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

Current American Beech (*Fagus Grandifolia* Ehrh.) Stand Archetypes in New Brunswick

July 2017

Technical Note

Silviculture

INTRODUCTION

In New Brunswick, American beech (BE) is widely distributed in tolerant hardwood stands. It is considered a species of low commercial importance that competes with more important species like sugar maple and yellow birch. Beech bark disease (BBD) is also commonly present in stands having a dense BE understory, and it has infected the entire province of New Brunswick in the past decades. In conjunction with previous forest management activities, it has created a variety of aftermath forest conditions with different proportions of species. In this context, we do not know the proportions of each types of forests that were created by past management and by BBD. Proper management of such stands requires detailed understanding of forest stand structure.

Therefore, it is important to classify and characterize forest stands based on BE dominance in different layers of forest canopy, as it has been done in our neighbouring jurisdiction (Bose et al. 2017). In order to provide-useful information for future management of BE-present stands, this study: 1) attempts to identify, classify, and characterize BE-present forest stands in New Brunswick, 2) evaluates the proportion of BE-present archetypes, and 3) demonstrates the location of these archetypes within the province of New Brunswick.

HIGHLIGHTS

- **Stand archetypes distributed spatially in New Brunswick were identified from Type-1 to Type-5, in order of increasing beech abundancy.**
- **Beech would be likely to dominate more stands in the future by their strong competition abilities in the absence of proper silviculture measures.**
- **Since BE has low commercial value and a high risk of being infected by BBD, a BE-dominant stand has far less economical value that stands dominated by other hardwood species.**

Reviewed: May 2018

METHODOLOGY

Forest inventory data of the most recent New Brunswick Forest Development Survey (FDS) cycle (between 2003 and 2012) was obtained from the New Brunswick Department of Energy and Resource Development. All FDS plots that had at least one individual of BE irrespective of their size (n=1113) were used for analysis. Total and species specific (beech, sugar maple, yellow birch, softwood and other hardwoods) live tree (DBH ≥ 9cm) and saplings (1cm ≤ DBH < 9cm) density, and basal area for each plot, were calculated. Hierarchical clustering algorithm used the plot-level species specific information to identify beech-dominated stand types from all plots where beech was present. Average density of different species at different diameter classes was plotted separately for each archetype to explore live and dead tree species proportions at different canopy layers separately.

RESULTS

Based on the hierarchical cluster analysis, five different stand types were identified in stands where beech was present (Table 1, Figure 1AB). More than half of the beech-present plots were grouped as '**Type-1**' plots where beech presence in overstory is very minimum. Commercial hardwoods (sugar maple and yellow birch) dominate overstory and mid-story of the stands (Live tree basal area proportion >40%, Table 2).

About 20% of beech-present plots were grouped as **'Type 2'** plots. Such stands had lower proportion of beech (BE 20-30% of live tree basal area) in the overstory (Table 2) and beech did not dominate the mid-story (Figure 1B, Table 2). Thirty to forty percent of overstory basal area was occupied by commercial hardwoods species (Table 2).

About 12% of beech present plots were grouped as '**Type 3**' plots (Table 1). Overstory beech proportion in this archetype was similar to the Type-2 plots. Unlike the Type-2 plots, mid-story (DBH = 9-19 cm) of Type-3 plots were found to be dominated by beech (Figure 1B and Table 2). Basal area proportion of commercial tree species was similar to the Type-2 stands.

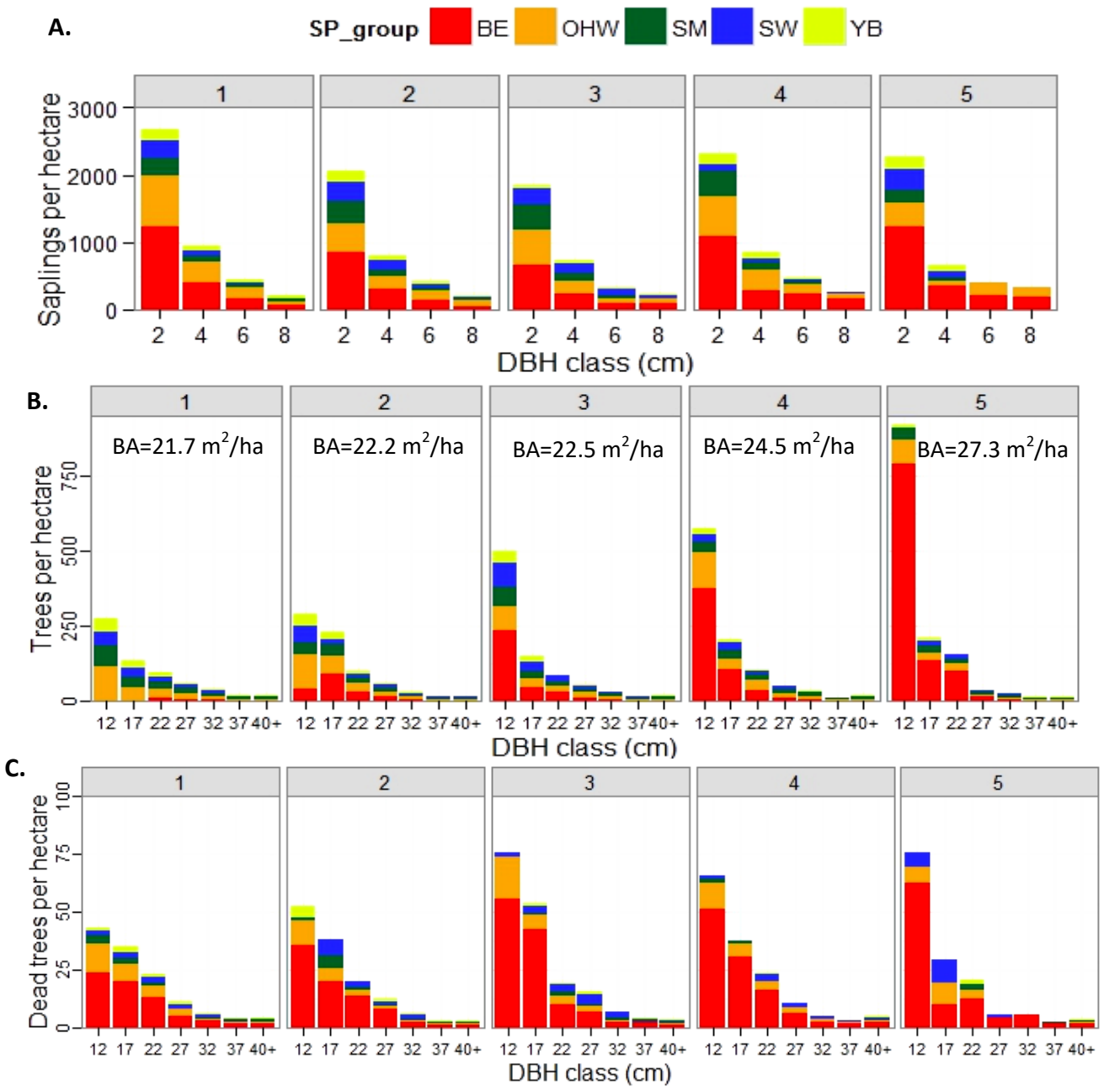
Remaining 13% of plots where beech was present were grouped as '**Type-4**' plots where significant presence of beech was in all canopy layers. Despite a significant beech proportion (30-50% of live tree basal area), about 30-40% of live tree basal area was occupied by commercial hardwood species (Table 2).

Only the 4% of beech-present plots were grouped as '**Type-5**' where beech dominated all three canopy layers. Beech occupied greater than 50% of live tree basal area whereas commercial hardwood species (SM and YB) occupied <30% of live tree basal area (Figure 1B, Table 2). Beech dominated the understory (saplings) layer in all the archetypes (Figure 1A).

Table 1: Number (and %) of plots that belong to different archetypes
(Total = plots where beech was present excluding SW stands).

Plots	Type-1	Type-2	Type-3	Type-4	Type-5	Total
Number	575	222	135	141	40	1113
Percent	52	20	12	13	4	100

Figure 1: Stand structure of current beech stand archetype (from 1 to 5). (**A**) Saplings, (**B**) Live trees and (**C**) Dead trees. BE = American Beech, OHW = other hardwoods, SM = sugar maple, SW = softwoods, and YB = yellow birch.



However there was a small difference in the proportion of desirable commercial hardwood species (SM and YB) among the different archetypes. Understory SM and YB proportion was greater than 20% in **Types-1** to **3**, 10 to 20% in the '**Type-4**' and less than 10% in the '**Type-5**' (Table 2). The number of dead beech trees gradually increased form the **'Type-1'** to the **'Type-5'** (Figure 1C). No live beech trees were observed that had greater than 35 cm DBH (Figure 1B). No spatial clustering was observed among different archetypes (Figure 2), however the '**Type-5**' plots were situated relatively in lower altitude (with an average of 225m) where temperature was relatively warmer (mean annual temperature 7.43ºC) compared to the location of the plots that belong to the other archetypes.

Table 2: Stand attributes of different archetypes. '1' in red cell denotes beech dominance and '0' in green cell denotes no dominance of beech in respective canopy layer.

Stand type (Archetypes)	Stand attributes							
	Beech dominance			Live tree BA proportion				Understory SM and YB proportion
	Understory	Midstory	Overstory	BE	SM +YB	OHW	SW	
1	1	0	0	<20%	>40%	>20%	>10%	>20%
2	1	0	0	20-30%	30-40%	>20%	>10%	>20%
3	1	1	0	20-30%	30-40%	>20%	>10%	>20%
4	1	1	1	30-50%	30-40%	>20%	<10%	10-20%
5	1	1	1	>50%	<30%	<20%	<10%	<10%

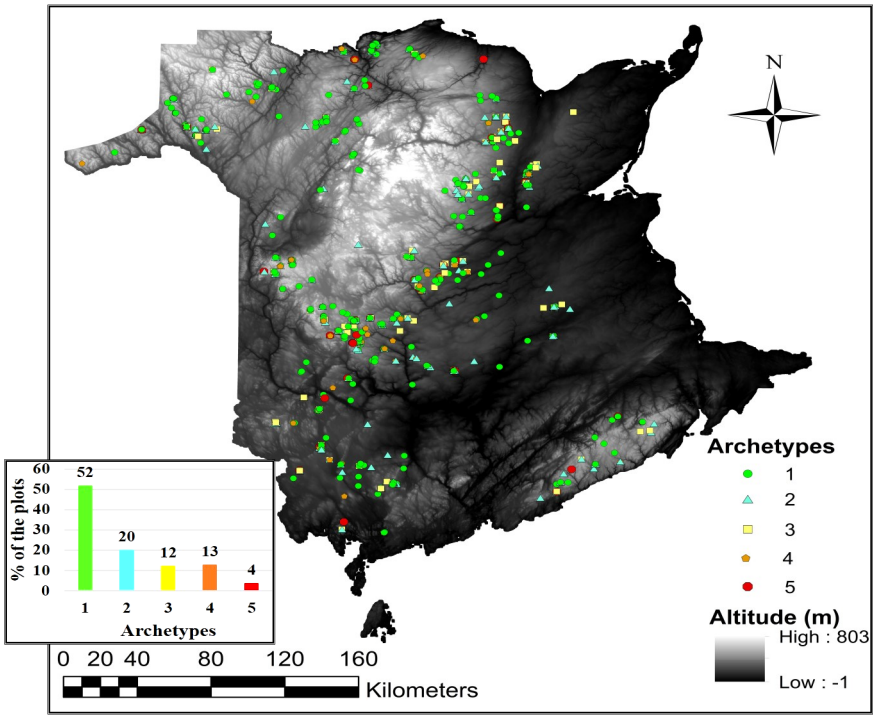


Figure 2: Spatial distribution of beech-present stand archetype (from Type-1 to Type-5) in New Brunswick.

CONCLUSION

The results of this study show that all the stands that went through the beech bark disease killing front created five major aftermath forest conditions (from Type-1 to Type-5) with different proportion of species composition in different canopy layers. Each of these five beech stand archetypal conditions need specific silviculture strategies to improve stand quality in future. In all types of stands, beech has become numerous in the understory since the disease (Figure 1A, B, C). The dominant beech understory indicates that these stands are likely to become dominated by beech in the future in the absence of proper silviculture measure (gradual transition from Type-1 to Type-5). Stand type-1, 2 and 3 can be improved by promoting maple and yellow birch present in understory, mid-story and overstory. However, stand type-4 and 5 need radical treatment to convert the stands. The results of this study indicated that the NHRI silviculture prescription system Key no. 6a and 7 need to be revised. For example: in the key (6a), a question related to proportion of beech in the understory needs to be added before suggesting the single tree selection treatment.

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