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

Multi-Treatment Planning Tool (MTPT)

July 2014

Technical Note

Harvesting and Operations

Introduction

A large proportion of hardwood stands in New Brunswick are highly variable (species distribution, development stage, tree form, etc.). In an attempt to better address this variability, the Northern Hardwoods Research Institute Inc. (NHRI) developed a multi-treatment method where silvicultural treatments within a single harvest block can vary on a one hectare scale. The rational for this project is that in order to treat complex and heterogeneous hardwood stands, flexibility on the type and spatial distribution of silvicultural treatments could be an asset. Instead of applying a single treatment over a large area that presents varying conditions, maps of treatment type and location would be produced to assist machine operators on the appropriate treatments to perform. In addition, with the help of the forest inventory at a resolution of one plot per hectare, areas comprised of desirable species (yellow birch and sugar maple) but with very low volume could be classified as wait zones (areas where no harvesting and machine traffic is permitted). We anticipated that by removing these areas and concentrating operations where sufficient volume is available for harvest, machine tracking would be reduced. This reduction could also translate in an improved management of hardwood dominated stands and lower operating costs.

Highlights

- *A tool enabling harvester operators to shift prescriptions on-the-fly in real time using on-board machine navigation computers was developed. It is designed to function using actual field inventory.*
- *An Excel spreadsheet and an ArcGIS extension tool were built for the planning of operations.*
- *The tool was beta tested and shows a great improvement over the status quo.*
- *The identification of no-entry zones before hand improve productivity.*

Methodology

1. Overview of the method developed.

The multi-treatment developed at the NHRI, named **M**ulti-**T**reatment **P**lanning **T**ool (MTPT), is a three step method aimed at determining the appropriate silvicultural treatments to apply at a resolution of one hectare and spatially distributing these treatments directly in a geographic information system such as ArcGIS. The latter is critical to permit harvester and feller-buncher operators to see, directly on their on-board computer, the location and type of treatments to

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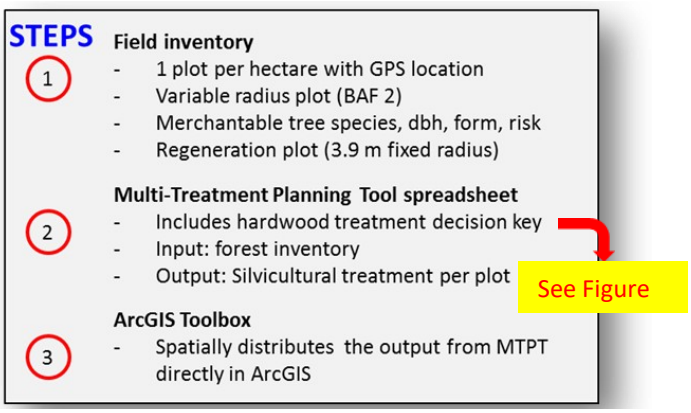
apply. In order for the two tools to work seamlessly, individual inventory plots required GPS locations and numbering. Additional details on each of the three main steps listed to the right can be obtained by contacting the NHRI.



2. Description of test sites.

In total, ten blocks have been tested using the multi-treatment approach. Before forest operations commenced, each block was separated randomly in two sections of similar size and named MTPT and Status Quo (SQ). Treatments in all SQ sections were determined by the industrial companies. From those ten blocks, nine MTPT sections have been developed using the same hardwood treatment decision key and will thus be the focus of the technical note (Table 1; Figure 1). Five test blocks were on New Brunswick Crown Lands (license 9) and four on Acadian Timber Corp. freehold land. They ranged in size from 19.2ha to 217.6ha. The total area operated was 612 ha represented by 655 field inventory plots. Two main mechanized harvesting methods were applied: 1) cut-to-length using a single-grip harvester and forwarder and 2) full-tree using a feller-buncher and grapple skidder combination. One block was selected by the sub-licensee for a tree length conventional operation with chain-saw and cable skidder teams.

Table 1: Basic block and harvesting method/system information.

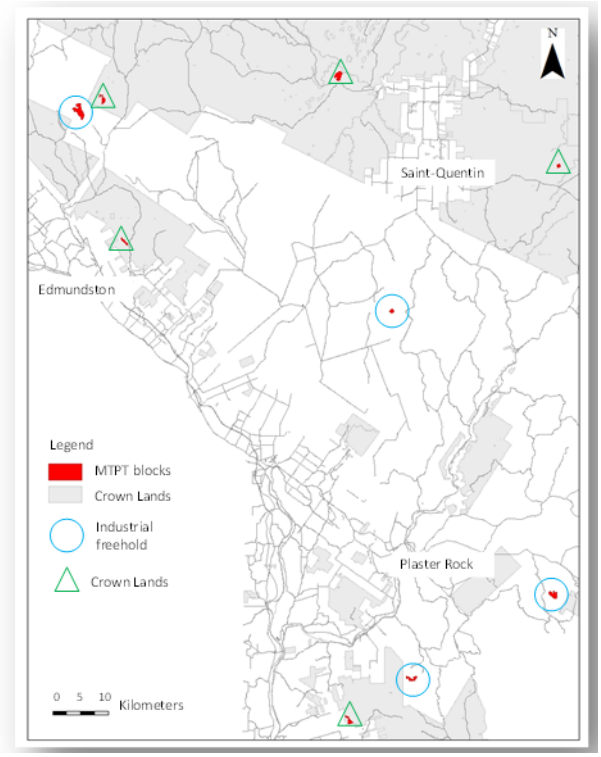
Block	Tenure	Method	Number of plots	Total area (ha)	Harvesting Method	Harvesting system
1096467	Crown	MTPT	62	67.1	Full tree	Feller buncher with grapple skidder
		SQ	101	58.3		
4092300	Crown	MTPT	25	20.8	Full tree	Feller buncher with grapple skidder
		SQ	28	20.0		
4092802	Crown	MTPT	10	9.3	Tree length	Conventional with cable skidder
		SQ	10	9.9		
4097180	Crown	MTPT	15	18.6	Cut-to-length	Harvester with forwarder
		SQ	9	9.4	Full tree	Feller buncher with grapple skidder
409415A	Crown	MTPT	13	11.3	Cut-to-length	Harvester with forwarder
		SQ	18	17.1		
F981966	Freehold	MTPT	117	106.0	Full tree	Feller buncher with grapple skidder
		SQ	113	111.6		
F985052	Freehold	MTPT	35	50.7	Full tree	Feller buncher with grapple skidder
		SQ	31	34.7		
F985243	Freehold	MTPT	18	19.0	Full tree	Feller buncher with grapple skidder
		SQ	17	10.2		
F989570	Freehold	MTPT	25	24.5	Full tree	Feller buncher with grapple skidder
		SQ	8	13.8		
		Total	655	612.3		

Results

Following the use of the MTPT spreadsheet, 37% of the total area attributed to MTPT was classified as shelterwood first pass (SH1), 24% as shelterwood second pass (SH2), 18% as single tree selection (SC), and 12% as clear cut (CC). Wait zones (WAIT) accounted for almost 10% of the total area (Figure 2A). Due to the limited length of the technical note, detailed treatment objectives and associated pecking order will not be addressed. Different silvicultural treatments were applied in the SQ sections with the highest area treated as single tree selection (62%) and seed treatments (15%), Over 80% of the area harvested in both methods was with a feller-buncher and grapple skidder combination (Figure 2B). A slightly higher proportion of cut-to-length was used in the MTPT sections since no seed tree treatment was available in the MTPT decision key. This treatment usually requires the use of a feller-buncher to expose mineral soil.

Once harvesting operations were completed, all plots were re-inventoried to quantify percent removal rates. Table 2 presents a summary of initial, residual, and percent removal for merchantable volume (m^3/ha) as well as basal area (m^2/ha). Average merchantable volume removal rate was lower in MTPT sections for 5 out of the 9 blocks (avg. 46%) compared to SQ sections.

Figure 1: Location of MTPT test blocks. Blue circles represent blocks on industrial freehold while green triangles depict blocks on New Brunswick Crown Land.



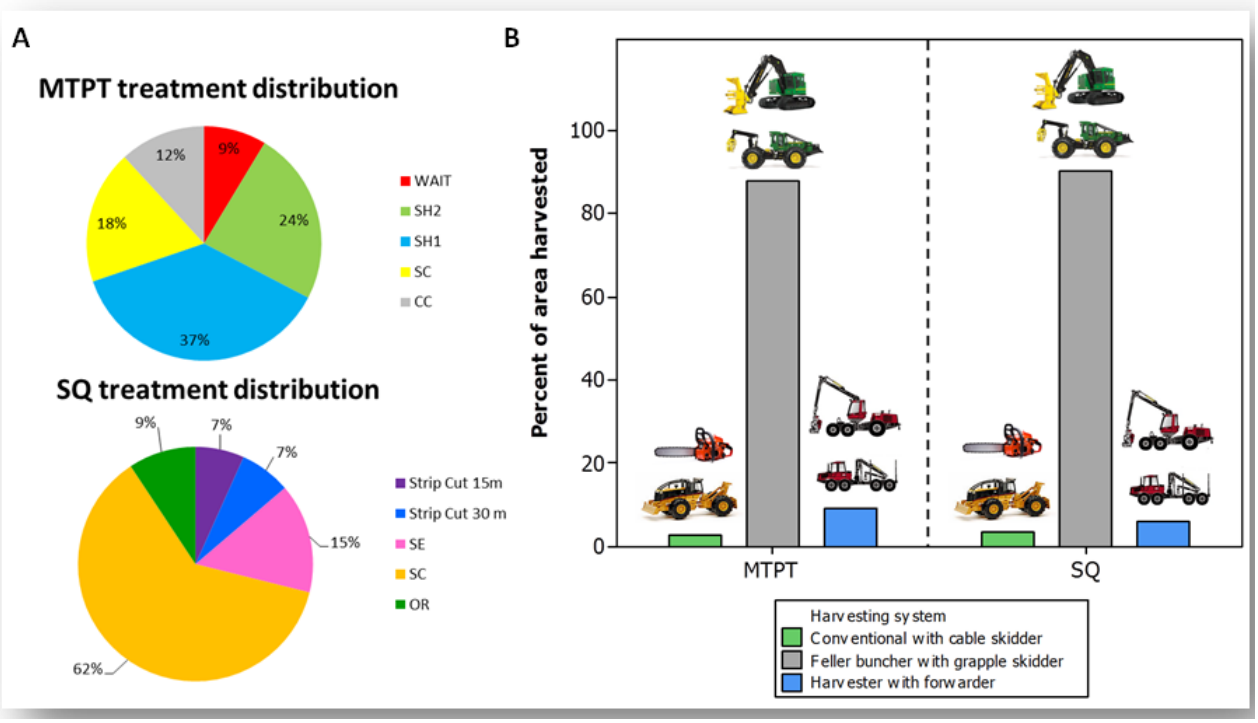


Figure 2: A Distribution of silvicultural treatments for MTPT and SQ B. Percent of area treated for MTPT and SQ according to harvesting system. Image sources: www.deere.com; www.komatsuforestab.com; www.tigercat.com; www.mississaugalife.ca.

Table 2: Merchantable volume and basal area for each method and block.

Block	Method	Total area (ha)	Merchantable volume (m^3/ha)			Basal area (m^2/ha)		
			Initial	Harvested	Average percent removal	Initial	Harvested	Average percent removal
1096467	MTPT	67.1	93	34	36%	17	5	29%
	SQ	58.3	61	22	36%	11	4	40%
4092300	MTPT	20.8	108	30	28%	17	4	25%
	SQ	20.0	111	33	30%	19	6	30%
4092802	MTPT	9.3	115	65	56%	19	11	58%
	SQ	9.9	127	62	49%	22	10	47%
4097180	MTPT	18.6	115	77	67%	18	11	59%
	SQ	9.4	160	133	83%	27	23	84%
409415A	MTPT	11.3	124	43	35%	18	4	22%
	SQ	17.1	132	32	24%	21	3	12%
F981966	MTPT	106.0	111	74	66%	17	11	63%
	SQ	111.6	81	60	73%	13	11	81%
F985052	MTPT	50.7	123	102	82%	21	16	79%
	SQ	34.7	107	71	66%	17	11	64%
F985243	MTPT	19.0	104	56	54%	17	9	52%
	SQ	10.2	111	34	31%	19	6	31%
F989570	MTPT	24.5	95	32	34%	17	4	26%
	SQ	13.8	80	38	48%	17	3	20%

To quantify the impact of the multi-treatment method, we used two key performance indicators. First, by collecting harvester and feller-buncher tracking from on-board computers, we determined the density of machine operating trails (in-stand trails) and related the results on a per-hectare basis (Figure 3A). When combining results from all blocks that had machine tracking, MTPT resulted in a 4% lower machine tracking as expressed by the reduced machine operating trail density compared to SQ. This total average reduction is primarily attributed to the identification and respect of wait zones, which do not allow any machine entry. Actual machine tracking per block is available in Figure 5.

Second, in an attempt to understand and evaluate the performance of the operations, we summed the amount of wood harvested and divided this number by the length of machine operating trails to obtain a ratio of cubic meter harvested per linear meter of trail (Figure 3B). For all blocks combined, MTPT generated 0.20m^3 of wood harvested per linear meter of trail compared to 0.16m^3 for the SQ section, which translates to a 20% increase. This finding can be linked to the wait zones that are allowed in the MTPT sections and also the possibility of performing small-scale clear cut treatments. Despite allowing the use of these small-scale clear-cuts, the difference in the ratio of Acceptable growing stock to Unacceptable (AGS vs. UGS) between pre- and post-harvest was slightly higher for MTPT sections compared to SQ (Figure 4).

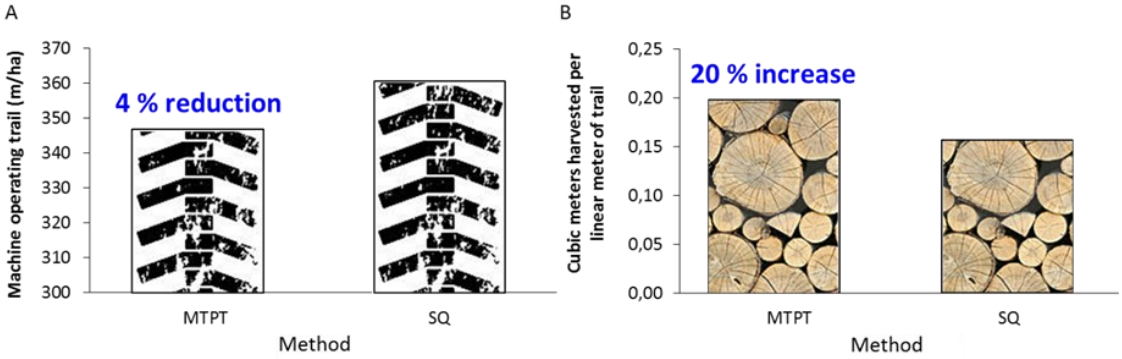


Figure 3: A. Machine operating trail density (m/ha) for all blocks combined and B. Cubic meters of wood harvested per linear meter of machine operating trail for all blocks combined.

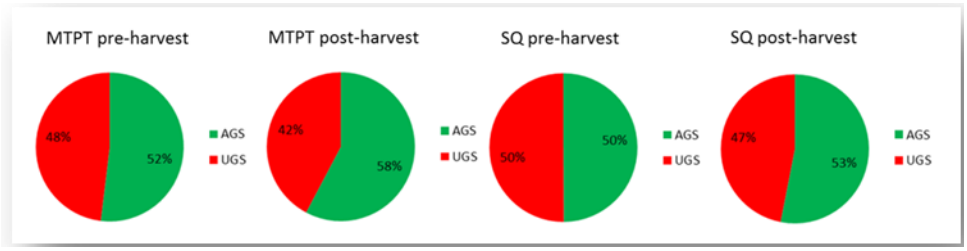


Figure 4: Acceptable and unacceptable growing stock (AGS/UGS) distribution for MTPT and SQ sections.

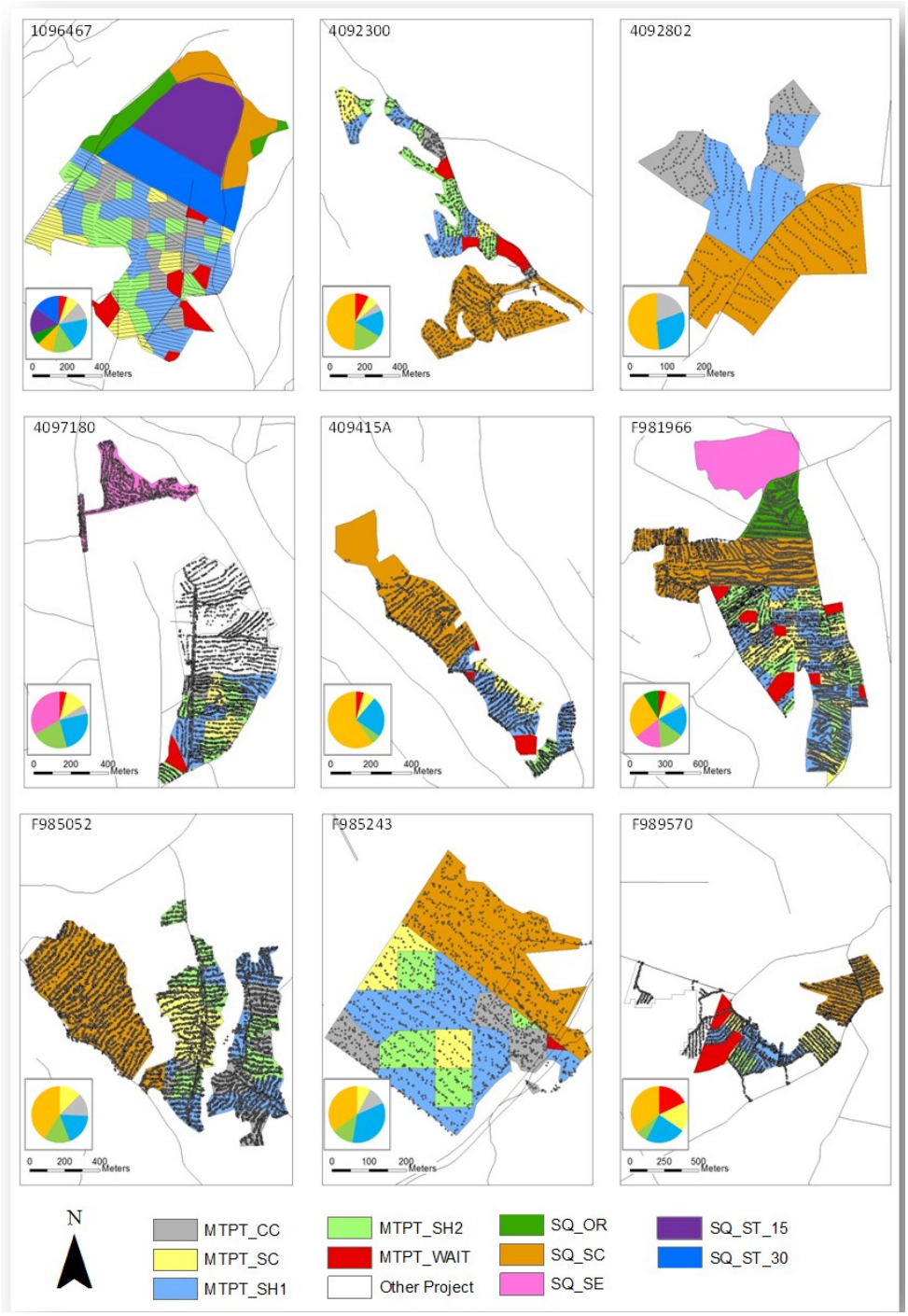


Figure 5: Type and spatial distribution of silvicultural treatments along with actual machine tracking.

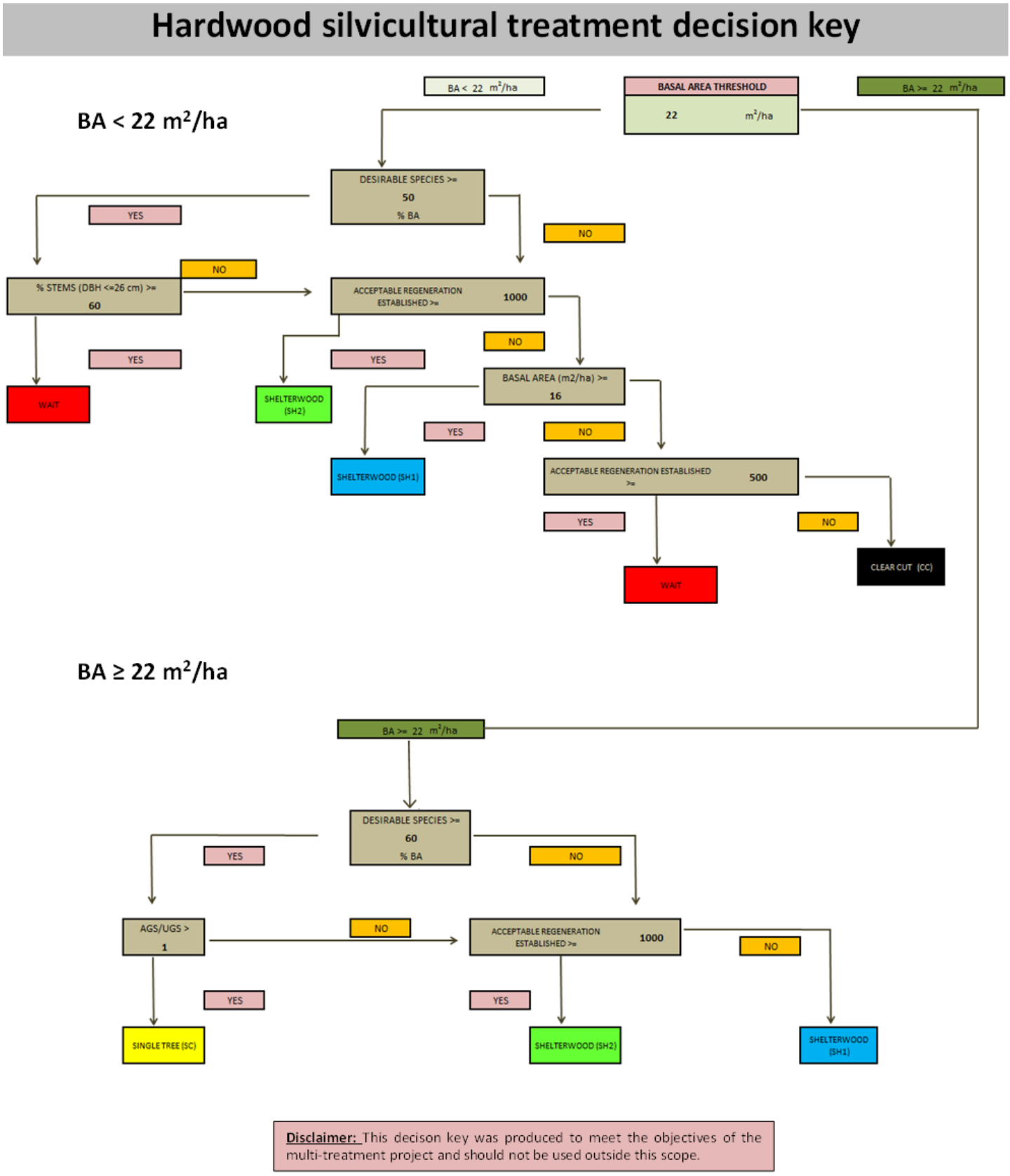


Figure 6: Preliminary Hardwood silvicultural treatment decision key used in the MTPT project.

Conclusion

The development and field testing of the multi-treatment method MTPT has demonstrated to be a valuable and operationally feasible alternative of treating variable hardwood stands. Pre-identification of wait zones, which can be viewed directly on on-board navigation systems have been particularly useful in reducing machine tracking in areas of low volume. The availability of treatment maps directly on board harvesting equipment was appreciated by all operators. Further analysis of harvesting costs in a multi-treatment setting will be presented in a separate analysis.

Acknowledgement

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