Competition, species interaction and ageing control tree mortality in boreal forests

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1. Introduction

Why we study tree mortality? → Forest structure; Species composition; Biodiversity

What has been done previously? → Competition-driven; Short range of stand development stage; Juvenile trees

What we have done?

Main objective: Identify the mechanisms that control tree mortality in boreal forests, which cover a wide range of tree sizes, stand development stages, and species compositions.

Specification: Examine effects of competition, species interaction and ageing on individual tree mortality of four common boreal tree species: jack pine, trembling aspen, white birch, and black spruce.

Hypotheses:

Mortality is relative-size-dependent as a result of asymmetric competition, with sensitivity of relative-size-dependent mortality decrease with increase of species' shade tolerance (H1).Mortality increase with stand crowding (H2), with intra-specific neighbors in the stand (H3), and with stand age (H4).

2. Materials and methods

Brief data introduction: Ontario forest permanent sampling plot data was used. The plots were located in northeast Ontario (Fig. 1)

All plots were originated from fire.

Live trees with DBH>=2 cm were measured in DBH, identified by species, tagged in the first measurement.

Plots experienced major disturbances were discarded.

Most measurements were 5-year interval. (5-year interval used for current study)

Data for jack pine, trembling aspen, white birch, and black spruce were enough for conducting analyses.

BRT was used to analyze data. Sensitivity of relative-size-dependent mortality was using linear regression.

Independent variables: relative basal area (RBA)
stand basal area (SBA)
ratio of focal species basal area to stand basal area (FSBA)
stand age (SA)

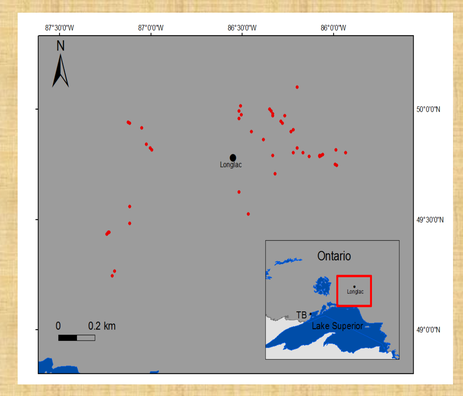

Fig. 1 Study area

3. Results

3.1 Relative importance of independent variables (Fig. 2)

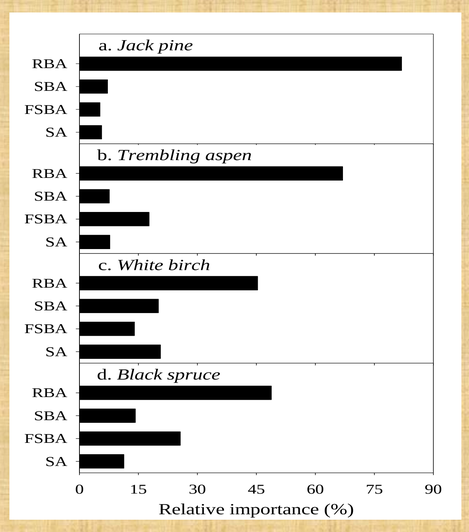

Fig. 2 Relative importance

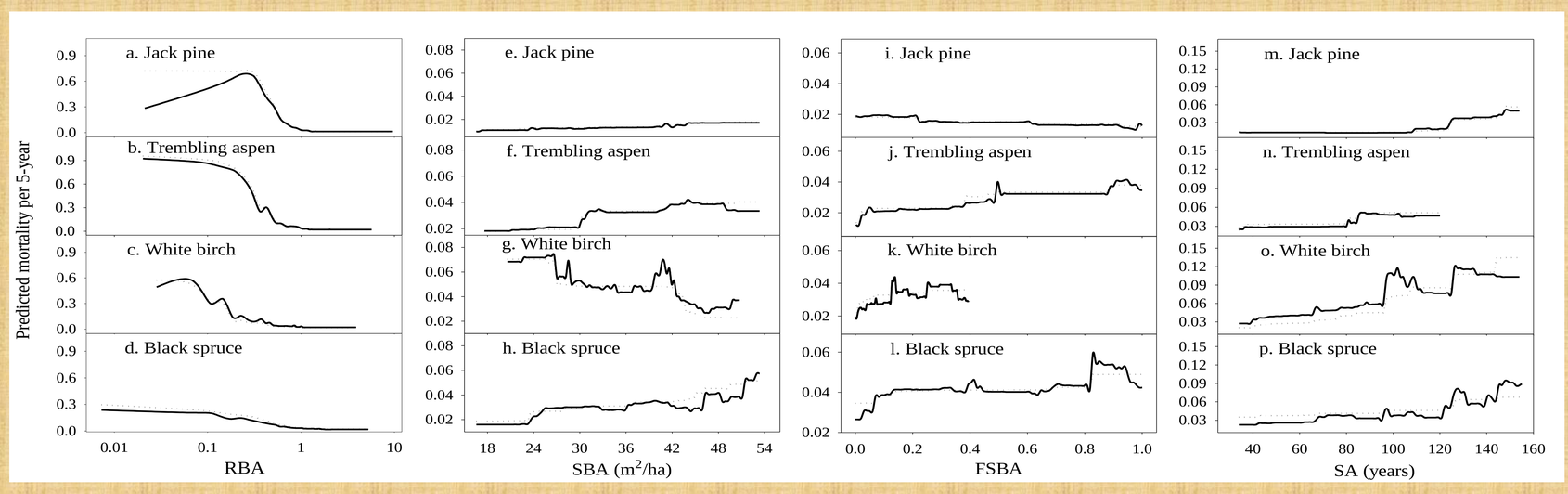

Fig. 3 Relationship between independent variables and mortality

3.2 Relationship between mortality and dependent variables (Fig. 3)

3.3 Sensitivity of relative-size-dependent mortality (Table 1)

3.4 Main interactions (Fig. 4)

Species	Range of RBA	Slope	95% Confidence interval		r^2
			Lower	Upper	
Jack pine (with initial increase)	0.02-1.29	-4.17	-4.40	-3.94	0.91
Jack pine (without initial increase)	0.18-1.29	-4.73	-4.91	-4.56	0.96
Trembling aspen	0.02-1.29	-4.53	-4.73	-4.32	0.89
White birch	0.03-1.08	-2.18	-2.31	-2.05	0.81
Black spruce	0.01-1.88	-1.52	-1.58	-1.46	0.87

Table 1 Sensitivity of relative-size-dependent mortality

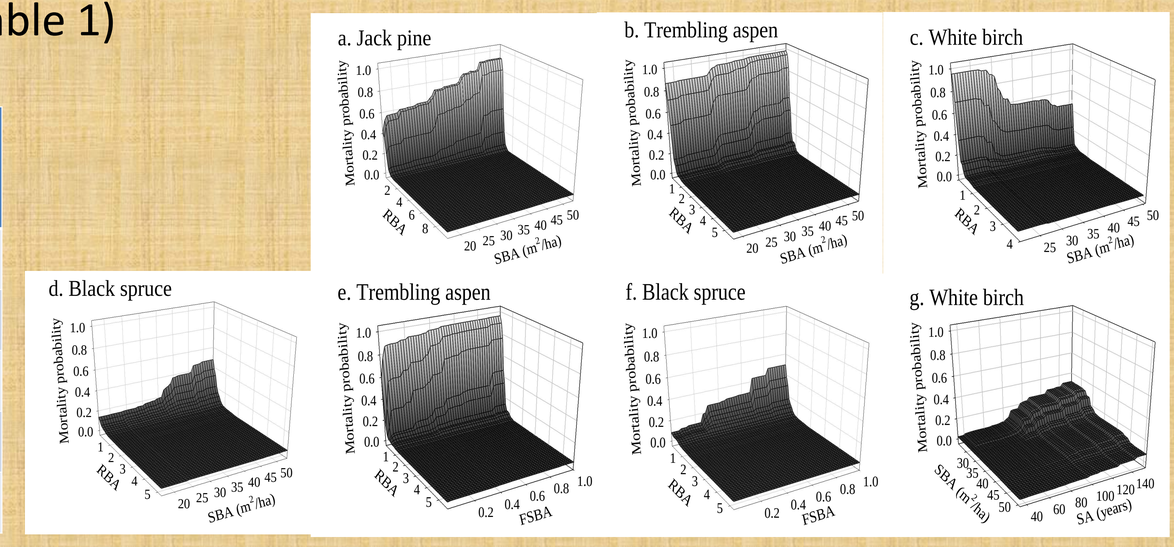

Fig. 4 Main interactions found in monotonic BRT

4. Conclusions

In boreal forests, which cover a wide range of sizes, stand developmental stages and species compositions, we found that

1. Mortality is relative-size-dependent, and sensitivity of relative-size-dependent mortality decrease with shade tolerance.
2. Mortality generally increase with stand crowding.
3. Mortality generally increase with increase of intra-specific neighbors.
4. Mortality increase with stand age.