Proposed use of LAI to attribute cohort coverage of a site in PnET-Succession

To enable the breadth of multi-cohort and disturbance processes required of PnET succession within LANDIS-II, we make the following simplifying assumptions:

1. Competition for horizontal (i.e., 2D) canopy space occurs WITHIN a canopy layer.
2. Tree species cohorts compete for horizontal canopy space but must fill up their 3D canopy volume.
3. Cohorts within the same canopy layer occupy discreet (non-overlapping) horizontal space. Therefore, cohort growth calculations performed with density units (m-2) require no adjustment from PnET-II methods.
4. Site-level attributes (e.g., biomass, LAI) represent the total amount of all cohorts present on the site, where each cohort contributes to the total in proportion to its estimated horizontal coverage.
5. The proportion of horizontal canopy space for a given LANDIS site (cell) a cohort can POTENTIALLY occupy is a function of its calculated LAI divided by its maximum LAI. This assumes that when growing alone, a cohort completely fills the horizontal canopy space when it reaches its maximum LAI. It also means that small (young) cohorts do not completely fill the growing space.

1. Layer-Level Canopy Area is the sum of the canopy proportions for the cohorts in the layer. Coverage of a canopy layer can be less than one (i.e., incomplete crown closure), but no greater than one (i.e., complete crown closure), so when the sum exceeds 1 a limit is applied.
   1. When PCanAreaLayer <= 1, no adjustment to cohorts’ canopy area is necessary.
   2. When PCanAreaLayer is estimated as >1, the PCanArea of cohorts are constrained to sum to 1, apportioning the canopy space in proportion to their potential canopy area relative to each other.
   3. Once a limit has been applied to a cohort due to canopy closure (PCanArea.act < PCanArea.pot), that limit will always represent the maximum PCanArea that cohort can reach, even if the cohort is later relieved of the canopy competition. This means that after canopy closure, the removal of a cohort leaves “empty space” in the canopy layer that cannot be filled by the previous competitors.
   4. Site-level attributes (LAI, biomass, etc.) are then calculated as the weighted sum of the cohort-level values for all cohorts in the canopy (e.g., the sum of LAI of cohorts multiplied by their respective proportions of the canopy layer)

1. The above formulations will make succession more sensitive to parameters affecting cohort foliage and the distribution of that foliage via LAI
   1. FracFol, FrActWd, SLWMax, MaxLAI
2. The above approach has some desired behaviors
   1. Cohorts do not instantly occupy growing spaced freed by a partial or complete removal of another cohort within their respective layer.
   2. The process of canopy closure is modelled explicitly.
3. Undesired behaviors
   1. Once a cohort has been constrained, it is completely unable to acquire space when the space is open. In reality, a cohort cannot “move” into the empty space, or add stems to the vacated space, but there is some capacity for branches to extend into empty canopy space.