Indirect effects of urban development on understory plant communities of Mont St.Hilaire

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Importance of the herbaceous layer



Over-density of white-tailed deer

□ Higher survival rate of deer in exurban areas

□ Since 1950 : demographic explosion →
since 1980 : increase of deer populations →
lagged responses in herbaceous communities ?



(Augustine & Jordan, 1998; Storm etal. 2007)













Exotic earthworm invasion

Absent from Quebec prior to European settlement



Zone free of native earthworms after the last glaciation

- Introduction and spread of exotic earthworms is closely related to human disturbances
- Timing of disturbances is a crucial factor because invasion is a slow process















Research objectives

- 1) Assess changes in the understory plant communities of Mont St-Hilaire during recent decades
- 2) Evaluate the relative importance of two drivers of changes: deer and earthworms













Hypotheses

- 1) Herbaceous communities have become simplified during recent decades
- 2) Deer grazing pressure and the spread of earthworms have been important drivers vegetation change
- 3) Earthworms invasion has been greatest where the oldest human disturbances occurred





Study site: Mont-Saint-Hilaire (MSH)



History of anthropogenic disturbances on MSH



Mountain Village



Partial cuts



Apples production



Quarries



Fishing



Tourism



Today



History of anthropogenic disturbances on MSH







Apples production



Quarries



Fishing



Tourism





Methodology : resampling permanent sites

9-year time span



(Gilbert & Lechowicz 2004)

Methodology : resampling permanent sites

9-year time span



(Gilbert & Lechowicz 2004)

Methodology : *a priori* predictions using "tolerance traits"



Results for the 9-year time span

Sampling period	Species richness (No. of taxa)	Abundance (% cover)	
2002	195	47	
2011	182	34	
Student-t test (paired)	t = 0.1021 df = 68 p-value = 0.919	t = 4.92 df = 68 p = 5.781e-06 *	



Results for the 9-year time span



 \mathbf{X} = statistically significant (0.05 level)

Results for the 40-year time span

Sampling period	Species richness (No. of taxa)	Abundance (No. of presences)
1969-1979	83	1169
2012	59	417



Results for the 40-year time span



Stages of earthworm invasion

Relatively little invasion		Highly invaded	
Stage 0	No adults	Stage 3	2
Stage 1	2	Stage 4	
Stage 2		Stage 5	

Dispersal of earthworms on MSH



Explanation of earthworm dispersal



Explanation of earthworm dispersal



Explanation of earthworm dispersal



Some conclusions

- Substantial changes have occurred in understory plant communities during recent decades
- Exotic earthworms and deer have likely driven some of these changes
- Past and recent urbanization of the region have likely had a direct impact on these two drivers





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