## Lodgepole Pine (LPN)

**General Information**

**Cover Type Overview**

**Lodgepole Pine (LPN)**

* Area under simulation: 7,005 acres / 2,835 hectares
* Project area only: 2,085 acres / 844 hectares
* 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)**

* Area under simulation: 73 acres / 30 hectares
* Project area only: 18 acres / 7 hectares
* 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, in contrast to the even aged character of stands in the northern Cascades and Rocky Mountains. 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 are generally characterized by relatively dense populations of willows (*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 Sierra 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. At 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. (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*), which has a life history often tied closely to stand-replacing crown fires and often occurs in large even-aged cohorts, *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 smaller-scale disturbances such as windfall and avalanches convert *P. contorta* ssp. *murrayana* to the uneven-aged structure typical of this subspecies (Cope 1993).

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) and Van de Water and Safford (2011). Numbers for SMC-ASP were derived from BpS model 0610610 (LandFire 2007c) and Safford (pers. comm. 2013).

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variant** | **Fire Mortality** | **Mean** | **Min** | **Max** | **% of Fires** |
| LPN | High | 122 | – | – | 29 |
| Low | 50 | – | – | 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. The condition classes described below are based on the classes described in the pertinent LandFire Biophysical Setting model descriptions, which in turn were based on a “5-box” state and transition models describing major successional stages related to fire regime condition classification. According to the Fire Regime Condition Class guidebook, up to five successional classes may be utilized to describe age, size, canopy cover, and vegetation composition, ranging from early seral (post-disturbance) to late seral (such as old growth) (Barrett et al. 2010).

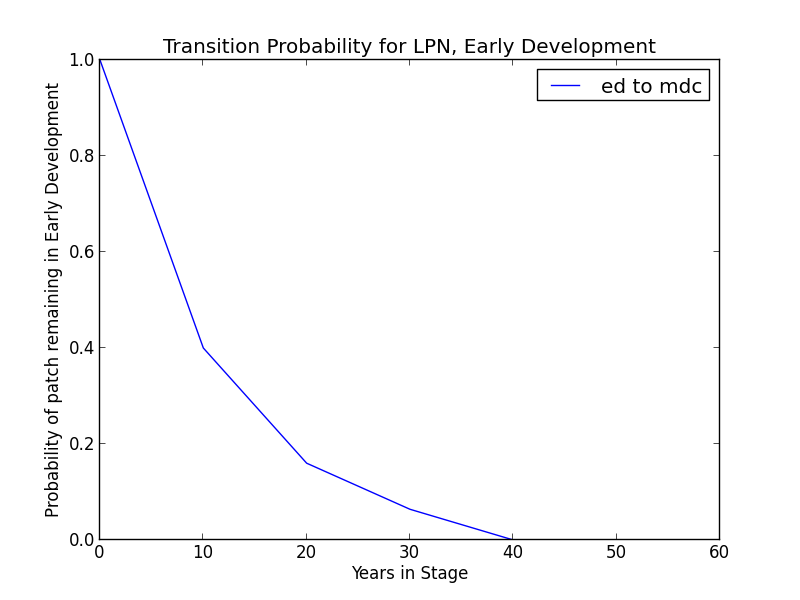
The LPN variant is assigned to five separate condition classes: Early Development (ED), Mid Development Open (MDO), Mid Development Closed (MDC), Late Development Open (LDO, and Late Development Closed (LDC). The LPN-ASP variant is also assigned to five condition classes: Early Development – Aspen (ED-A), Mid Development – Aspen (MD-A), Mid Development – Aspen with Conifer (MD-AC), Late Development Closed (LDC), and Late Development – Conifer with Aspen (LD-CA).

**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).

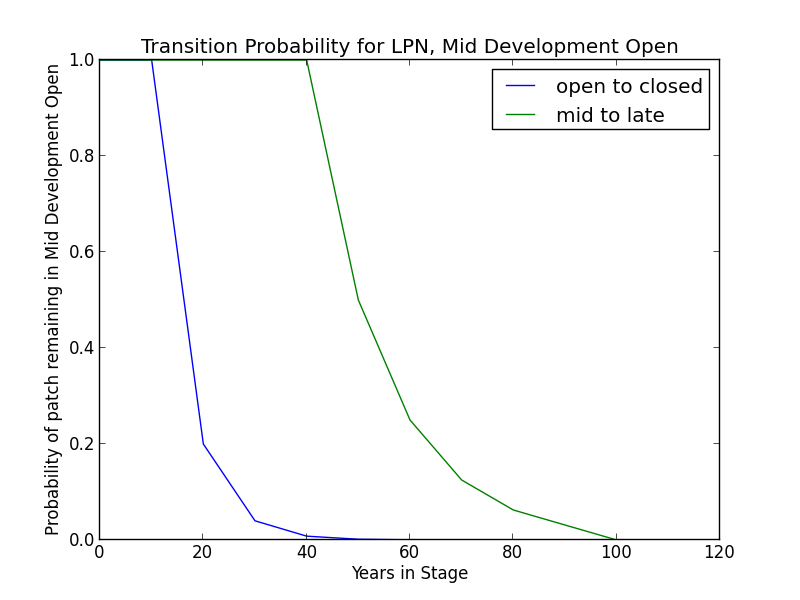
**Succession Transition** In the absence of disturbance, this class will begin transitioning to MDC after 10 years at a rate of 0.6 per time step. At 40 years, all stands will have succeeded.

**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).

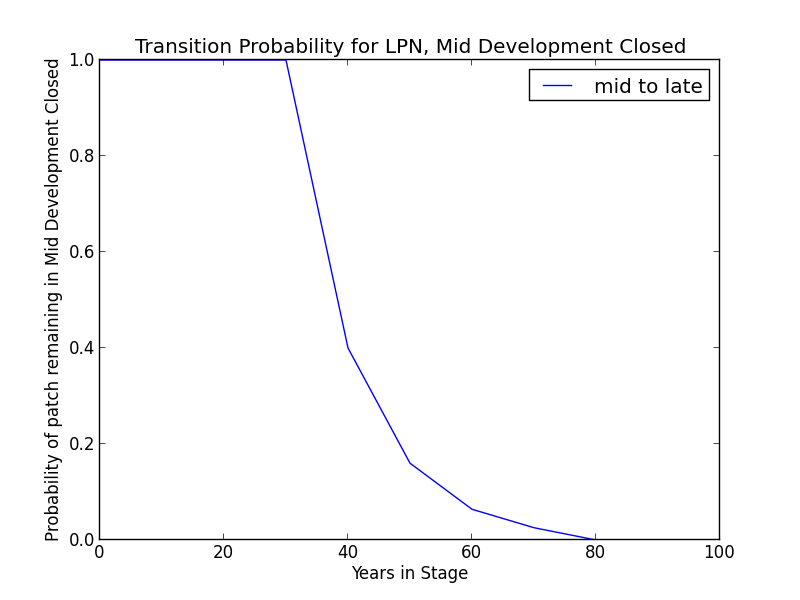
**Succession Transition** This class will maintain under low mortality disturbance, but after 20 years without fire it begins transitioning to MDC at a rate of 0.8 per time step. Succession to LDO occurs once the patch has been in mid development for 50 years. The rate of succession per time step is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

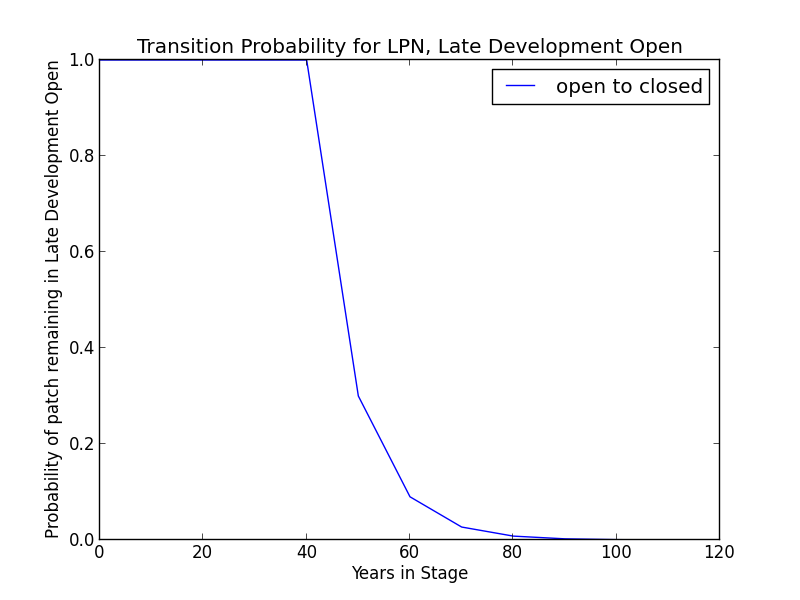
Continued recruitment into stands produces overstocking and slow growth of the overcrowded trees. This overcrowding may make them susceptible to insects, although others have argued that the more vigorously growing trees are more likely to be attacked. Beetle infestation creates large quantities of fuel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



**Succession Transition** After 40 years without a wildfire-triggered transition, this class will begin transitioning to LDC. Patches moving between MDC and MDO begin transitioning after 40 years since transition to mid development. The ate 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.

**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 overtopping the aspen. 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 fire, after which stands transition to LDC.

**Wildfire Transition** High mortality wildfire (55.6% of fires in this condition) returns the patch to ED-A. Low mortality wildfire (44.4%) 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 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 |

Methodology for assigning condition classes to LPN-ASP is still under development.

**Draft Models**

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

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