Climbing towards the light:
Liana distribution and diversity in urban ecosystems

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Urbanization

Urbanization transforms biotic composition and functions of ecosystems through fragmentation, habitat loss and alteration of local abiotic conditions. These changes reduce habitat quality for sensitive species while increasing the opportunity for early colonizers, heliophytes and invaders, such as lianas[1].

Objective → My study aims to assess the relative importance of environmental factors, such as patch size, connectivity, adjacent land uses and heat islands, on liana distribution in an urban landscape.

Lianas and vines

Opportunistic → Often benefiting from anthropogenic disturbances, lianas can quickly colonize open habitats (e.g., forest edges), and then alter forest regeneration and diversity [2].

Competitive → Their reliance on other species for structural support enables allocation of resources to competitive strategies, i.e. high leaf area: biomass ratio, rapid growth rate, and root system elongation [2].

Plastic → Due to their broad diversity of growth forms, mainly anatomical and morphological features and climbing mechanisms, lianas are adapted to a large range of ecological conditions[3].

Study area

The study was conducted in 50 forest patches located on the Montréal, Bizard, Perrot and Nun's Islands (Figure 1). This area faces major anthropogenic pressures which have created a complex mosaic of forests of various sizes and disturbed to varying degrees, surrounded by a residential, commercial or industrial matrix.

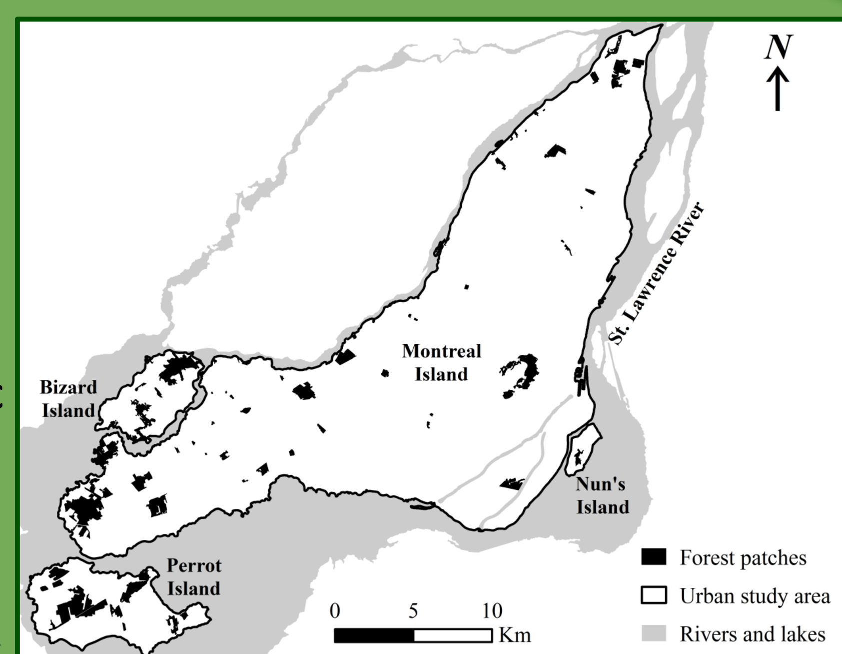


Figure 1 *Location of the 50 forest patches in the study area.*

Methods

Liana species were identified in 430 plots of 20x20m. Landscape variables (Table 1) were extracted from satellite images and land use maps with GIS. Proportion of heat islands was defined by assessing the number of pixels above the average surface temperature in a 500-m buffer zone around patches using Landsat thermal bands [4].

Analysis

Prior to analysis, a cubic root transformation was applied to liana abundance in order to reduce distribution asymmetry. Landscape variables were also standardized. We first tested for differences in mean abundance between edge and core areas using a randomization test for one-way ANOVA. A multiple regression model explaining abundance was built using landscape variables selected by a forward-selection procedure with the double stop criterion. No significant spatial structure was found in the data (PCNM; p = 0.42) and variables did not show multicollinearity.

Landscape variables (in a 500-m buffer zone)	
Forest patch size	AREA
Perimeter : Area ratio	PAR
Forest patches density	PATCH
Urban heat island	UHI
Street density	STREET
Green	GREEN
Water	WATER
Rural area	RURAL
Residential area	RESID
Public utilities	UTILITY

Table 1 *Landscape variables and their abbreviations.*

Results and Discussion

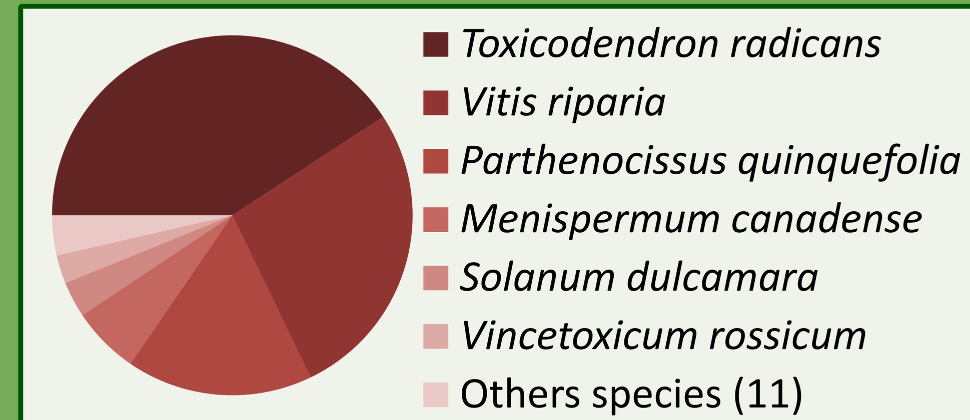
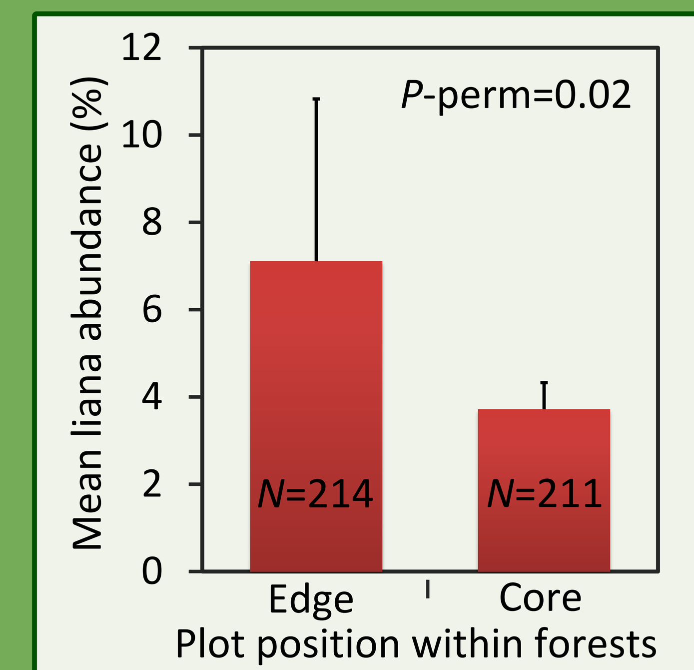


Figure 2 *Liana relative importance across the study area.*

A total of 17 liana and vine species, from 13 different families, were identified across the 50 forest patches. *Toxicodendron radicans*, *Vitis riparia* and *Parthenocissus quinquefolia* were the most dominant species.

Figure 3 *Comparison of liana abundance (%) between edge and core plots using randomized ANOVA. Error bars represent standard errors.*



Liana abundance was significantly higher in forest edges than in core areas. Indeed, within forest patches, edges promote liana growth and establishment due to increased light availability, greater variety in structural supports, and the recurrence of disturbances. Thus, lianas benefit from urbanization, through habitat fragmentation and isolation in a disturbed matrix.

	Liana and vine abundance	
	Coefficient	p-perm
intercept	1.5694	0.0001
UHI	0.4023	0.0001
STREET	- 0.3824	0.0002
WATER	0.1675	0.0347
RURAL	- 0.1504	0.0538
Adjusted R-square :	40.10 %	
F-statistic :	9.199	
Full model p-perm :	0.0001	

Table 2 *The most parsimonious multiple regression model explaining liana abundance patterns. Significance was verified with a one-tailed test of regression coefficients (9999 permutations).*

Liana abundance was positively correlated with the proportion of urban heat islands and water bodies around forests.

→ Lianas are limited by cold temperatures in northern latitudes. Urban heat islands likely promote the formation of suitable microclimates where lianas can thrive (Figure 4).

→ Streams act as migration corridors for birds and thus facilitate liana dispersal, since dominant species are bird-dispersed.

In contrast, street density and the proportion of rural areas around patches act negatively on liana abundance.

→ High street density areas are generally subjected to heavy winter salting, which may affect liana survival considering their high intolerance to salinity.

→ In the study area, rural zones are less disturbed than residential zones, which could limit liana abundance as they mainly colonize open habitats.

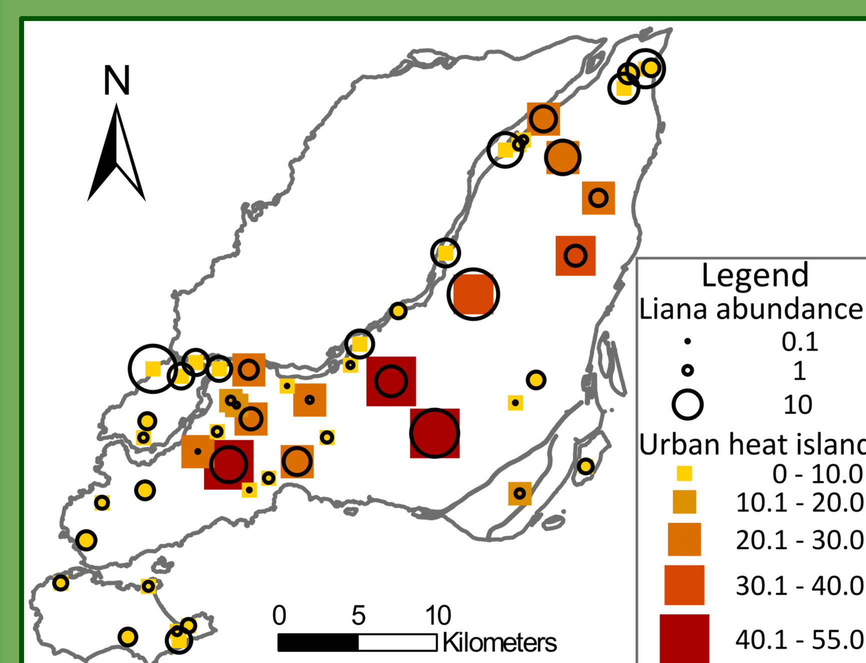


Figure 4 *Total liana abundance in forest patches and proportion of urban heat islands around patches.*

Conclusions and perspectives

→ Only a few species of lianas are ubiquitous in urban landscapes.

→ Lianas are more abundant in forest edges.

→ Lianas respond positively to the proportion of urban heat islands and water bodies, and negatively to street density and rural areas.

To further understand their distribution within a forest and their interaction with other life forms, biotic and abiotic factors should be analysed at the patch scale.

References

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