Spatial relationships between nearby forest composition, tree seed dispersal and seedling establishment in a power right-of-way

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Relation entre la composition forestière de la bordure, la dispersion des semences et le recrutement des espèces d'arbre dans une emprise de lignes à haute tension

Résumé

La compréhension des facteurs influençant l'établissement des semis à l'intérieur de sites perturbés peut contribuer à améliorer les stratégies d'interventions pour contrôler la recolonisation arborescente dans les emprises. Notre objectif est d'établir la relation spatiale entre la composition des arbres de bordures, la pluie de semences et l'établissement de semis à l'échelle d'une emprise de lignes à haute tension du Québec. Pour les espèces plus abondantes, l'érable rouge et le bouleau gris, nous avons aussi mesuré à une échelle fine la distribution des semences et des semis le long de transects traversant l'emprise. L'abondance des arbres de bordure constitue un bon indicateur de la présence de semis à l'intérieur d'une emprise pour l'érable à sucre, le sapin baumier, le frêne d'Amérique, le bouleau jaune et le thuya occidental. La proximité des semenciers est davantage déterminante pour la distribution des espèces que l'hétérogénéité spatiale des conditions environnementales dans l'emprise. Il y a une faible relation entre l'abondance des arbres de bordure, des semences et des semis pour le bouleau blanc, le cerisier tardif et la pruche du Canada. La faible dispersion de l'érable rouge se manifeste autant à l'échelle régionale que locale. Bien que l'abondance de semenciers de bouleau gris en bordure soit variable, de nombreuses semences hivernales et estivales sont observées dans l'ensemble des sites échantillonnés, suggérant une grande distance de dispersion à l'échelle régionale. Cependant, la distribution non aléatoire des semences le long de transects traversant l'emprise suggère un patron de dispersion agissant à une plus fine échelle spatiale.

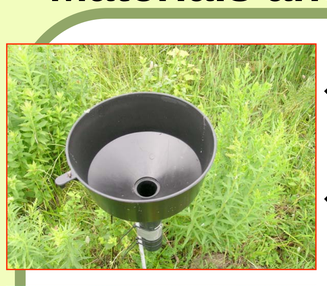
Abstract

Understanding the factors that influence tree seedling establishment in open sites can contribute to better strategies in right-of-way management to control tree establishment. Our objective was to establish the spatial relationship between bordering tree forest composition, seed rain and seedling establishment at the scale of a powerline right-of-way of southern Quebec. For the most abundant species, red maple and grey birch, we also measured the fine-scale distribution of seeds and seedlings along local transects crossing the right-of-way. The combined tree abundance of both borders of the powerline is a good indicator of seedling presence within the right-of-way for sugar maple, balsam fir, white ash, yellow birch and eastern white-cedar. The primary reason for this relation is related to dispersal constraints rather than to a spatial heterogeneity in suitable habitat conditions along the right-of-way. There was little relation between bordering tree, seed and seedling abundances for paper birch, pin cherry, and eastern hemlock along the right-of-way. For red maple, a short distance dispersal pattern was apparent both at the regional and at the finer spatial scale. Grey birch seeds, both summer and winter dispersed, were present in great numbers in all sampling sites, irrespective of the abundance of seeding trees in the nearby border, suggesting long-distance dispersal at the regional scale. However, spatial autocorrelation in seed distribution along transects crossing the right-of-way suggested smaller-scale dispersion processes.

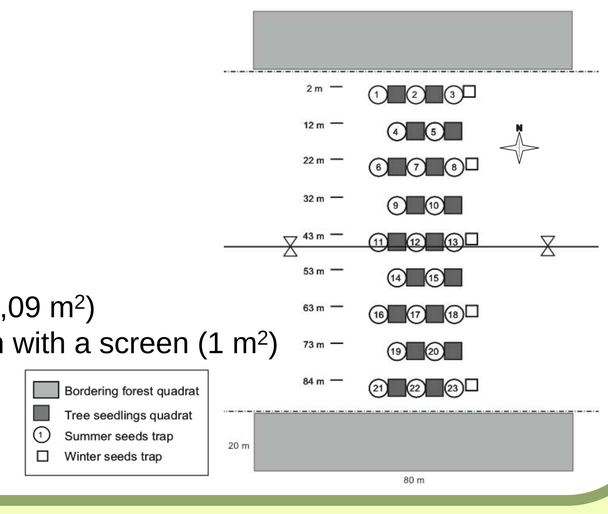
Introduction

Tree establishment in open sites such as clear cut or abandoned fields may be beneficial or detrimental depending on management purposes. On sites assigned to forest production, natural establishment contributes to reforestation, and cutting practices frequently include protection of nearby forest patches or strips in order to insure sufficient seed sources. In the case of powerline rights-of-way, tree establishment is a nuisance and frequent cutting operations are needed to keep a low vegetation cover that does not interfere with powerline operation and safety. Because they act as seed sources, composition of trees bordering the opening is the best predictor of recolonisation pressure. Our objective was to establish the spatial relationship between bordering tree forest composition, seed rain and seedling establishment at the scale of a powerline right-of-way of southern Quebec. For the most abundant species, red maple and grey birch, we also measured the fine-scale distribution of seeds and seedlings along local transects crossing the right-of-way.

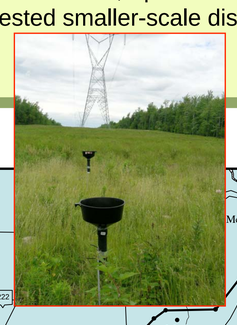
Materials and method



- Forest border composition
  - 20 m x 80 m quadrats
- Seedlings
  - 1 m² quadrats
- Seed rain
  - Summer : funnel traps (0,09 m²)
  - Winter seeds: nylon cloth with a screen (1 m²)



Study site



- The study site is located in Roxton County in the Montérégie Region of southern Quebec.
- Six sampling sites are distributed along a 14 km of a powerline.

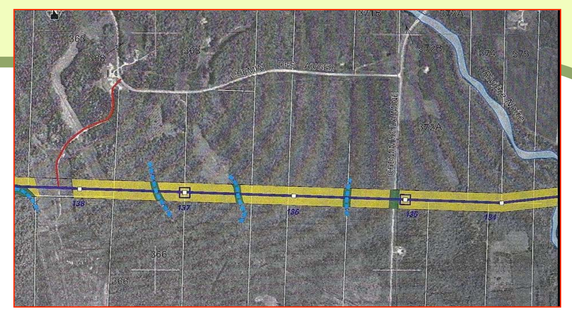
Table 1: Characteristics of the sampled sites S1 to S6

Name	Site restoration after the total cut[1]	Topography	Slope (deg.)	Rockiness	Bordering vegetation: dominant[2] / co-dominant (forest age)[3]		Distance from S1 (km)
					North right-of-way border	South right-of-way border	
S1	none	Flat top	0	high	Rma / Sma (young)	Rma / Las (young)	0
S2	none	Mid-slope	3	high	Rma / Sma (young)	Rma / Tas (young)	0.4
S3	Stumps removed and site seeded	Mid-slope	16	very high	Sma / Rma (mature)	Rma / Sma (sub-mature)	3.8
S4	Stumps removed and site seeded	Flat	0	low	Rma / Gbi (sub-mature)	Rma / Tas (sub-mature)	8.6
S5	Stumps removed and site seeded	Flat	2	low	Rma / Ael (young)	Bfi / Tas (sub-mature)	13.7
S6	none	Flat	0	low	Gbi / Rma (young)	Rma / Wil (young)	14.0

1: Sites with stumps removed were seeded with a herbaceous seeding mix (*Phleum pratense; Trifolium reprens; Trifolium pratense*) for revegetation purposes.
2: Ael = American elm; Bfi = Balsam fir; Gbi = Grey birch; Las = Large-toothed aspen; Rma = Red maple; Sma = Sugar maple; Tas = Trembling aspen; Wil = willows
3: young (20-40 years); sub-mature (41-60 years) and mature (61-80 years).

Results and discussion

Regional scale



- Grey birch and red maple are the most common species invading the opening.
- The combined tree abundance of both borders is a good indicator of seedling presence within the right-of-way for red maple, sugar maple, balsam fir, white ash, yellow birch and eastern white cedar. This relation is more likely attributed to low dispersal rather than to local suitable habitat conditions since the absence of trees in a particular sampling site often results in a low number or in the absence of seeds. Other tree species show little or no relation between tree and seed abundances within a sampling site.
- For red maple, which trees are present in all borders, there is a close relation between tree, seed and seedling abundances.
- Grey birch seeds, both summer and winter dispersed, are present in great numbers in all sampling sites, irrespective of the abundance of seeding trees in the nearby border, suggesting a predominance of long-distance dispersal at the regional scale.

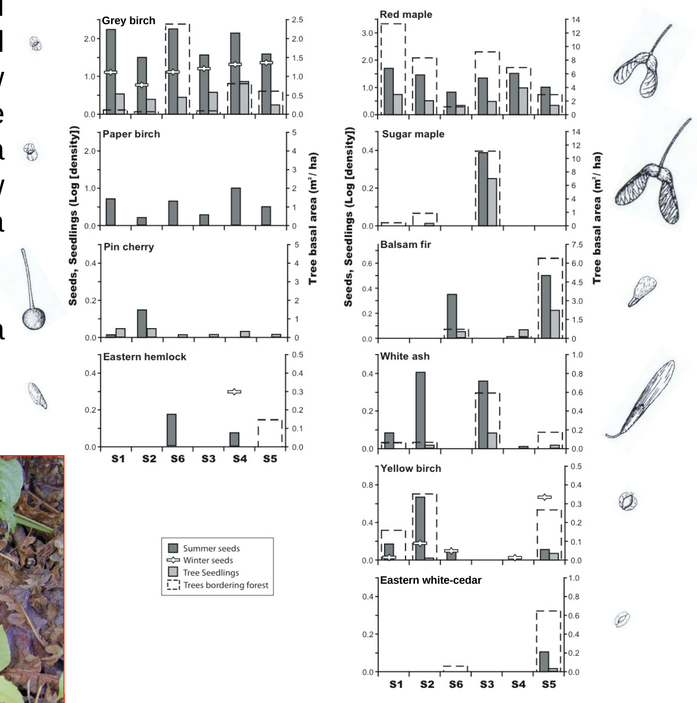


Figure 1: Abundance of trees (borders), seeds and seedlings in each sampling site of the powerline right-of-way for the most common tree species.

Illustrations: modified from Farrar, J. L. 1995. Trees of Canada. Fitzhenry & Whiteside Publ. 502 p.

Local scale

- For red maple, there is an overall decreasing number of seeds and seedlings from the edge to the center of the right-of-way (Spearman r = -0.654; p < 0.001 and r = -0.421; p < 0.001 respectively). These patterns suggest a low seed dispersal at the scale of the transect.
- Although spatial patterns of seed distribution for grey birch suggests long-distance seed dispersion at the regional scale, the pattern along transects crossing the right-of-way reveals smaller-scale dispersion processes, as shown by the overall autocorrelation of seed distribution in sampling sites. This pattern was the same for winter and summer seeds dispersion (r = 0.731; p < 0,001). There appears to be a slight increase in seed abundance toward the center of some transects (S1, S2, S5). This suggests that there is a decreasing number of seeds from the borders, but that the seed rain coming from both borders adds up toward the middle of the right-of-way.

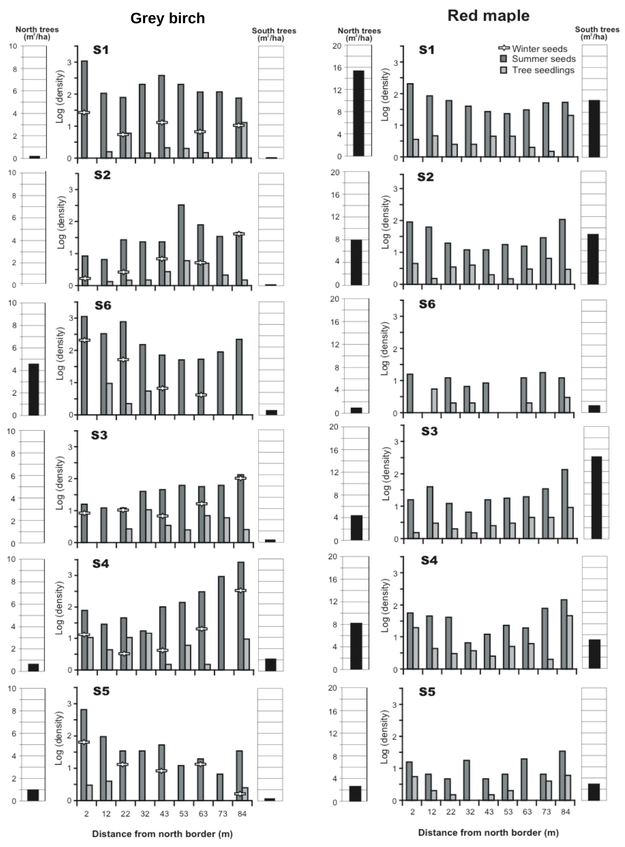


Figure 2: Tree abundance on each border and spatial distribution on seeds and seedlings across the right-of-way for grey birch and red maple. The x-axis represents the distance, in meter, from the northern edge of the right-of-way to the center of the seed trap or seedling quadrat. At S3, the right-of-way was narrower, so that the transect was one quadrat (winter trap) shorter than for the other sampling sites.

Conclusion

- While the relations between nearby bordering tree, seed and seedling abundances vary among tree species, tree composition was an overall good predictor of nearby seedling establishment. This relation is more likely attributed to dispersal constraints rather than local suitable habitat conditions.
- Red maple shows a low dispersal pattern both at the regional and at the local scale. Red maple invasion is higher near the edge of the right-of-way.
- Regional distribution of grey birch seeds and seedlings suggests long distance dispersal at the regional scale. However, at the local scale, spatial autocorrelation of seed dispersion reveals smaller-scale dispersion processes. Invasion appears higher at the edge, but also in the center of the right-of-way, where the seed rain from both borders adds up.

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