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

Developing a Methodology to Map Trees to Harvest in Low Volume Stands

January 2016

Technical Note

Harvesting and Operations

Introduction

- In local forests, natural disturbances and past silvicultural regimes have in some cases created uneven-aged stands that are challenging to manage.
- The sparse overstory of these stands contains valuable trees, but they vary in terms of species composition, tree quality and age, and require different harvesting treatments. Areas to harvest are often spread over large distances, and harvesters are required to cover large areas to harvest low wood volume. This reduces productivity, increases wood cost and destroys established regeneration.
- Mapping zones of financial interest, i.e. 20x20 m micro-stands or individual trees with high sawlog content and high risk of losing vigour, is crucial for the planning of efficient trail networks for lower logging costs and reduced damage to soil and regeneration.
- This project aimed to develop a methodology that uses low point density LiDAR to map (1) tree diameter, (2) risk of value deterioration, and (3) tree form, both at the 20x20 m micro-scale and the individual tree level.

Highlights

- ***An area based approach (20x20m plots) yields a higher classification accuracy for inventory attributes than an individual tree crown approach.***
- ***DBH was classified with an accuracy of 71% and the proportion of risk class 3 and 4 with an accuracy of 64%.***
- ***This method has great potential but would benefit from denser LiDAR data.***

Methodology

1) The study was carried out in the McCoy Brook area in northwest N.B.
2) Within the study region, mapping units (i.e.: 20x20m plots or individual tree crowns) were delineated.
3) For each mapping units, a larger number of metrics were calculated from [1] LiDAR data (1 pulse/m^2) and [2] geospatial layers.
4) Using a random forest variable selection method, the best LiDAR and geospatial metrics were selected for each desired inventory variable.

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5) The k-Nearest Neighbour algorithm was used to impute the inventory attributes to unsampled areas.

6) Maps were created and the accuracy of the predictions was verified with ground truthing.

Results

1. Area-based approach:

When considering 20x20m plots, the correct DBH class was assigned to 71% of the plots. The quadratic mean diameter and proportion of risk class 3 and 4 trees were classified correctly at 64%.

Table 1: Overall classification accuracy (%) of four estimated forest attributes with a *k*--NN imputation measured on 14 random sampled 400m^2 tiles among four study blocks.

Inventory attributes	n of classes	Overall accuracy
Diameter at breast height (DBH)	4	71%
Quadratic mean diameter (QMD)	4	64%
Stem density	8	21%
Proportion risk 3 and 4	4	64%

Classified inventory attributes can be integrated in a map to be used as a decision helper for operation planning. The map below shows the 20x20m plots to be harvested in priority, in green, based on the area-based classification.

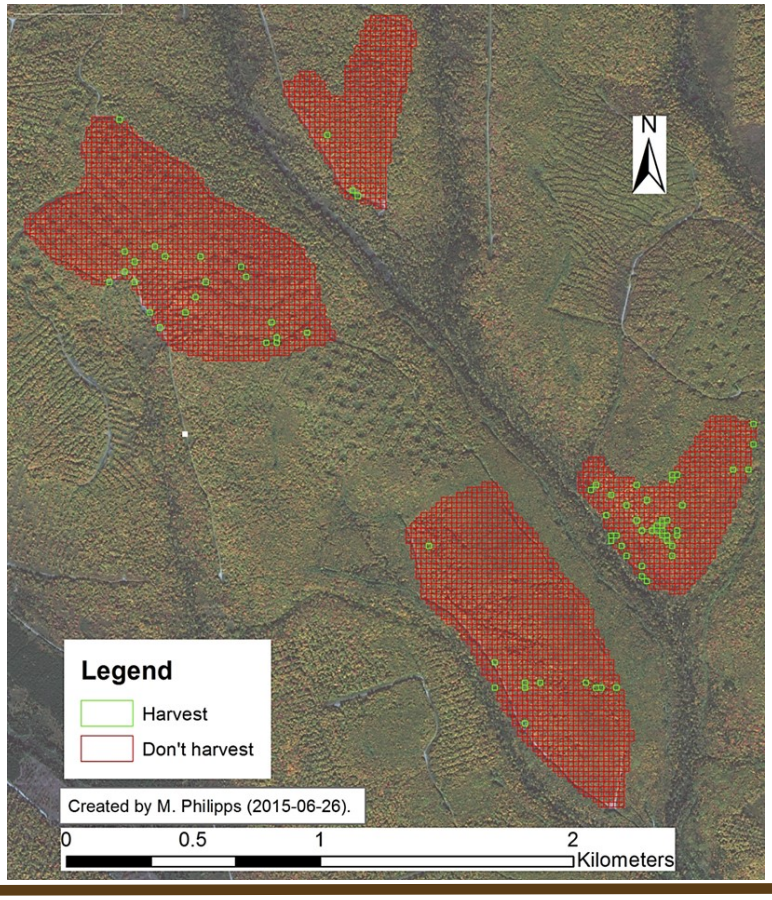

Figure 1: Final map based on the area based approach predictions. Green tiles indicate the cells to harvest in priority. Note that this selection is not absolute and is context related.

Automatic tree crown segmentation could not be achieved successfully partly due to the low density of the LiDAR data (1 pulse/m^2). Classification at this scale was, therefore, not completed. Variable selection performed on manually segmented crowns suggests, however, that height and crown projection area metrics are relevant predictors of inventory variables, although not significantly enough to be used in a classification. This indicates that this method using higher density LiDAR has great potential of yielding accurate classification of inventory attributes.

Conclusion

Using 1 pulse/m^2 LiDAR data and combining a random forests variable selection method with the k-Nearest Neighbour algorithm, we achieved a classification with 71% accuracy for DBH class, and 64% accuracy for the quadratic mean diameter and proportion of risk class 3 and 4 trees on 20x20 m plots. For individual trees the classification was not accurate enough and, therefore, we recommend the use of higher density LiDAR data (e.g. 6 pulses/m^2 or more) for future attempts at tree crown segmentation and inventory variable prediction.

References

Philipps, M. (2015). *Development of a methodology to map trees to harvest in low volume stands*. (Master's thesis). Université de Liège - Gembloux Agro-Bio Tech & NHRI.

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