  CFA (%) | Conifer  CFA (%) | Hardwood  CFA (%) |
| Early All | null | any | any | any | any |
| Early All | 0-5.9” | any | any | any | any |
| Mid Open | 5-19.9” | any | null | null | null |
| Mid Open | 5-19.9” | any | <50 | any | any |
| Mid Open | 5-19.9” | any | null | <50 | null |
| Mid Closed | 5-19.9” | any | >50 | any | any |
| Mid Closed | 5-19.9” | any | null | >50 | any |
| Late Closed | 20”+ | any | >50 | any | any |
| Late Closed | 20”+ | any | null | >50 | any |
| Late Open | 20”+ | any | null | null | null |
| Late Open | 20”+ | any | <50 | any | any |
| Late Open | 20”+ | any | null | <50 | null |

**Draft Models**

**Note**, these are a range of options for displaying the model information. We can change/add/alter these as necessary.



Figure 1: Disturbance-Succession model for SMC, including aspen. Each box lists the name of the stage (based on LandFire) and the age range for patches in that class.



Figure 2: Disturbance-Succession model for SMCM, including aspen. Each box lists the name of the stage (based on LandFire) and the age range for patches in that class. Probabilities given are the probability of that outcome relative to others for that type of disturbance in that stage. For example, given that a fire reaches a patch in MDC, it has 3 relative probabilities of transitioning to ED, MDO, or remaining in MDC, which sum to 1. The probabilities highlighted in yellow are approximations and will need to be reviewed closely to determine the appropriate modifier. See description of that stage for details on the uncertainty. Probabilities per time step of succession have not yet been calculated.



Figure 3: Disturbance-Succession model for SMCX. Each box lists the name of the stage (based on LandFire) and the age range for patches in that class.