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Institut de recherche sur les feuillus nordiques Inc.
Northern Hardwoods Research Institute Inc.

Effects of Decay and Discolouration on Value in Tolerant Hardwoods

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Technical Note

Resource Characterization

Introduction

Veneer and sawlog quality hardwood logs are highly valuable in the market. Besides log geometry (diameter, length, and taper), quality attributes (presence of defects and dark heart ratio) are the major criteria that are being used to grade hardwood logs. Although 1/3 of dark heart (discoloured wood) is acceptable for sawlog quality logs, un-blemish white colored lumbers are always desirable and more valuable than the one which has some discoloration (e.g. Fig 1, FAS grade, No. 1C grade and pulpwood). Moreover, the log value drops down significantly for pulpwood grade. Generally, trees of genus *Acer* and *Betula* do not have colored heartwood (Fig 2a). However, stem damages (due to branch death or other mechanical damages) that expose sapwood to the micro-organisms introduce discoloration (Fig 2b).

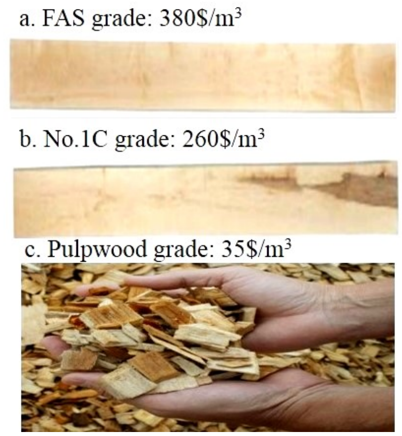

Fig. 1: Log price variation due to quality.

Fig. 2:a. Sugar maple stem cross-section (diameter ≈30 cm) **b.** Decay and discoloration linked to old dead branch injury in a sugar maple stem.

Highlights

- ***Retaining DBH > 50cm trees does not improve the production of high-value timber, as they increase proportions of decay and discolouration.***
- ***Minimize harvesting damage to increase proportions of high vigour (R1 and R2) trees in the stand.***
- ***As vigorous trees are likely to have less discolouration, let canopy grow vigorous crowns by reducing competition.***
- ***Think hard before considering red maple as a crop tree during partial harvesting as they grow with more discolouration.***

Reviewed: May 2018

Injury-discolouration-decay is a three-phase continuum of processes beginning with (1) wounding, entrance of air and subsequent oxidation; then (2) invasion by bacteria and non-decay fungi; and finally (3) invasion of decay fungi. Since they are both linked to stem damages, decay and discoloured wood proportions in crop trees can be minimized through careful implementation of silvicultural operations. Therefore, this study aimed at exploring relationships between decay/discoloured wood proportions and tree characteristics so that silvicultural decisions can be made to keep decay and discolouration minimum in crop trees.

Methodology

A total of 383 trees were used for the analysis that were coming from three different sites of northwest New Brunswick. The sample included a wide range of tree sizes from 18 to 82 cm DBH and 12.5 to 29.2 m tree height (Table 1). Trees were classified by their form (F, 8 classes) and risk of losing vigour (R, 4 classes) using Tree Classification System for New Brunswick. However these classes were regrouped to detect statistical significant differences between the groups. Thirty five percent (35%) of sample trees were forked (F2, F5 and F7) and the remaining were non-forked. Almost half of the sample trees were at high risk of losing vigour (R3 and R4). Width of decay and discoloured wood column at both large and small end of logs were measured to compute cross-sectional area of decayed and discoloured wood area at the point. This cross-sectional area information was then used along with log length in Smalians's formula to compute decayed and discoloured wood volume in a given log. Tree level decayed and discoloured wood volume was obtained by summing up the log level decayed and discoloured wood volume. This information was used in regression analysis to develop the models for predicting decay and discoloured wood proportion in a given diameter tree.

Table 1: Sample tree information (* indicates average value. Range is provided in parenthesis. ** indicates number of trees. Percentage of the respective category is provided in parenthesis).

Species	DBH (cm)*	Height (m)*	Forked **	Non-forked**	High risk**	Low risk**	Total
SM	31 (18-82)	19.8 (12.5-29.2)	41 (33%)	85 (67%)	59 (47%)	67 (53%)	126
RM	29 (18-74)	18.9 (14.4-24.7)	57 (49%)	59 (51%)	72 (62%)	44 (38%)	116
WB	24 (18-30)	18.7 (14.2-21.3)	3 (21%)	11 (79%)	6 (43%)	8 (57%)	14
YB	32 (18-74)	18.3 (12.5-24.8)	39 (31%)	88 (69%)	66 (52%)	61 (48%)	127

Results

1. Probability of a tree to have decay: Tree and site information (e.g. species, DBH, height, site, risk class, form class) were used to predict probability of a tree to have decay (Fig 3). Among the tested variables, risk class and tree diameter at breast height (DBH) were found to have significant effect on probability of a tree to have decay in it. Probability to have decay increased as tree diameter increases. Trees that have several defects are more likely to have decay than the trees that have few minor defects for a given tree diameter.

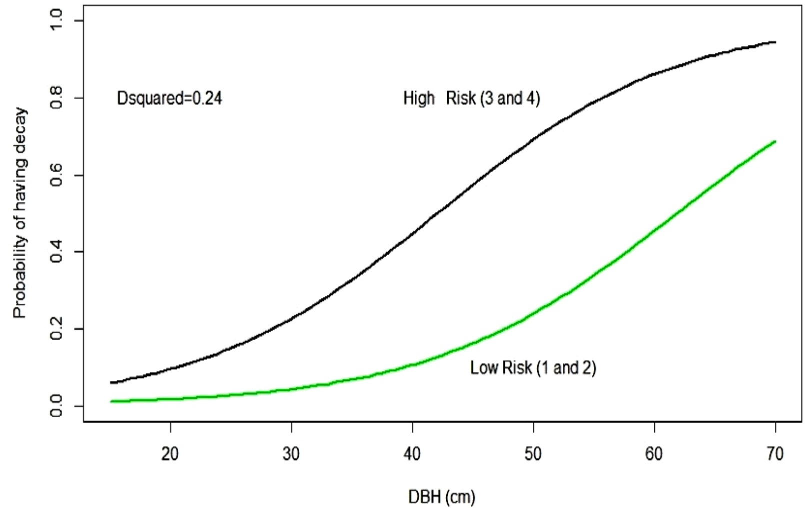

Figure 3: Decay probability in trees of different vigor class with increasing tree diameter in tolerant hardwoods of northwest New Brunswick.

2. Proportion of discoloured wood volume in a tree: Discoloured wood proportions in the tree stem were found to vary with tree diameter, height, species, tree form and risk of losing vigour at a site (Fig 4). Large diameter trees that are at high risk of losing vigour (most likely due to presence of severe damages on the stem) were found to contain higher proportion of discoloured wood volume. Compared to other hardwood trees, red maple was found to have higher proportions of discoloured wood volume for a given tree diameter. On the other hand, tall and forked trees were found to have smaller proportions of discoloured wood volume.

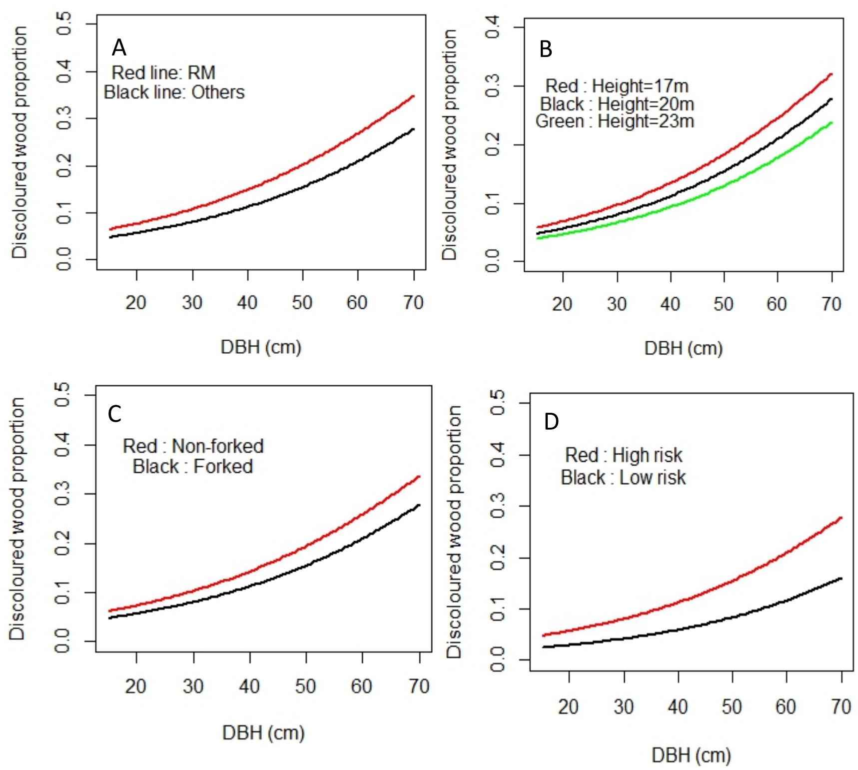

Figure 4: Effects of (A) species, (B) Height, (C) Form class (Forked=F3,F5,F7; Non-forked=Others), (D) Risk of losing vigour (High risk=R3 and R4, Low risk=R1 and R2) on proportion of discoloured wood volume for a given diameter tree. Note that trees that have zero discoloured wood volume were not used in the analysis.

Conclusion

Large diameter trees (DBH > 40cm) that are associated with more damages (R3 and R4) are highly probable to have decay in them. However, proportions of decay volume were found to increase only as the tree diameter increased (results not shown). Moderately precise predictions (D-squared = 0.35) of the proportions of discoloured wood proportions were also found to increase as the tree diameter increased and with the presence of several damages on the tree stem (high risk: R3 and R4 — model not shown).

As taller trees for a given diameter are generally more vigorous than the shorter ones, such trees were found to have less proportions of discoloured wood volume. Although we did not find any significant differences on discoloured wood proportions among sugar maple, yellow birch, and white birch, there was significantly higher discoloured wood proportions in red maple. One reason could be the higher representation (62%) of high-risk (R3 and R4) red maple trees in our sample. In addition, red maple trees might have been growing less vigorously in the northern limit of tolerant hardwoods. As tree vigour is positively related to tree's compartmentalization ability, red maple trees would have been poorly compartmentalizing the damages and this have higher proportions of discoloured wood volume.

Surprisingly, contrary to the general observations, we found that forked trees had significantly lower proportions of discoloured wood volume than non-forked trees. This could be possible due to larger crown projection area of forked trees that might increase tree vigour by a higher solar inception and thus have lower proportions of discoloured wood volume (results not shown).

These are preliminary results. Whiles the study is being finalized, we still want to go further on developing a taper equation for decay and discoloured wood column inside a tree stem. In addition, as decay and discolouration varies significantly among site, we are expecting data from other sites as well.

Acknowledgement

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