Patterns of impacts of four highly invasive plants species on native vegetation in Belgium

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Introduction

It is often suggested, based on the idea of niche saturation, that diverse communities are less likely to be invaded , at least at the local scale. However, both negative relationships and positive ones between richness of native flora and invasion have been reported.
Besides the changes that an invader can have on the abundance of all members of a community, it may also induce differential impacts on different species, resulting in fundamental changes in community structure

Objectives

The current study intends to determine patterns of impacts in the field for multiple highly invasive plant species (HIPS) invading different communities in Belgium, with a focus on high biological value sites.

Methods

Four highly invasive plant species were selected for this study, namely *Fallopia* spp. (including both *F. japonica* and the hybrid *F.* x *bohemica*)(Polygonaceae), *Impatiens glandulifera* (Balsaminaceae), *Senecio inaequidens* (Asteraceae) and *Solidago gigantea* (Asteraceae). Those species are widespread in Belgium and are considered as highly detrimental. Three of them are on the Belgian black list of invasive species (Branquart, 2008).

Study sites were chosen in geographically distinct areas throughout Belgium, covering as much as possible the habitat heterogeneity of invaded sites. Common sites such as road sides or ruderal places were included but a particular attention was paid at including sites of high biological value (nature reserves, Natura 2000, Sites of Great Biological Interest). As we were using a space for time substitution approach, site selection aimed at minimizing the probability of differences existing prior to the invasion event (homogeneity of abiotic characters between invaded and adjacent uninvaded vegetation). We also selected large well established and still expanding HIPS populations.
Ten sites were selected for *Fallopia* spp. and *S. inaequidens* and eleven sites were studied for *I. glandulifera* and *S. gigantea*. At each site, 12 quadrats of 1 x 1 m (6 in invaded and 6 in uninvaded vegetation) were selected, including a gradient of increasing invasive plant density. Within each quadrat, vascular plants species were recorded and their cover abundance was scored using projection cover (percentage scale 0-100%).

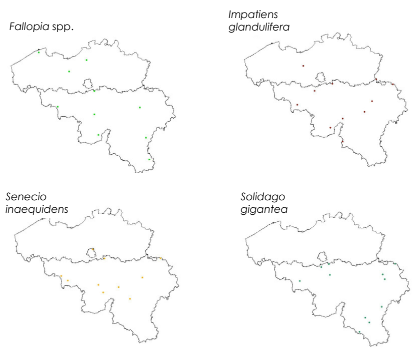


Figure 1: Location of selected study sites for the 4 target HIPS in Belgium

Table 1: Selected study sites for the 4 target HIPS, protection status, and type of habitat.

HIPS	Site code	Site protection status	Habitat
Fallopia x bohemica	RixCon	SGIB	Riparian forest
Fallopia japonica	BouSeb	SGIB	Riparian forest
Fallopia japonica + F. x bohemica	BlaBru	Nature reserve	Sand pit
Fallopia japonica	FreCar	SGIB	Meadow
Fallopia japonica	SavMil	/	Road side
Fallopia japonica	KalMee	Nature reserve	Meadow
Fallopia x bohemica	TerDoe	Nature reserve	River bank
Fallopia japonica	HobPlo	Nature reserve	Park
Fallopia japonica	ComTar	Nature reserve	Road side
Fallopia japonica	OlRou	/	Road side
Senecio inaequidens	GemSab	SGIB	Sand pit
Senecio inaequidens	AcoGar	SGIB	Abandoned railway
Senecio inaequidens	FloCar	SGIB	Quarry
Senecio inaequidens	RocLam	SGIB	Rocky cliff
Senecio inaequidens	SpoCar	SGIB	Quarry
Senecio inaequidens	BlaBru	Nature reserve	Sand pit
Senecio inaequidens	SchGar	/	Dump
Senecio inaequidens	ComCar	SGIB	Rocky cliff
Senecio inaequidens	ArcSab	SGIB	Sand pit
Senecio inaequidens	ColTer	/	Coal tip
Impatiens glandulifera	DouVlr	/	River bank
Impatiens glandulifera	LanFra	SGIB	Spawning area
Impatiens glandulifera	ItrSen	SGIB	River bank
Impatiens glandulifera	DurOur	SGIB	Ruderal humid zone
Impatiens glandulifera	LauBoi	/	Forest understorey
Impatiens glandulifera	DinCol	SGIB	River bank
Impatiens glandulifera	HowEln	/	River bank
Impatiens glandulifera	HauSab	Close to SGIB	Forest understorey
Impatiens glandulifera	FraNou	SGIB	River bank
Impatiens glandulifera	ComOur	/	River bank
Impatiens glandulifera	WicMeg	/	Moist meadow
Solidago gigantea	BauRou	/	Road side
Solidago gigantea	LibRou	/	Green wastes
Solidago gigantea	HauSab	SGIB	Sand pit
Solidago gigantea	BraSab	SGIB	Sand pit / road side
Solidago gigantea	MabRou	/	Road side
Solidago gigantea	FicCar	SGIB	Quarry
Solidago gigantea	TilRou	/	Road side
Solidago gigantea	LonMeg	SGIB	Moist meadow
Solidago gigantea	ReiGar	/	Railway
Solidago gigantea	TheRou	/	Road side
Solidago gigantea	RixHum	Nature reserve	Moist meadow

Results

Our results showed that mean species richness decreased with invasion, both at the stand or at the quadrat (1m²) level (table 2). Initial mean species richness in uninvaded vegetation was similar for the 4 HIPS and the impact of invasion was most important for *Fallopia* s ppand the least for *S. inaequidens.*
For *Fallopia* spp., *S. gigantea* and *S. inaequidens* there was a linear effect of HIPS density on native plant richness (fig. 2). For the 4 HIPS, Correspondence Analyses did not allow to detect any difference between invaded and uninvaded stands, neither for species cover (fig. 3a) nor for species composition (fig. 3b), suggesting similar vegetations. Moreover, only *S. inaequidens* sites were differentiated from the others, but no differences were found between the sites studied for the three other HIPS (fig. 3), suggesting that the latter tend to invade similar habitats.

Table 2: Mean species richness (+/-SD) per site and per m² for the 4 target HIPS.

	Mean species richness / stand			Mean species richness / m²		
HIPS	**N**	**Invaded**	**Uninvaded**	**N**	**Invaded**	**Uninvaded**
***Fallopia* spp.**	10	9.7 (5.1)	21.9 (10.9)	60	3.2 (2.6)	7.2 (3.7)
Senecio inaequidens	10	18 (7.3)	20.2 (9.2)	60	7 (3)	7.2 (3.4)
Impatiens glandulifera	11	14.2 (5.4)	19.9 (4.7)	66	5.8 (2.5)	6.9 (2.9)
Solidago gigantea	11	11.7 (4.6)	22.1 (9.05)	66	4.6 (2.3)	7.6 (3.5)

Conclusions

Even though nature reserves or sites of high biological interest were selected, human disturbances (past or recent) remained a constant in our study sites.
Although the different HIPS invaded various kinds of habitats, mean initial species richness was similar between uninvaded stands. Following invasion and depending on HIPS, mean plant richness was found to be between 9% and 56% lower in invaded vs. uninvaded vegetation. Indeed, as a general pattern, the invasion of HIPS decreases the available area and cover of other plant species, which in turn lowers the plant species richness and diversity. However, the magnitude of this impact is species specific.

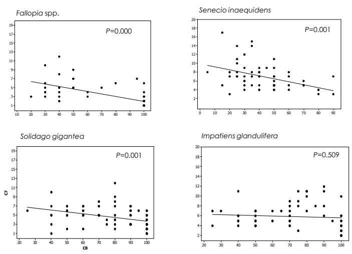


Fig 2. : Linear regressions Native plant richness vs. HIPS density for the 4 target HIPS

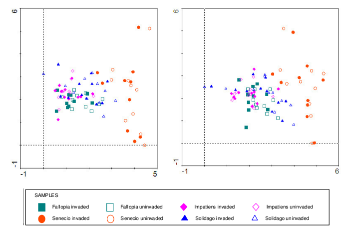
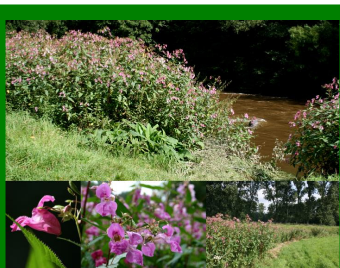
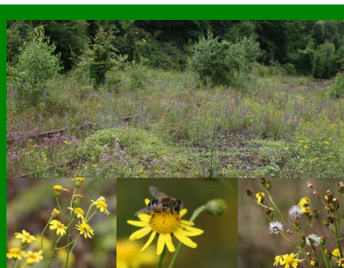
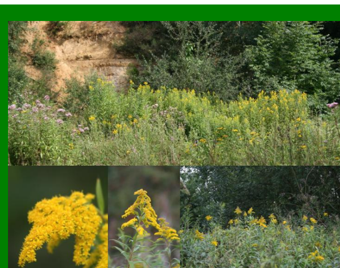


Fig. 3 : Correspondence analysis ordination graph of plots realised from (a) species abundance data (b) presence-absence data.

It is a clear-cut observation that high densities of the target invasive species reduce native plant richness. The impact of an invader is expected to correlate with its own population density, since any biomass (or space or energy) controlled by the invader constitutes resources no longer available to other species. However we found that low densities can already induce a substantial impact in the cases of *Fallopia* spp. and *S. gigantea*.
No effect of invasion were found on plant composition, when comparing invaded and uninvaded stands. Although some plants disappeared following invasion, HIPS did not alter the dominant native species composition in terms of presence / absence, nor in terms of covers. However a shift in dominance of the invasive species was a common trend on all invaded sites.
In terms of implications for nature conservation, it has to be noted that changes in the plant communities are likely to have effects on higher trophic levels. Pollinator web disruption are also an important drawback attributed to invasive plant species.
These consequences on the whole community, have to be further studied and taken into account in order to produce an integrated ranking of HIPS impacts.







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