## Lodgepole Pine (LPN)

**General Information**

**Cover Type Overview**

**Lodgepole Pine (LPN)**

* Reviewed by Shana Gross, Ecologist, USDA Forest Service
* Crosswalk to EVeg: Regional Dominance Type 1
  + Lodgepole Pine
* Crosswalk to EVeg: Regional Dominance Type 2
  + Any
* Crosswalk to Presettlement Fire Regime Type
  + Lodgepole Pine
* Crosswalk to LandFire Biophysical Settings
  + 0610581 Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland – Wet
  + 0610582 Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland – Dry

**Lodgepole Pine with Aspen (LPN-ASP)**

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

**Vegetation Description**

**Lodgepole Pine (LPN)** *P. contorta* ssp. *murrayana* is the overwhelming dominant within its forest community, mixing occasionally with *Abies magnifica*, and with scattered *Pinus jeffreyi*  and *Pinus monticola*, and *Tsuga mertensiana* at higher elevations (Fites-Kaufman et al. 2007). Mature Sierran stands often contain significant seedlings and saplings. Understory characteristics are influenced by proximity to meadow and stream margins. *Arctostaphylos* and *Ribes* are common shrubs. Stands associated with meadow edges and streams may have a rich herbaceous layer consisting of grasses, forbs, and sedges. Species associations are likely very location specific. Plants present may include but are not limited to *Cassiope, Vaccinium, Phyllodoce, Kalmia*, *Ceanothus, Chrysolepis,* and *Carex*. Elsewhere, the understory may be virtually absent, consisting of scattered shrubs such as *Quercus vaccinifolia*, and herbs like *Antennaria, Arabis, Eriogonum,* and *Gayophytum.* Fast-moving streams within the cover type are generally characterized by relatively dense populations of *Salix* (Bartolome 1988, Fites-Kaufman et al. 2007, LandFire 2007a, LandFire 2007b).

**Lodgepole Pine with Aspen (LPN-ASP)** When *Populus tremuloides* co-occurs with LPN on the west side of the Sierran crest, it is typically found in smaller patches, often less than 2 ha (5 acres) in size. Mature stands in which *P. tremuloides* are still dominant are usually relatively open. Average canopy closures 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 (Verner 1988).

**Distribution**

**Lodgepole Pine** Open stands of *P. contorta* ssp. *murrayana*, which make up a widespread upper montane forest/woodland, tolerating both rocky soils and semisaturated meadow edges, in an elevational belt within and above the *A. magnifica* zone. These forests, strongly dominated by *P. contorta* ssp. *murrayana*, generally occur at elevations of about 1,830 to 2,400 m (6000 to 7875 ft) in the northern Sierra Nevada. Stands of *P. contorta* ssp. *murrayana* may reach much lower, however, with cold air drainage down glacial canyons (Fites-Kaufman et al. 2007, Anderson 1996). On infertile soils, *P. contorta* ssp. *murrayana* is often the only tree species that will grow (Lotan and Critchfield 1990).

More than any other Sierran conifer, *P. contorta* ssp. *murrayana* is relatively tolerant of poor soil aeration, and thus grows well around the margins of wet meadows and other moist areas. Many upper montane and subalpine meadows in the Sierra Nevada exhibit invasion of young *P. contorta* ssp. *murrayana* moving inward from their drier margins. It is not clear how much this process has been influenced by changes in fire frequency or grazing over the last 150 years (Fites-Kaufman et al. 2007).

**Lodgepole Pine with Aspen** Sites supporting *P. tremuloides* are associated with added soil moisture, i.e., azonal wet sites. These sites are found throughout the LPN zone, often close to streams, lakes, and meadows. Other sites include rock reservoirs, springs and seeps. Terrain can be simple to complex (LandFire 2007c).

**Disturbances**

**Wildfire**

**Lodgepole Pine** Wildfires tend to be high mortality, stand-replacing fires that initiate a process of post-fire forest succession. High mortality fires kill large as well as small trees, and may kill many of the shrubs and herbs as well, although below-ground organs of at least some individual shrubs and herbs survive and resprout. Low mortality fires tend to only kill small seedlings and depend on the herbaceous layer to carry fire.

Unlike the Rocky Mountain subspecies of *P. contorta* (ssp. *latifolia*), *P. contorta* ssp. *murrayana* does not have serotinous cones (Fites-Kaufman et al. 2007). Following high mortality fire, it initially establishes in even-aged stands, but small-scale disturbances and the ability of the subspecies to regenerate in the absence of fire promote uneven-aged structure (Cope 1993, Gross 2013).

High mortality fire occurs at long intervals. Mixed severity fire is related to fire behavior across the often moist areas where *P. contorta* ssp. *murrayana* is found. Surface fires are more common on drier sites, although in general sparse fuels limit fire ignition and spread. Most fires are small (less than 1 ha) but very large fires covering hundreds of hectares do occur (LandFire 2007a, LandFire 2007b). This is due in part to the high susceptibility to fire mortality by *P. contorta* ssp. *murrayana* because of its thin bark and shallower roots. Postfire conditions provide an ideal seedbed, and *P. contorta* ssp. *murrayana* is an early post-fire colonizer (Cope 1993).

Data on fire return intervals (FRIs) are available from a few review papers. Van de Water and Safford’s 2011 review paper aggregates hundreds of articles, conference proceedings, and LandFire data on fire return intervals, with an emphasis on Californian sources. We also include here data from the pertinent individual LandFire BpS models (2007a, 2007b, 2007c, 2007d).

Van de Water and Safford (2011) did not distinguish the two Sierran *P. contorta* ssp. *murrayana* types, and report one set of values: a mean FRI of 37 years, median of 36 years, min of 15 years, and max of 290 years.

Dry southern Sierran subalpine lodgepole pine forest had intervals ranging from 31-74 years (LandFire 2007b). The LandFire model for this dry type predicts a mean FRI of 27 years. Replacement FRI has a mean of 250 years with a range of 31 to 500 years, while mixed FRI has a mean of 60 years with a range of 31 to 350 years. Surface FRI has a mean of 60 years with a range of 9 to 350 years (2007b). We recalculated these numbers using condition-specific information and using only high and low mortality fire categories, which resulted in a mean FRI of 241 years for high mortality fire, 30 years for low mortality fire, and 27 years for any fire.

Wet lodgepole types in Klamath Mountains and Oregon had a FRI range of 70-100 yrs (LandFire 2007a). The LandFire model for this wet type predicts a mean FRI of 35 years. Replacement FRI has a mean of 260 years with a range of 37 to 764 years, while mixed FRI has a mean 50 years and surface FRI has a mean of 500 years (2007a). We recalculated these numbers using condition-specific information and using only high and low mortality fire categories, which resulted in an interval of 122 years for high mortality fire, 50 years for low mortality fire, and 36 years for any fire. We use these values as a baseline for project area.

**Lodgepole Pine with Aspen** Sites supporting *P. tremuloides* are maintained by stand-replacing disturbances that allow regeneration from below-ground suckers. Upland clones are impaired or suppressed by conifer ingrowth and overtopping and intensive grazing that inhibits growth. 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 (LandFire 2007c, Verner 1988).

Van de Water and Safford (2011) found a mean fire return interval of 19 years, median of 20 years, mean min interval of 10 years and mean max of 90 years for Aspen. The LandFire model for northern Sierra Nevada aspen that is seral to conifers predicts a mean FRI of 37 years. Replacement FRI has a mean of 150 years with a range of 50-300 years, while mixed severity FRI is 250 years, and low severity fire FRI is 60 years (2007c). We recalculated these numbers using condition-specific information and using only high and low mortality fire categories, which resulted in an interval of 92 years for high mortality fire, 91 years for low mortality fire, and 46 years for any fire.

Table 1. Fire return intervals (years) and percentage of high versus low mortality fires. Numbers for LPN were derived from BpS model 0610581 (LandFire 2007a), Van de Water and Safford (2011), and Estes (Pers. comm. 2013). Numbers for LPN-ASP were derived from BpS model 0610610 (LandFire 2007c) and Safford (pers. comm. 2013).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variant** | **Fire Mortality** | **Mean** | **Min** | **Max** | **% of Fires** |
| LPN | High | 180 | – | – | 29 |
| Low | 120 | – | – | 71 |
| All Fires | 36 | 15 | 290 | 100 |
| LPN–ASP | High | 92 | – | – | 50 |
| Low | 91 | – | – | 50 |
| All Fires | 46 | 20 | 200 | 100 |

**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 condition classes, or shift/accelerate succession to a more open condition.

**Vegetation Condition Classes**

We recognize five separate condition classes for LPN and LPN-ASP. We use condition classes not in the sense of fire regime condition classes, but as an alternative to “successional” classes that imply a linear progression of states and tend not to incorporate disturbance. The condition classes identified here are derived from a combination of successional processes and anthropogenic and natural disturbance, and are intended to represent a composition and structural condition that can be arrived at from multiple other conditions described for that landcover type. Thus our condition classes incorporate age, size, canopy cover, and vegetation composition as well as relative seral stages. In general, the delineation of stages has originated from the LandFire biophysical setting model descriptive of a given landcover type; however, condition classes are not necessarily identical to the classes identified in those models.

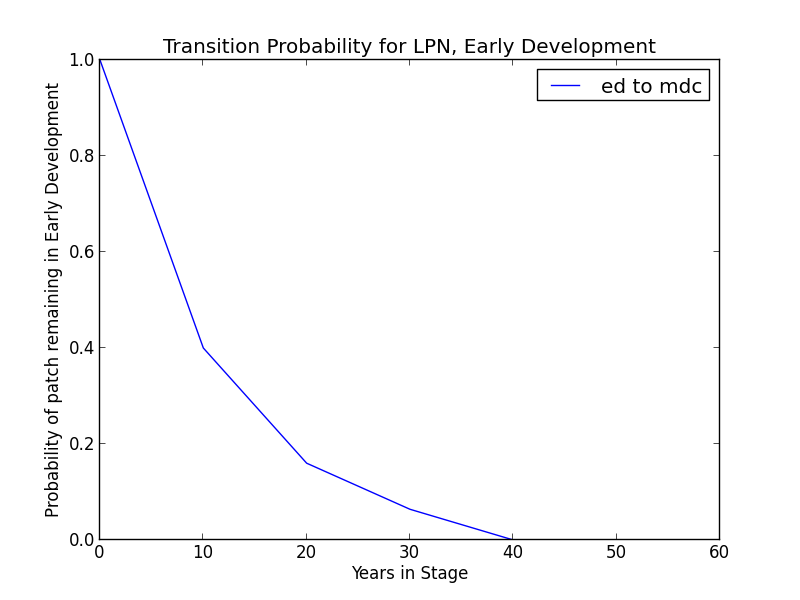
The LPN variant is assigned to five separate condition classes: Early Development (ED), Mid Development Open (MDO), Mid Development Closed (MDC), Late Development Open (LDO, and Late Development Closed (LDC). The LPN-ASP variant is also assigned to five condition classes: Early Development – Aspen (EDA), Mid Development – Aspen (MDA), Mid Development – Aspen with Conifer (MDAC), Late Development Closed (LDC), and Late Development – Conifer with Aspen (LDCA).

**Lodgepole Pine Variant**

**Early Development (ED)**

**Description** Grasses, forbs, low shrubs, and sparse to moderate cover of trees (primarily *P. contorta* ssp. *murrayana*) 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.

A short period of herbaceous productivity precedes closure of the tree canopy on productive sites. The prolific seed output, establishment, and seedling growth of *P. contorta* ssp. *murrayana* makes the period of herbaceous production short (Bartolome 1988). *P. contorta* ssp. *murrayana* regeneration density ranges from moderate to dog hair thickets (LandFire 2007a).

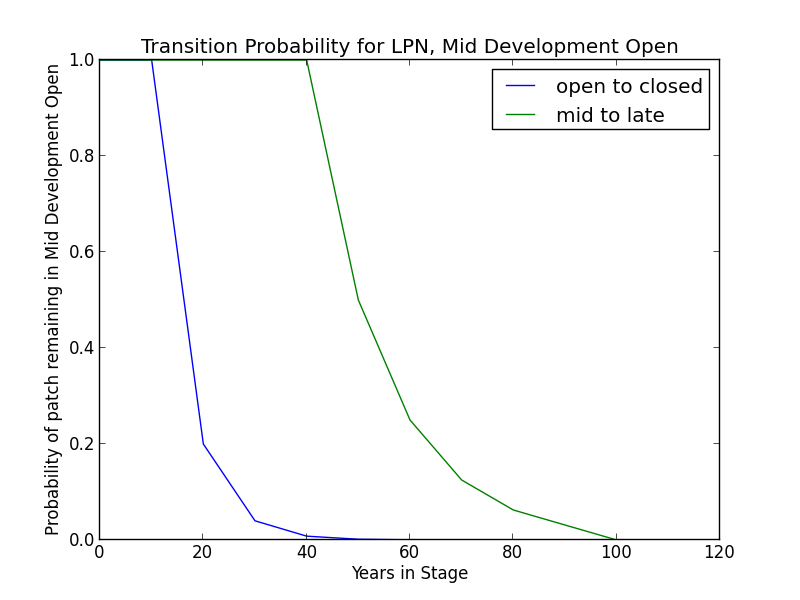
**Succession Transition** In the absence of disturbance, this class will begin transitioning to MDC after 10 years at a rate of 0.6 per time step. At 40 years, all stands will have succeeded.

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

**Mid Development - Open (MDO)**

**Description** Sparse ground cover of grasses, forbs, and shrubs. Mid-maturity *P. contorta* ssp. *murrayana* where surface fire or other disturbance has opened the stand. Canopy cover ranges from 10-50% (LandFire 2007a).

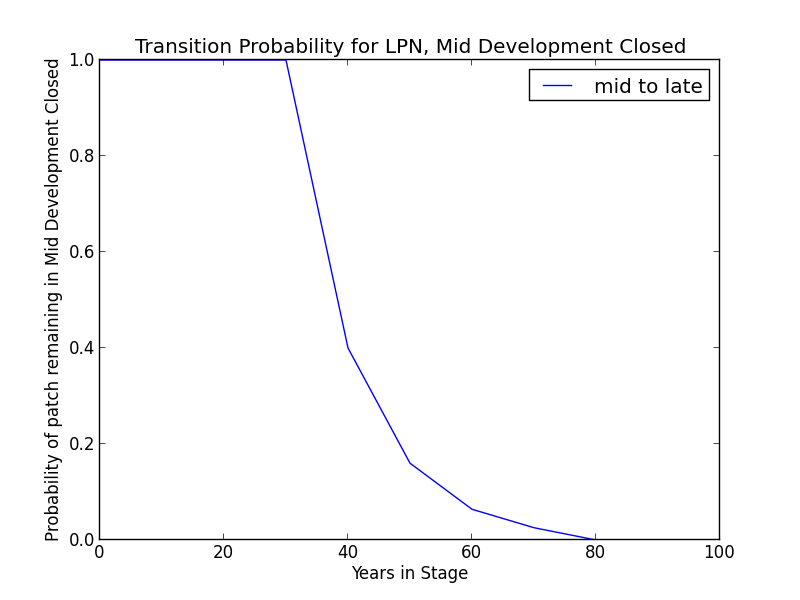
Continued recruitment into stands produces overstocking and slow growth of the overcrowded trees. This overcrowding may make them susceptible to insects, although others have argued that the more vigorously growing trees are more likely to be attacked. Beetle infestation creates large quantities of fuel that increase the probability of wildfire (Bartolome 1988).

**Succession Transition** This class will maintain under low mortality disturbance, but after 20 years without fire it begins transitioning to MDC at a rate of 0.8 per time step. Succession to LDO occurs once the patch has been in mid development for 50 years. The rate of succession per time step is 0.5. After 100 years, all stands will have succeeded.

**Wildfire Transition** High mortality wildfire (7% of fires in this condition) recycles the patch through the Early Development condition. Low mortality wildfire (93%) maintains the patch in MDO.

**Mid Development - Closed (MDC)**

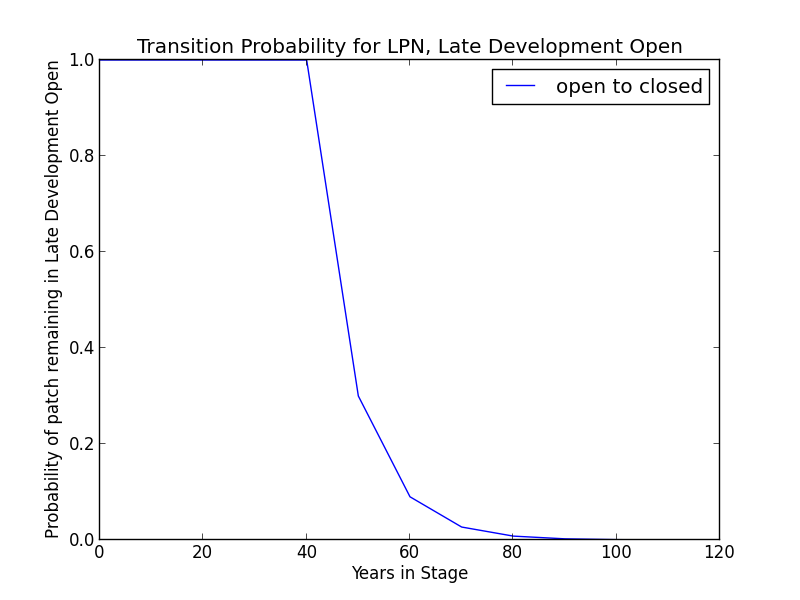
**Description** Sparse ground cover of grasses, forbs, and shrubs; mid-maturity *P. contorta* ssp. *murrayana* undergoing intrinsic stand thinning. Considerable surface fuel from tree mortality from previous fire. Canopy cover is greater than 50% (LandFire 2007a).

Continued recruitment into stands produces overstocking and slow growth of the overcrowded trees. This overcrowding may make them susceptible to insects, although others have argued that the more vigorously growing trees are more likely to be attacked. Beetle infestation creates large quantities of fuel that increase the probability of wildfire. (Bartolome 1988).

**Succession Transition** After 40 years in a MD condition without a wildfire-triggered transition, this class will begin transitioning to LDC. The rate of succession per time step is 0.6. After 80 years, all stands will have succeeded.

**Wildfire Transition** High mortality wildfire (41.7% of fires in this condition) recycles the patch through the Early Development condition. Low mortality wildfire (58.3%) triggers a transition to MDO 80% of the time; otherwise, it remains in MDC.

**Late Development - Open (LDO)**

**Description** Areas that have experienced one or more low severity understory fires that had reduced stand density or old stands that have not experienced fire but have been thinned by other processes (tree falls, etc.). Stands are uneven aged. Canopy cover ranges from 10-50% (LandFire 2007a).

**Succession Transition** This class will maintain under low mortality disturbance, but after 50 years without fire, this class succeeds to LDC at a rate of 0.7 per timestep.

**Wildfire Transition** High mortality wildfire (7% of fires in this condition) recycles the patch through the Early Development condition. Low mortality wildfire (93%) maintains the patch in LDO.

**Late Development - Closed (LDC)**

**Description** Old *P. contorta* ssp. *murrayana* stands where fire has had minimal influence. Canopy cover exceeds 50%.

**Succession Transition** This class will maintain in the absence of disturbance.

**Wildfire Transition** High mortality wildfire (26.3% of fires in this condition) recycles the patch through the Early Development condition. Low mortality wildfire (73.7%) maintains the patch in LDC.

**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.

Following disturbance, succession proceeds rapidly from an herbaceous layer to shrubs and trees, which invade together (Verner 1988). *P. tremuloides* suckers over 6ft tall develop within about 10 years (LandFire 2007c).

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

**Wildfire Transition** High mortality wildfire (100% of fires in this condition) recycles the patch through the ED–A condition. Low mortality wildfire is not modeled for this condition.

**Mid Development – Aspen (MD–A)**

**Description** *P. tremuloides* trees 5-16” DBH. Canopy cover is highly variable, and can range from 40-100%. These patches range in age from 10 to 110 years. Some understory conifers, predominantly *P. contorta* ssp. *murrayana,* are encroaching, but *P. tremuloides* is still the dominant component of the stand (LandFire 2007c).

**Succession Transition** MD-A persists for at least 50 years in the absence of fire, after which stands begin transitioning to MD-AC at a rate of 0.6 per timestep. After 100 years all remaining MD-A patches transition to MD-AC.

**Wildfire** **Transition** High mortality wildfire (100% of fires in this condition) recycles the patch through the ED–A condition. Low mortality wildfire is not modeled for this condition.

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

**Description** These stands have been protected from fire since the last stand-replacing disturbance. *P. tremuloides* trees are predominantly 16” DBH and greater. Conifers (predominantly *P. contorta* ssp. *murrayana*) are present and becoming increasingly dominant over the *P. tremuloides*. Conifers are pole to medium-sized, and conifer cover is at least 40% (LandFire 2007c).

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

**Wildfire Transition** High mortality wildfire (70% of fires in this condition) returns the patch to ED-A. Low mortality wildfire (30%) maintains the patch in MD–AC.

**Late Development – Closed (LDC)**

**Description** Some *P. tremuloides* continue to be present in the understory, but large *P. contorta* ssp. *murrayana* are now the dominant tree species, having overtopped the *P. tremuloides.* Smaller conifers are present in the midstory as well (LandFire 2007a). This condition class is analogous to the LDC condition for the LPN variant.

**Succession Transition** This class will maintain in the absence of disturbance.

**Wildfire Transition** High mortality wildfire (9% of fires in this condition) will return the patch to ED–A. Low mortality wildfire (91%) usually has little effect, although 15% of the time it opens the stand up to LD-CA.

**Late Development – Conifer with Aspen (LD–CA)**

**Description** If stands are sufficiently protected from fire such that conifer species overtop *P. tremuloides* and become large, they may be able to withstand some fire that more sensitive *P. tremuloides* cannot. When this occurs, it creates a patch characterized by late development conifers, such as *P. contorta* ssp. *murrayana*, and early seral *P. tremuloides*.

**Succession Transition** LD-CA persists for 70 years in the absence of any fire, after which stands transition to LDC.

**Wildfire Transition** High mortality wildfire (20% of fires in this condition) returns the patch to ED-A. Low mortality wildfire (80%) maintains the stand in LD-CA.

**Condition Classification**

Table 2. Classification of cover condition for LPN. Diameter at Breast Height (DBH) and Cover From Above (CFA) values taken from EVeg polygons. DBH categories are: null, 0-0.9”, 1-4.9”, 5-9.9”, 10-19.9”, 20-29.9”, 30”+. CFA categories are null, 0-10%, 10-20%, … , 90-100%. Each row in the table below should be read with a boolean AND across each column.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Cover Condition | Overstory Tree  Diameter 1 (DBH) | Overstory Tree  Diameter 2 (DBH) | Total Tree  CFA (%) | Conifer  CFA (%) | Hardwood  CFA (%) |
| Early All | 0-4.9” | any | any | any | any |
| Mid Open | 5-9.9” | any | <50 | any | any |
| Mid Closed | 5-9.9” | any | >50 | any | any |
| Late Open | 10”+ | any | <50 | any | any |
| Late Closed | 10”+ | any | >50 | any | any |

LPN-ASP conditions were assigned manually using NAIP 2010 Color IR imagery to assess condition.

**Draft Models**

See PDF – Disturbance-Succession model for LPN and LPN-ASP.

**References**

Bartolome, James W. “Lodgepole Pine (LPN).” *A Guide to Wildlife Habitats of California*, edited by Mayer, Kenneth E. and William F. Laudenslayer. California Deparment of Fish and Game. 1988. <http://www.dfg.ca.gov/biogeodata/cwhr/pdfs/LPN.pdf>. Accessed 4 December 2012.

“CalVeg Zone 1.” Vegetation Descriptions. *Vegetation Classification and Mapping*. 11 December 2008. U.S. Forest Service. <http://www.fs.usda.gov/Internet/FSE\_DOCUMENTS/fsbdev3\_046448.pdf>. Accessed 2 April 2013.

Cope, Amy B. 1993. “Pinus contorta var. murrayana.” In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). <http://www.fs.fed.us/database/feis/> [Accessed 4 December 2012].

Fites-Kaufman, Jo Ann, Phil Rundel, Nathan Stephenson, and Dave A. Wixelman. “Montane and Subalpine Vegetation of the Sierra Nevada and Cascade Ranges.” In *Terrestrial Vegetation of California, 3rd Edition*, edited by Michael Barbour, Todd Keeler-Wolf, and Allan A. Schoenherr, 456-501. Berkeley and Los Angeles: University of California Press, 2007.

Gross, Shana. Ecologist, USDA Forest Service. Personal communication, 3 July 2013.

Lotan, James E. and William B. Critchfield. “Lodgepole Pine.” Russell M. Burns and Barbara H. Honkala, tech. coords. Silvics of North America, vol 1. Conifers; Glossary. Agriculture handbook no.654. Washington, D.C.: U.S. Dept. of Agriculture, Forest Service, 1990.

LandFire. “Biophysical Setting Models.” Biophysical Setting 0610581: Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland. 2007a. LANDFIRE Project, U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior. <http://www.landfire.gov/national\_veg\_models\_op2.php>. Accessed 9 November 2012.

LandFire. “Biophysical Setting Models.” Biophysical Setting 0610582: Sierra Nevada Subalpine Lodgepole Pine Forest and Woodland. 2007b. LANDFIRE Project, U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior. <http://www.landfire.gov/national\_veg\_models\_op2.php>. Accessed 9 November 2012.

LandFire. “Biophysical Setting Models.” Biophysical Setting 0610610: Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland. 2007c. LANDFIRE Project, U.S. Department of Agriculture, Forest Service; U.S. Department of the Interior. <http://www.landfire.gov/national\_veg\_models\_op2.php>. Accessed 7 January 2013.

Safford, Hugh S. Regional Ecologist, USDA Forest Service. Personal communication, 5 May 2013.

Skinner, Carl N. and Chi-Ru Chang. “Fire Regimes, Past and Present.” *Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, Assessments and scientific basis for management options*. Davis: University of California, Centers for Water and Wildland Resources, 1996.

Van de Water, Kip M. and Hugh D. Safford. “A Summary of Fire Frequency Estimates for California Vegetation Before Euro-American Settlement.” *Fire Ecology* 7.3 (2011): 26-57. doi: 10.4996/fireecology.0703026.

Verner, Jared. “Aspen (ASP).” ).” *A Guide to Wildlife Habitats of California*, edited by Kenneth E. Mayer and William F. Laudenslayer. California Deparment of Fish and Game, 1988. <http://www.dfg.ca.gov/biogeodata/cwhr/pdfs/ASP.pdf>. Accessed 4 December 2012.