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

# Increasing Sawlog Yields I:
## Prediction Tool for Product Basket by Using Tree Form and Risks

July 2015

Technical Note

Resource Characterization

## Introduction

Product baskets for hardwoods can be predicted using volume tables and applying non-empirical reduction factors to reflect product downgrade rates and cull amounts, but this relies on equations developed decades ago using data from other jurisdictions and are not species specific. Furthermore, the equations are known to contain biases and errors.

To provide a tool for predicting product basket from empirical values, a bucking study was conducted on hardwood trees to create a product recovery matrix linked to four standing tree attributes: DBH, species, tree form and risk of losing vigour/ value.

## Highlights

- ***Tree form and its risk of losing vigour have impacts on sawlog recovery.***
- ***A tool using DBH, tree form, risk of losing vigour, and species was developed to create an interactive matrix that can help predict sawlog recovery.***
- ***It can be used to set targets for sawlog recovery and therefore greatly improve value***
- ***We are working on having the tool to use Enhanced Forest Inventory variables (LiDAR-derived EFI)***

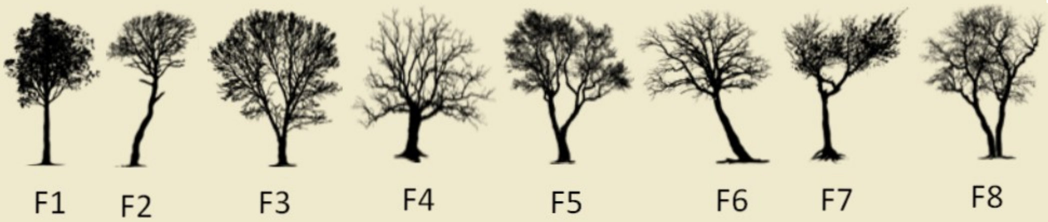
## Methodology

Across five sites, a total of 851 trees were selected for the study (2013 and 2015), all having a minimum DBH of 16 cm and were topped at 8 cm. Each tree was identified by its species and its DBH was recorded. Additionally, trees were classified by their form (8 classes) and risk of losing vigour (4 classes). All these variables are part of the Tree Classification System for New Brunswick (Figure 1).

The sampled stems covered three different species with eight different form classes (Table 1) and four risk of losing vigour classes (Table 2). Stem DBH ranged from 16 to 82 cm (Figure 2).

Reviewed: May 2018

**Figure 1:** A Tree Classification System for New Brunswick.
The Northern Hardwoods Research Institute has developed a Tree Classification System for New Brunswick based on species, DBH, tree form (F1 to F8) and risk of losing vigour (R1 to R4). Readers are invited to refer to the complete guide at [www.hardwoodsnb.ca](www.hardwoodsnb.ca)




| Risk of Losing Vigour Rating | Probability of mortality | Value ($) projected in time | Probability of product downgrade |
|---|---|---|---|
| **R1** | Nil, > 25 years | Improve | Low |
| **R2** | Low, 15-25 years | Stable | Moderate |
| **R3** | Medium, 5-15 years | Deteriorate | High |
| **R4** | High, < 5 years | Substantial loss | Very High |

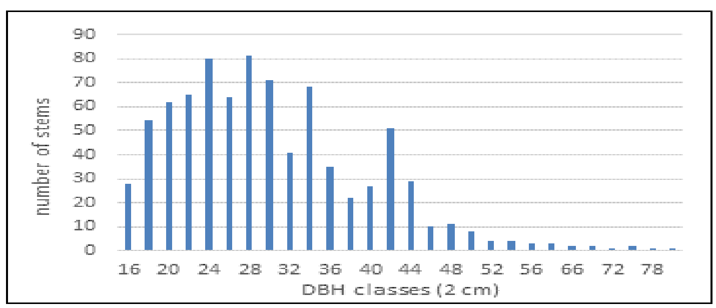
**Table 1:** Form class distribution (F1 to F8) among sampled species.

| Species distribution | F1 | F2 | F3 | F4 | F5 | F6 | F7 | F8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| Sugar Maple | 220 | 27 | 14 | 1 | 19 | 22 | 38 | 37 | 378 |
| Yellow Birch | 96 | 38 | 21 | 0 | 10 | 8 | 26 | 12 | 211 |
| Red Maple | 146 | 38 | 8 | 0 | 36 | 5 | 8 | 21 | 262 |
| | 462 | 103 | 43 | 1 | 65 | 35 | 72 | 70 | 851 |

**Table 2:** Risk class distribution (R1 to R4) among sampled species.

| Species distribution | R1 | R2 | R3 | R4 | Total |
|---|---|---|---|---|---|
| Sugar Maple | 72 | 208 | 51 | 47 | 378 |
| Yellow Birch | 21 | 108 | 48 | 34 | 211 |
| Red Maple | 26 | 110 | 86 | 40 | 262 |
| | 119 | 426 | 185 | 121 | 851 |

**Figure 2:** DBH distribution.




Each stem was assessed for the presence of defects and evaluated/bucked following the Petro log classification system (Appendix 1) into F1, F2 and F3 sawlogs of 8 and 9 feet. Additionally, bolts of 6 and 7 feet were produced using Quebec Natural Resources Department specifications (Appendix 2) to maximize recovery. Remaining logs were classified as pulp logs or wood chip sections.

The Petro log classification system was developed as a tool to improve slashing in today's hardwoods stands where trees that produce up to three, 16-foot sections free of defects are rare and where stands of low quality are relatively common (Petro and Clavert 1990).

# Results

Results are for the lot of sampled trees and do not represent a typical harvest block land run. Sample trees have been selected to cover all the tree variables and to fulfil statistical requirements on variability and standard error in certain categories. The bucking exercise was carried out manually and does not represent operational conditions. Hence, the resulting potential sawlog recovery may surpass expected operational yield. Sawlog potential was calculated by summing up all possible sawlog materials: F1, F2 and F3 sawlog and recovery bolts sections. Pulp and wood chips sections were excluded.

The eight tree form classes (F1 to F8) have been grouped into three categories (good form, acceptable form and poor form), based on the location of the fork along the main stem (Figure 3). This fork location has a great impact on the resulting possibility of producing sawlog.

The trial results show that sawlog recovery tends to be higher for good form trees compared to acceptable or poor form trees, except for larger diameters where sampling rate was lower (Figure 4). Similarly, sawlog recovery tends to be higher for vigorous trees compared to less vigorous trees (Figure 5). Among species, sawlog yield varies only slightly between Sugar Maple and Yellow Birch but seems to be lower for Red Maple (Figure 6).

**Figure 3:** Fork presence affecting sawlog yield.

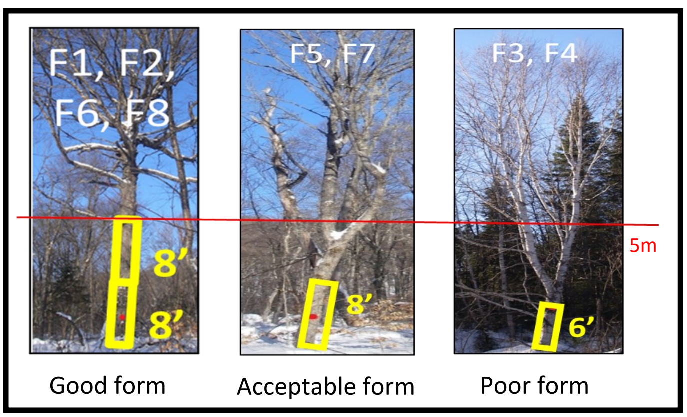



**Figure 4:** Varying sawlog recovery by tree form.

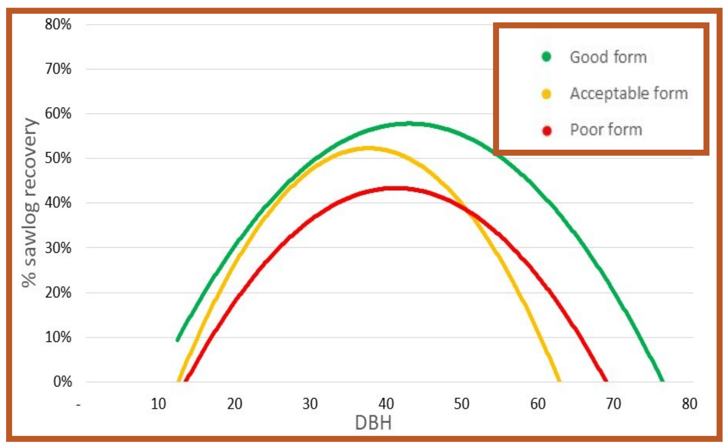



**Figure 5:** Varying sawlog recovery by tree risk.

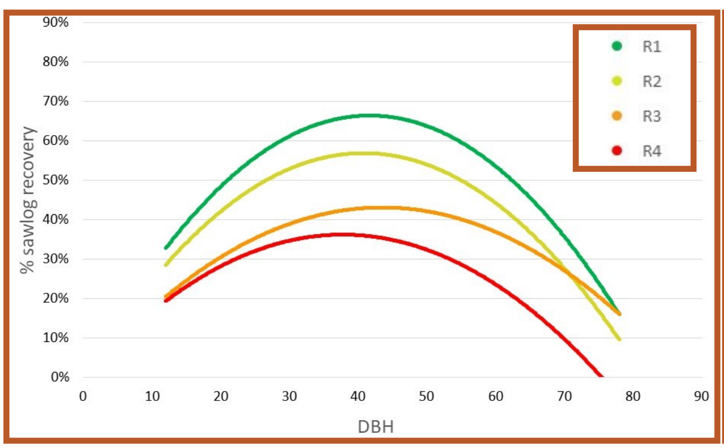
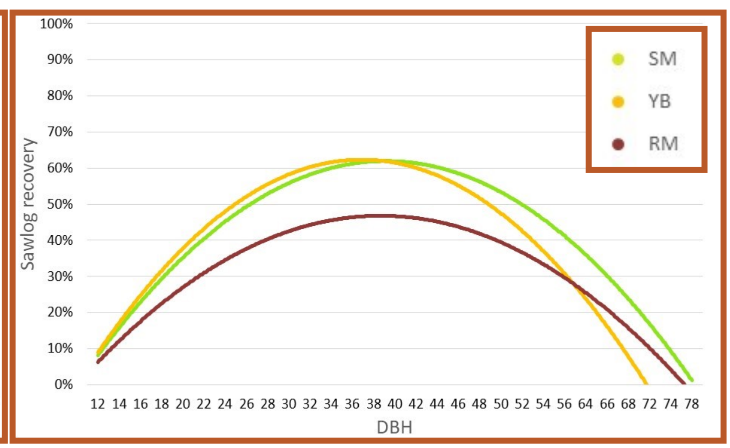



**Figure 6:** Varying sawlog recovery by species.

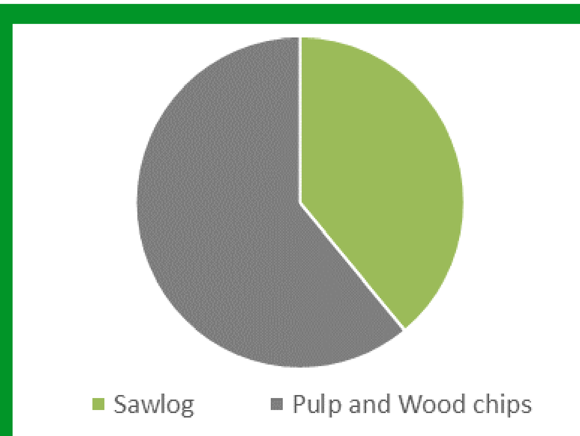


# Tool

With the study data, a product recovery matrix has been developed to estimate sawlog recovery at the tree level, from four standing tree variables: species, DBH, tree form and risk. This matrix is also available from the NHRI as an interactive, electronic tool to provide product recovery from computerized data, such as stand tables (Figure 7).

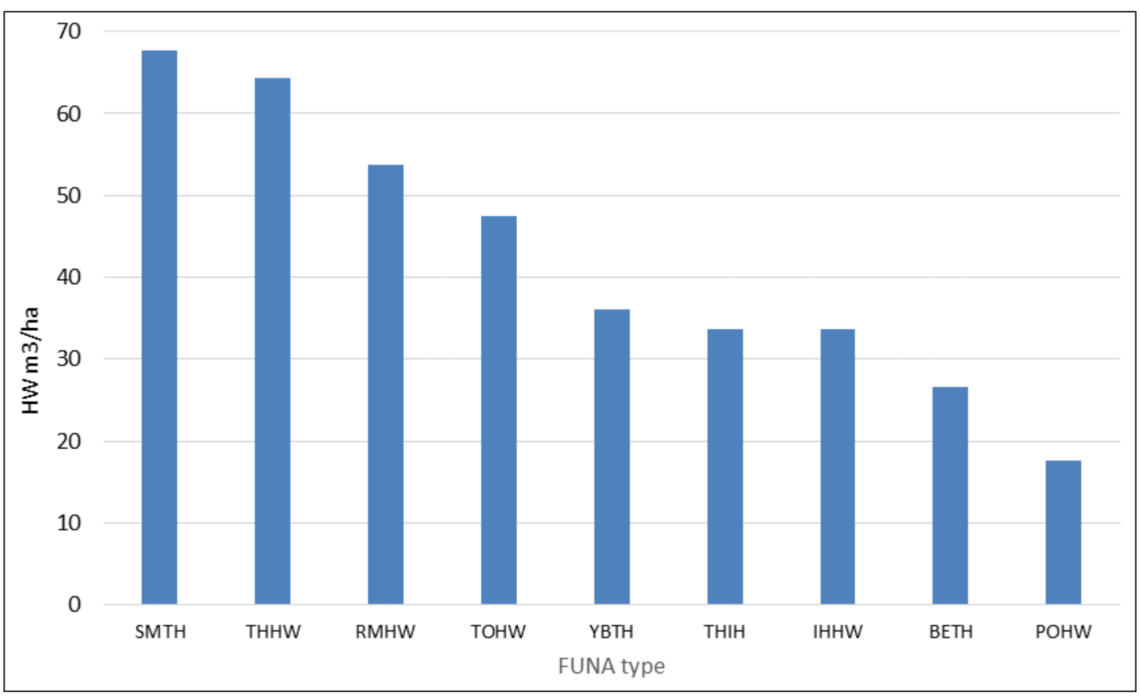
**Figure 7:** Snapshot of the electronic interactive hardwoods product matrix and predicted sawlog yield.

| Enter stand table here: | | | | | Results: | |
|---|---|---|---|---|---|---|
| Tree # | Species | DBH | Form | Risk | % sawlog | Sawlog volume (m3) |
| 1 | YB | 30 | F1 | R2 | 55% | 0,23 |
| 2 | SM | 24 | F2 | R1 | 52% | 0,15 |
| 3 | YB | 20 | F3 | R2 | 32% | 0,05 |
| 4 | SM | 22 | F4 | R1 | 41% | 0,09 |
| 5 | SM | 30 | F5 | R4 | 27% | 0,13 |
| 6 | SM | 18 | F6 | R2 | 34% | 0,05 |
| 7 | RM | 40 | F7 | R3 | 41% | 0,33 |
| 8 | SM | 20 | F8 | R1 | 42% | 0,08 |
| 9 | RM | 25 | F5 | R4 | 20% | 0,06 |
| 10 | SM | 36 | F2 | R3 | 47% | 0,32 |




As an example, the product matrix has been applied to some plot data to illustrate the predicted sawlog yield of different FUNA types (Figure 8). Even though the product matrix was derived from the sample trees, it can be applied to any stand. It should be noted that the predicted sawlog yield with the matrix represents the maximum potential yield.

**Figure 8:** Sawlog yield for different FUNA types predicted by the hardwoods product matrix.



# Conclusion

The goal of the project was to develop a predictive matrix for hardwood trees. A bucking exercise was conducted on hardwood trees to produce a recovery matrix linked to four tree attributes: DBH, species, tree form and risk. The results show that those four variables affect the resulting sawlog yield. This tool is useful to managers in decision making by providing a way of predicting sawlog yield from standing tree inventory.

Future work is already underway to develop algorithms to link the matrix tool to aerial LiDAR data. This new technology allows to produce enhanced inventory attributes and could provide a mean of predicting product baskets over large areas. As for the electronic version of the product recovery matrix tool, NHRI is ready to partner with potential users and their operations.

# References

Petro, F.J. and Clavert, W.W. 1990. La classification des billes de bois franc destinées au sciage. Forintek Canada Corp. SP519F.

# Acknowledgement

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# Appendices

**Appendix 1:** Petro log classification system.

| Quality Criteria | | F1 log | | | F2 log | | | | F3 log |
|---|---|---|---|---|---|---|---|---|---|
| Position of log: | | Butt log | Butt log and others | | Butt log and others | | | | Butt log and others |
| Minimum diameter (cm) | | 34-48 | 40-48 | 50 + | 28 | 30 + | | | 20 + |
| Minimum length (ft) | | 10 | | | 10 | 8-9 | 10 | 12 + | 8 + |
| Clear sections | Minimum length (pi) | 7 | 5 | 3 | 3 | | | | 2 |
| | Number | 2 | | | 2 | | | 3 | Unlimited |
| | Yield % | 83% | | | 67% | 75% | 67% | 67% | 50% |
| Sweeps | Less than 1/4 small end sound defects | 15% | | | 30% | | | | 50% |
| | More than 1/4 small end sound defects | 10% | | | 20% | | | | 35% |
| | Decay and sweeps | 40% | | | 50% | | | | 50% |

**Appendix 2:** Quebec Natural Resources Department bolt specifications.

| Quality criteria | | Bolt |
|---|---|---|
| Minimum diameter (cm) | | 16 |
| Minimum length (ft) | | 6 |
| Clear sections | Length of sections (ft) | 2 |
| | Yield % | 66% |
| Decay and sweeps | Less than 1/4 small diameter sound defects | 10% |
| | More than 1/4 small diameter sound defects | 5% |