Blended Canopy Species Composition for the Two-Tiered Condition of the White Pine Forest Unit

Background

The Forest Resources Inventory (FRI) includes more detail with a vertical structure attribute (VERT) attached to every forest polygon[1]. All FRI information is determined from, and assigned to, one overstory layer for the following vertical structures:

- Single Story. Vertical structure code SI is assigned to mainly single story stands.
- Single Story with Veterans. Vertical structure code SV is assigned to mainly single story stands with a veteran (super canopy) component representing less than 10% of the total crown closure. During FRI interpretation the veteran layer is included in the species string with the main single story layer beneath.
- Complex. Vertical Structure code is CX is assigned to sands with multiple ages and heights to the point of not being able to distinguish separate layers. Even though these stands are associated with an uneven-aged condition only one species composition string is interpreted.

Since only one species string is interpreted for the above conditions, the forest unit and associated growth and yield parameters are based on the single layer. However, for stands that are consider multi-tiered, two distinct layers are present of at least 3 m in height difference or 20 years of age difference, and where each layer occupies at least 10% total crown closure, then assigning a forest unit, and growth and yield parameters requires adjustment.

The following vertical structure indicates a multi-tiered condition.

- Two-tiered: Overstory is considered the dominant layer during photo interpretation/inventory creation, thus the overstory is the layer used to assign the DEVSTAGE value. Vertical structure code TO.
- Two-tiered with veterans: Overstory is considered the dominant layer during photo interpretation/inventory creation thus the overstory is the layer used to assign the DEVSTAGE value. The veteran layer occupies less than 10% crown closure of the stand. The veteran layer is included in the species string for the nearest layer in height. Vertical structure code MO.
- Two-tiered: Understory is considered the dominant layer during photo interpretation/inventory creation, thus the understory is the layer used to assign the DEVSTAGE value. Vertical structure code TU.
- Two-tiered with veterans: Understory is considered the dominant layer during photo interpretation/inventory creation, thus the understory is the layer used to assign the DEVSTAGE value. The veteran layer occupies less than 10% crown closure of the stand. The veteran layer is included in the species string for the nearest layer in height. Vertical structure code MU.

For the two-tiered condition, both the overstory and understory have an associated separate complete FRI description.

[1] Ontario Forest Resources Inventory Photo Interpretations Specifications (Revised Specifications March 1, 2012).

The Issue

This added level of detail for the two-tiered condition represents an improvement over past FRI where the interpreter would assign only one FRI description for multi-tiered polygons, however current forest management planning structures and tools still require a single FRI description for the multi-tiered condition. However, this discrepancy between previous FRI and the current FRI presents challenges for the current planning process, in particular for the Great Lakes-St. Lawrence forest region where white pine shelterwood silviculture systems are commonly planned and implemented. A single FRI description assigned to the polygon is necessary for several reasons:

- Current modeling practices requires a stand description based upon one canopy. Standard forest units are based upon a single species composition string (Parton et al. 2006[2]) thus assignment to a forest unit requires a single species composition string with an associated single set of yield curve parameters.
- Yield curves reflect the combined volume of both upper and lower tree canopies. This is important in particular for the shelterwood where during a prep cut or seed cut, the lower canopy could be the main source of product volume.
- The Landscape Guide targets were determined under the former FRI where the canopies were blended by the photo interpreter into one species string. Thus current forest units must be able to, as much as possible roll up into Landscape Guide classes. Blending is in effect an attempt to capture the older photo interpreted blending to be consistent with the Landscape Guide.
- For white pine shelterwood systems both overstory and understory canopies are being managed.

Simply using the overstory layer FRI description for TO and MO vertical structures, and using the understory layer FRI description for TU and MU vertical structures is one option to assigning one FRI description to a polygon. However, we feel that there is a lot of information lost by only using the description assigned to one layer and ignoring the description of the second layer. Consider the example presented in Table 1 which may have a TU vertical structure attribute. The overstory species composition is dominated by white pine with a component of red pine and collectively have a crown closure of 30%. The overstory is greater than three meters in height compared to the understory or has a year of origin greater than 20 years from the understory. The understory has a mixture of spruce, birch, white pine, red maple, hard maple and balsam fir. Collectively the understory has a crown closure of 70%. If only the understory were used to describe the species composition, we would use the mixedwood for strategic level planning and reporting. Writing a silvicultural ground rule based on the understory FRI description misses the contribution of the white pine seed source and the potential for a shelterwood silviculture system. For yield determination, the contribution of the white pine to volume is overlooked.

Proposed Blending Procedure for Unmanaged White Pine Polygons

To overcome what could be a misleading FRI description based on only one of the stand forest story layers, we suggest a process for blending the overstory and understory canopies into one FRI description. Blending of the two canopies into one FRI description is one method to bring two-tiered conditions in line with planning processes requiring a single descriptor. In addition,

[2] Parton, J., S. Vasiliauskas, G. Lucking and W.R. Watt. 2006. Standard Forest Units for Northeastern Ontario Boreal Forests. Ontario Ministry of Natural Resources, Northeast Science & Information, South Porcupine, ON. NESI Technical Note TN-021. 23p.

where the blending procedure causes the lead species to change a procedure is also required to determine the associated yield parameters with the blended species composition string. The following note describes a procedure for blending the canopy layers for multi-tiered stands where both the overstory and understory canopies are known to be a component of the forest stand and the management of the stand is directed at both canopies.

Table 1. An example where overstory and understory canopies have distinctively different species compositions and crown closure. The resulting blended species composition has representation form all species present in the forest stand.

Overstory		Understory		Blended Species Composition
Species Composition	Crown Closure	Species Composition	Crown Closure	
Pw80Pr20	0.3	Sb30Bw20Pw20Mr10Bf10Mh10	0.7	Pw38Sb21Bw14Mr7Bf7Mh7 Pr6
Pw80Pr20	0.3	Sb30Bw20Pw20Mr10Bf10Mh10	0.5	Pw43Sb19Bw13Pr7Mr6Mf6 Mh6
Pw80Pr20	0.3	Sb30Bw20Pw20Mr10Bf10Mh10	0.8	Pw36Sb22Bw15Mr7Bf7Mh7 Pr5

To blend the species composition, the crown closure of each of the overstory and understory is used to proportionally represent each species correctly in the blended species composition. The blended species composition will equal the weighted sum by species to the nearest 1% by crown closure for the overstory and understory respectively.

The procedure for developing a blended species composition from the overstory and understory involves parsing each individual species contribution in the species composition string and multiplying by the respective percentage crown closure. The resulting blended species composition string is the derived from all weighted species from both the overstory and understory.

$$SPCOMP_i = \left(OSPP_i \times \frac{OCCLO}{(OCCLO + UCCLO)}\right) + \left(USPP_i \times \frac{UCCLO}{(OCCLO + UCCLO)}\right)$$

Where:

$SPCOMP_i$: Overstory/understory blended species composition for species i expressed as a percentage.

$OSPP_i$: Individual species proportion contributing to the FRI overstory species composition string.

$OCCLO$: Overstory crown closure expressed as a percentage

$USPP_i$: Individual species proportion contributing to the FRI understory species composition

$UCCLO$: Understory crown closure expressed as a percentage

The blended species composition string is the result of each individual blended species determination amalgamated into a single species composition string. In addition, one set of associated growth and yield parameters is needed when canopy blending is applied. The

following gives a procedure to blend both canopies and associated yield curve parameters depending on the vertical structure.

- Two-tiered where the overstory is considered the dominant layer during photo interpretation/inventory creation (TO, MO). Selecting only the overstory species composition would under-represent species contributing to the stand structure in the understory. There are two white pine conditions when the blended approach could be considered:

    i. When the overstory year of origin is the same or within 10 years of the understory year of origin, or the height difference between understory and overstory is less than 3 m. In this case, the overstory and understory essentially originated close to the same time so should be treated as one canopy layer.

    ii. When the overstory contains white pine and the understory stand is associated with a mature forest condition where the understory trees are of sufficient size to be merchantable. A merchantable understory defines a threshold between a mature forest condition in the understory as opposed to advance regeneration or 2-stage harvest (i.e., large advance regeneration that will be released).

    In all other conditions, only the overstory species will be used to define the species composition string of the forest stand.

    For the growth and yield parameters, if the lead species of the blended canopy equals the lead species of the overstory then use the parameters associated with the overstory. If the lead species of the blended canopy is not the same as the lead species of the overstory then use the parameters associated with the overstory.

- Two-tiered where the understory is considered the dominant layer during photo interpretation/inventory creation (TU, MU). Selecting only the understory species composition would under-represent key seed source species contributing to the forest stand structure in the overstory. There are two conditions when the blended approach will be used:

    i. When the overstory year of origin is the same or within 10 years of the understory year of origin, or the height difference between understory and overstory is less than 3 m. . In this case, the overstory and understory essentially originated close to the same time so should be treated as one canopy layer.

    ii. When the overstory contains white pine. Ensures that stands with an overstory component of white pine can be assigned into the correct forest unit based on its contribution to the stand. The overstory white pine represents a seed source.

    In all other conditions the understory species will be used to define the species composition string of the forest stand.

    For the growth and yield parameters, if the lead species of the blended canopy equals the lead species of the understory then use the parameters associated with the understory. If the lead species of the blended canopy is not the same as the lead species of the understory then use the parameters, except site class, associated with the understory. For site class use the leading species of the overstory and then convert to the site class of the lead species of the understory using the look-up tables of Mauer (1993[3]). The use of height over age to determine site class and site index is based on open grown trees associated with the overstory; understory trees are likely suppressed to some degree so may not express the

[3] Mauer, N. 1993. Local tree volume tables for northeastern Ontario. Ministry of Natural Resources, Northeast Science and Technology, South Porcupine, ON. NEST Field Guide FG-002. 101 p.

height potential for the site.

For the example in Table 1, when the crown closure is used to weight the contributions of the species composition, the blended species composition indicates that the forest stand is still dominated by white pine but with a significant mixedwood component. We recognize that initially blending may potentially result in representation of a substantial area in the mixedwood condition but for white pine shelterwood this does represent the intent of the practice. We intend to move white pine mixedwoods into a more white pine dominated condition.

The Case of Actively Managed White Pine Shelterwoods

Consideration for blending under actively managed white pine shelterwood harvests (PWUS4, PWUSC, PWUSH) is dependent on the particular stand history and where you are along the shelterwood continuum. Where white pine shelterwood is indicated on the FRI but historically the management records for follow-up harvesting or treatments have been lost or shelterwood treatments were applied under older out-of-date prescriptions then canopy blending may be a necessary consideration. However, for actively managed white pine shelterwoods where the forest practitioner has records of the harvests, treatments and results, canopy blending may be unnecessary. In general though, consideration for the need of canopy blending is dependent upon where you are along the stage of management continuum for the white pine shelterwood system (Table 2). Stand identified as a prep cut are most likely in need of canopy blending since detailed species composition and yield parameters may not be identified at this stage. However, for stands later in shelterwood management, more detail is collected to ensure the proper harvest and whether subsequent regeneration is successful. Final removal is at the end of the process where the understory layer is known and the overstory canopy to be removed so will not need blending.

Table 2. Consideration for the need for canopy blending is dependent upon the stage of management for the white pine shelterwood silviculture system.

Stage of management along the shelterwood continuum	Need for Canopy Blending
Prep cut	Most likely to be blended
Seed cut	Likely to be blended
First cut	Might need to be blended
Final removal	Likely not to be blended