LIFE + « Information & Communication »

AlterIAS project

Socio-economic survey on invasive ornamental plants in Belgium

- Final report February 2011 -

M. Halford, L. Heemers, C. Mathys, S. Vanderhoeven, G. Mahy

Project coordinated by the Biodiversity & Landscape Unit

from the University of Liège Gembloux Agro-Bio Tech

In collaboration with:

Le Centre Technique Horticole de Gembloux
The Horticultural Technical Center of Gembloux

Het Proefcentrum voor Sierteelt
Research center for ornamental plants

The Federal Public Service
Health, Food Chain Safety and Environment

Supported and co-financed by:

TABLE OF CONTENT

1. INTRODUCTION

Horticulture is considered as one of the main pathway of invasive plant introductions worldwide (Reichard *et al.*, 2001; Bell *et al.*, 2003; Dehnen-Schmutz *et al.*, 2007; Burt *et al.*, 2007). In Belgium, 57 plant taxas are now included in the list of invaders, composed of a black list and a watch list of species (Branquart *et al.*, 2007). Most of them are ornamentals still planted in garden and green areas. Therefore it is necessary to communicate towards horticulture professionals and gardeners in order to prevent plant invasions. But invasive plants remain little known outside the scientific audience. In order to draw up the actual situation of invasive plants and horticulture in Belgium, a socio-economic survey was performed. The objectives are:

1. quantify the presence and economic value of invasive plants within the horticultural market;

2. assess the social perception (level of knowledge, awareness and concern, need for information, solutions) of horticulture professionals and gardeners on the invasive plants issue.

Assessing how people understand the issue of invasive alien species (IAS) is an essential prerequisite for establishing communication strategies (Vanderhoeven *et al.*, 2008). Such surveys are frequent in biological invasions (Vanderhoeven *et al.*, 2011 ; Andreu *et al.*, 2009 ; Gagliardi *et al.*, 2007 ; Bremmer *et al.*, 2007 ; Peters *et al.*, 2006). Results can help in identifying (1) information gaps and (2) preventive measures to adopt for reducing introductions of invasive plants. This survey can also help in perceiving how self-regulation tools like codes of conduct (Genovesi *et al.*, 2004; Heywood *et al.*, 2008) could be welcome by the horticultural sector.

AlterIAS - Alternatives for invasive plants - is a communication project dedicated to invasive plants and prevention in horticulture (http://www.alterias.be). *AlterIAS* [2010 – 2013] is supported and co-financed by the LIFE + program of the European Commission and by regional and federal administrations responsible for environment in Belgium (SPW-DGOARNE, ANB, IBGE-BIM, SPF-SPSCAE-DG Env).

2.1. Sampling design

This survey was addressed to **horticulture professionals** and **gardeners** in **Belgium**. Four public targets were identified among ornamental plant users: (1) nursery men; (2) public green managers; (3) private managers and (4) garden amateurs (table 1).

Table 1: Public target

Public target	Description
Nursery men	Producers and sellers gathered in horticultural federations (FWH, AVBS)
Public green managers	Managers gathered in associations (UVCW, APEC, VVOG, ABGP)
Private managers	Landscape architects, garden contractors (AVBS, BFG-FBEP, MAP-L)
Garden amateurs	Visitors of horticultural events, members of horticultural associations

FWH : Fédération Wallonne Horticole ; AVBS : Algemeen Verbond van Belgische Siertelers en Groenvoorzieners ; UVCW : Union des Villes et des Communes de Wallonie ; APEC : Association pour les Espaces Verts Communaux ; VVOG : Vereniging Voor Openbaar Groen ; ABGP : Association Bruxelloise des Gestionnaires Publiques. ; BFG-FBEP : Belgische Federatie Groenvoorzieners - Féderation Belge Entrepreneurs Paysagistes ; MAP-L : Mouvement des Architectes Paysagistes de Liège.

The sampling design was adapted from a previous survey conducted for the *Perinbel* project (Vanderhoeven *et al.*, 2008). Specific questionnaires were prepared (annex 1) and transmitted to the public target through mailing and/or direct consultations (phone or face-to-face interviews). For horticulture professionals, questionnaires were sent to affiliated members of federations or associations. The questionnaires included four distinct sections: (1) level of knowledge; (2) awareness and concern; (3) availability of information and (4) solutions. Surveys were addressed between February and September 2010 throughout Belgium (Wallonia, Flanders, Brussels). A total of **634 surveys** were collected (table 2). When possible, answer rates are mentioned, indicating the sampling effort related to the number of questionnaires sent.

The presence and economic value of invasive plants within the horticultural market were estimated through (1) horticultural catalogues analysis and (2) specific questions on plant sales addressed to nursery men only. The list of invasive plants analysed in this study is mentioned in annex 2. A total of **146 catalogues** were analysed and **69 nursery men** answered partially or exhaustively to questions related to economy (table 3).

Table 2: Number and percentage of answers

Public target	Region	Nb of members in federations or associations	Nb answers	% of total	Answer rate
Nursery men	Wallonia	325	41	6.5	12.6
	Flanders	340	73	11.5	21.5
Public green managers	Wallonia	262	93	14.6	35.5
	Flanders	308	72	11.4	23.4
	Brussels	50	10	1.6	20.0
Private managers	Belgium	1100	59	9.3	5.4
Garden amateurs	Wallonia	.	185	29.2	.
	Flanders	.	101	15.9	.
Total			**634**	**100.0**	.

Table 3: Number of horticultural catalogues and number of answers for economic assessment

Method	Region	Nb
Horticultural catalogues	Flanders	115
	Wallonia	31
Survey (economic value)	Flanders	40
	Wallonia	29

2.2. Data analysis

All data were analysed in Access and Excel databases. Examples of questions are indicated in table 4 (see annex 2 for the full list of questions). Basic statistics (%) were computed for each question.

Table 4: Examples of questions

Section	Question
Level of knowledge	Do you know what is an invasive plant (or invasive alien plant)? If yes, what do you know? Do you know examples of invasive plants? According to you, what are the impacts of invasive plants?
Awareness and concern	Do think it is an important issue? Do you feel concerned by this issue?
Availability of information	Do you feel enough informed about invasive plants? Have you already been informed about invasive plants? Do you think the horticultural sector should be better informed about invasive plants?
Solutions and prevention	Have you ever heard about codes of conduct on invasive plants and horticulture? Do you think the problem should be regulated by legislation? Which measure would you adopt voluntarily in order to reduce the risk of introduction of invasive plants?
Economic value	Which species do you sell? (among the Belgian list of invasive plants) Which proportion of your sales does it represent? Which species is considered of economic value? Do you feel your business would be threatened in case of withdrawing invasive plant(s) from sales?

Global level of knowledge on invasive plants was evaluated for each public target by analysing answers to questions included in this section. Answers were compared with the definition of invasive plants proposed in the Convention on Biological Diversity (2002) and referred in the *Perinbel* project (Vanderhoeven *et al.*, 2008):

"*An invasive plant is a species, sub-species or varieties introduced by men outside its natural distribution area, able to survive, reproduce and spread in a new environment, which may cause environmental, economic, socio-cultural and/or public health impacts when established*".

This definition highlights five main notions to refer concerning invasive plants: (1) spatial origin; (2) introduction by men; (3) naturalization; (4) expansion, proliferation and (5) impacts. Global level of knowledge was evaluated following criteria presented in table 5.

Table 5: Global level of knowledge

Level of knowledge	Criteria
High	Those who answered "Yes" to the question "Do you know what is an invasive plant?" AND indicated at least four notions of the definition AND at least two correct examples AND at least one impact.
Medium	Those who answered "Yes" to the question "Do you know what is an invasive plant?" AND indicated at least two notions of the definition AND at least one correct example AND at least one impact.
Low	Those who answered "No" to the question "Do you know what is an invasive plant?" OR those who answered "Yes" but indicated no notions AND wrong examples AND no impacts.

Only public targets with a "medium" or a "high" level of knowledge were taken into account to analyse answers related to the perception, availability of information and solutions.

3.1. Presence and economic value of invasive plants in the horticultural market

3.1.1. Presence of invasive plants

Results of the horticultural catalogues analysis are presented in figure 1. Invasive plants (scientific name and synonyms) were recorded. Plants were recorded when the species and/or cultivars of the species were listed. This figure shows for example that *Robinia pseudoacacia* is present in 53 % of catalogues, while *Fallopia japonica* in 3%. Aquatic plants were not analysed in this study. Among terrestrial invasive plants included in Belgian list, a total of **30 species** were identified in catalogues, meaning 67 % of terrestrial invasive plants are available in the horticultural market.

67 % of terrestrial invasive plants are available in horticultural catalogues.

Invasive plant species and/or cultivars thereof can be found in catalogues. In some cases, both species and cultivars of invasive plants are available (ex: *Acer negundo* and *Acer negundo* 'Variegatum' or *Acer negundo* 'Flamingo'). In other cases, only cultivars are available (ex: *Fallopia japonica* 'compacta'). Figure 2 illustrates the availability of species and cultivars in 115 catalogues in Flanders. For the following species, the cultivars are very frequent: *Rudbeckia laciniata, Aster novi-belgii, Prunus laurocerasus, Buddleja davidii, Cornus sericea, Acer negundo, Robinia pseudoacacia*.

Catalogues are not published every year and do not always reflect exactly the actual supply, so the presence of invasive plants in the market must be completed with surveys. When asking to nursery men which species they sell among the list of invasive plants, more species were identified. This survey includes both terrestrial and aquatic plants. Results are presented in figure 3. This figure indicates for example *Amelanchier lamarckii* is available in 57 % of nurseries investigated, while *Impatiens glandulifera* in 3%. Among the list of invasive plants, a total of **53 species** were identified, meaning 93 % of invasive plants in Belgium are available in nurseries.

93 % of invasive plants (terrestrial and aquatic) are available in nurseries.

3.1.2. Economic value of invasive plants

On average, 9 invasive plants are available in nurseries, with a minimum of 0 species and a maximum of 30. Figure 4 illustrates the proportion of sales of invasive plants. This estimation was made by nursery men themselves.

44% of nursery men estimate invasive plants represent less than 5% of sales.

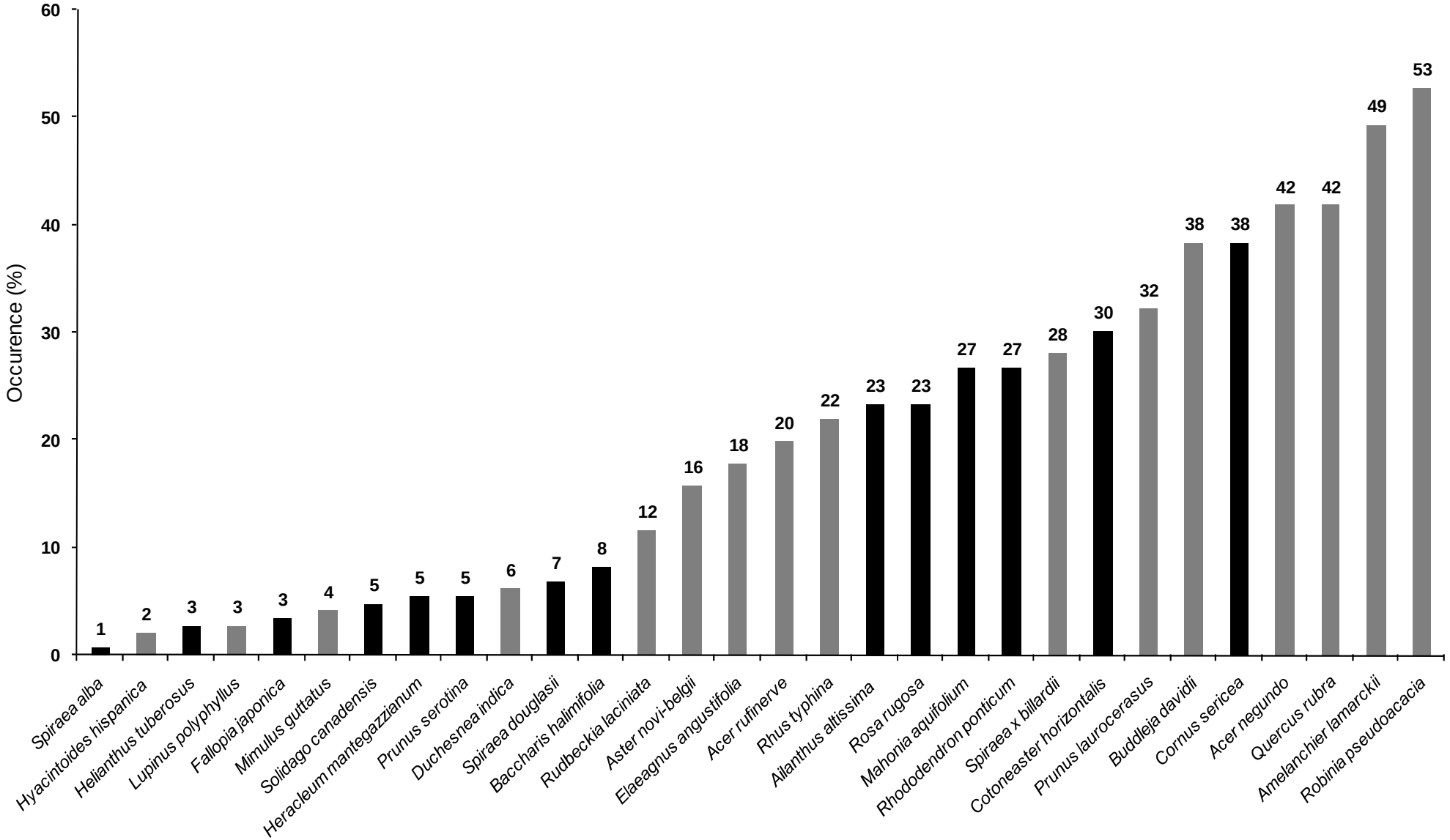

Figure 1: Occurrence of terrestrial invasive plants (species and cultivars) in horticultural catalogues in Belgium (n=146). Black bars: black list species; Grey bars: watch list species.

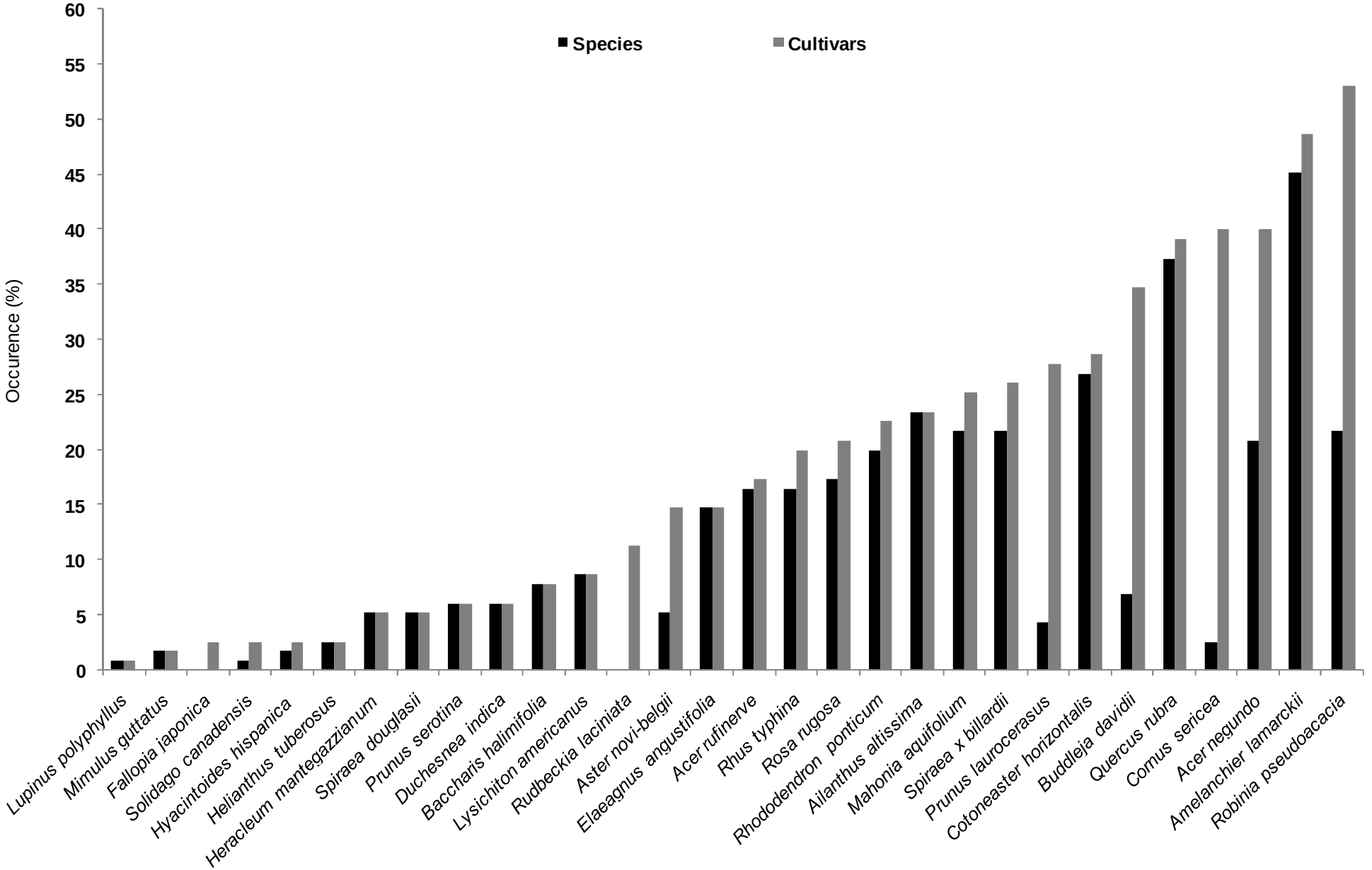

Figure 2: Occurrence of terrestrial invasive plants (species or cultivars) in horticultural catalogues in Flanders (n=115).

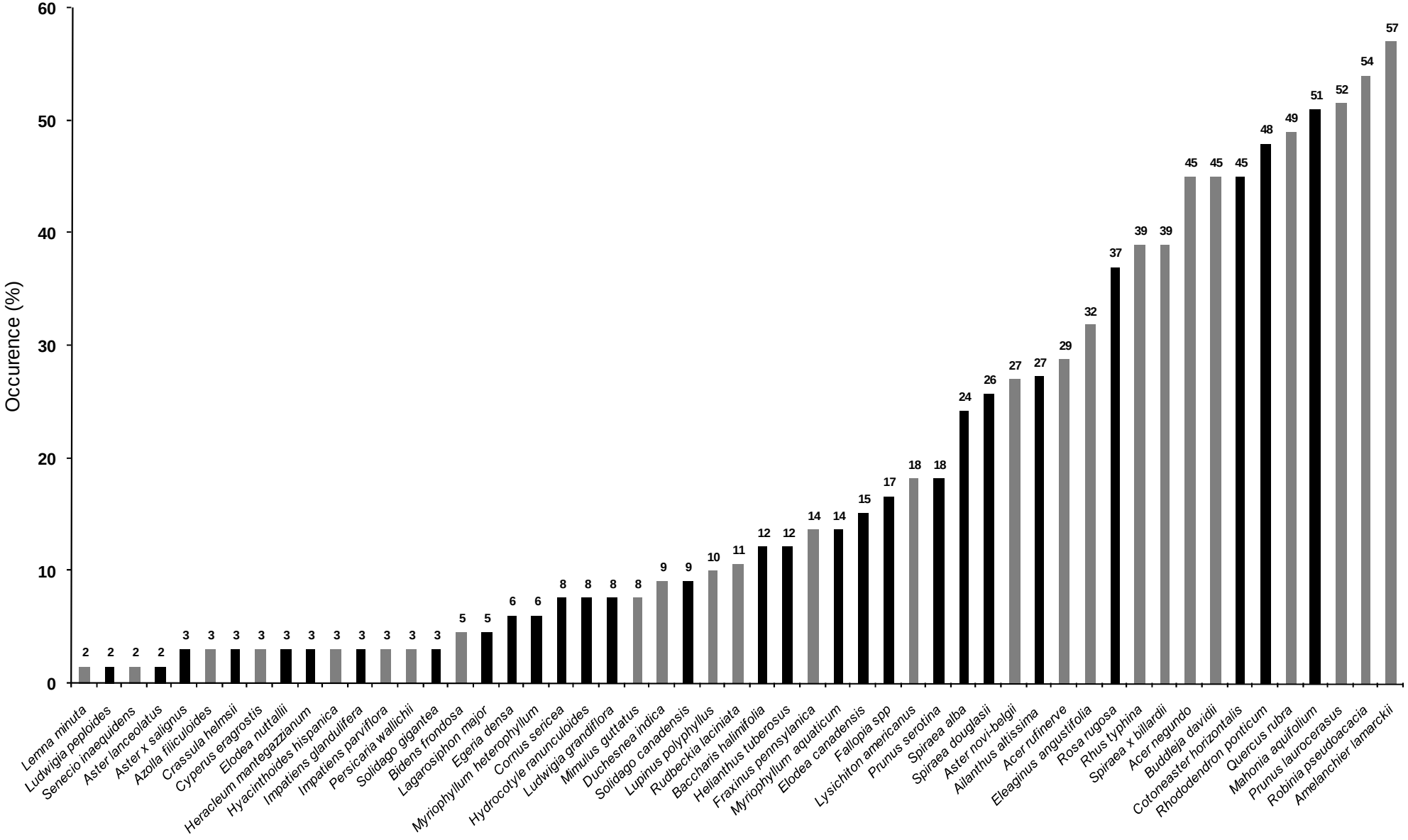

Figure 3: Occurrence of invasive plants (terrestrial and aquatic) sold in nurseries in Belgium (n=67). Black bars: black list species; Grey bars: watch list species

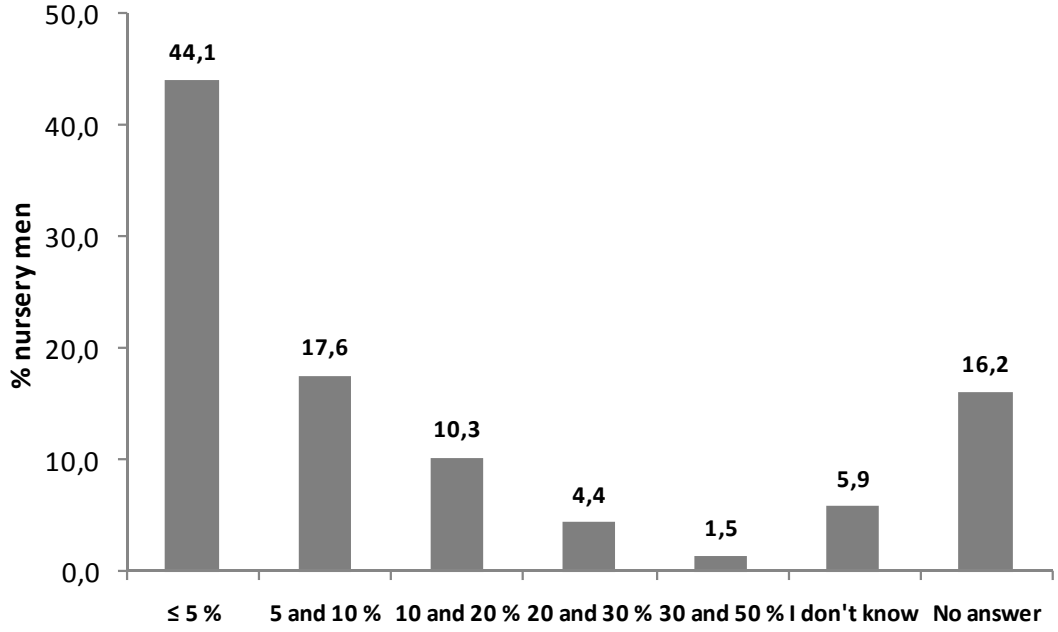

Figure 4: Proportion of sales of invasive plants (n=68)

When asking to nursery men which invasive plants are considered of economic value, **32 species** were identified. Results are presented in figure 5. This figure shows 48% of nursery men consider *Prunus laurocerasus* is economically important. Table 6 presents species considered of economic value by more than 5% of nursery men. No aquatic plants are considered of economic value here, but this probably reflects the lower sampling rate of aquatic plant producers or sellers in this study.

Table 6: The list of terrestrial invasive plants in Belgium and species considered of economic value by more than 5% of nursery men (in bold); n=63

Black list	Watch list
Ailanthus altissima	***Acer negundo***
Aster lanceolatus	***Acer rufinerve***
Aster salignus	***Amelanchier lamarckii***
Baccharis halimifolia	***Aster novi-belgii***
Cornus sericea	*Bidens frondosa*
Cotoneaster horizontalis	***Buddleja davidii***
Fallopia spp. *(F. japonica, F. sachalinensis, F. x bohemica)*	*Cyperus eragrostis*
Helianthus tuberosus	*Duchesnea indica*
Heracleum mantegazzianum	***Elaeagnus angustifolia***
Impatiens glandulifera	*Fraxinus pennsylanica*
Mahonia aquifolium	*Hyacinthoides hispanica*
Prunus serotina	*Impatiens parviflora*
Rhododendron ponticum	*Lupinus polyphyllus*
Rosa rugosa	*Lysichiton americanus*
Solidago canadensis	*Mimulus guttatus*
Solidago gigantea	*Parthenocissus* spp. (not assessed in this survey)
Spiraea alba	*Persicaria wallichii*
Spiraea douglasii	***Prunus laurocerasus***
	Quercus rubra
	Rhus typhina
	Robinia pseudoacacia
	Rudbeckia laciniata
	Senecio inaequidens
	Spiraea x billardii

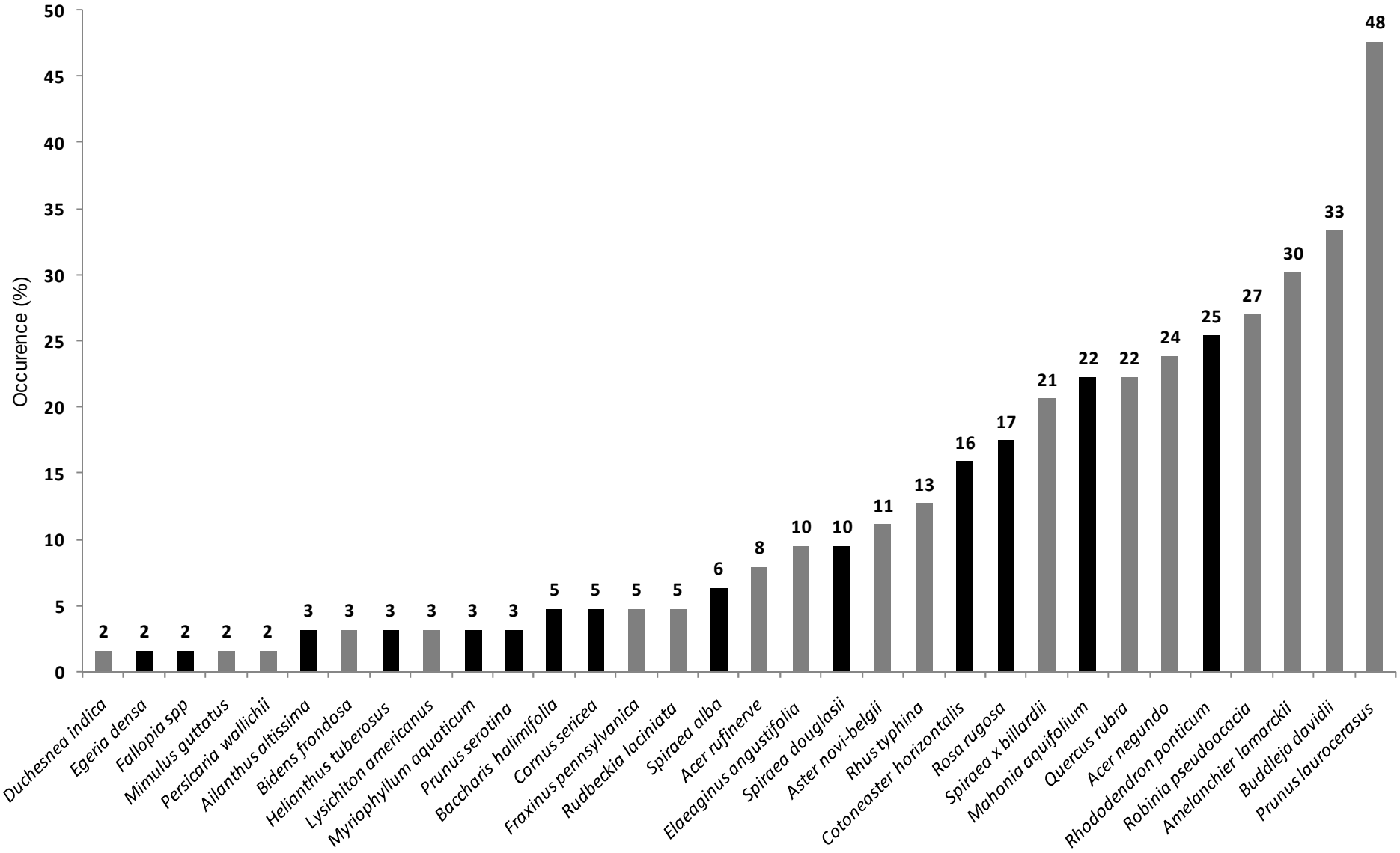

Figure 5: Species considered of economic value for nursery men (n=63)

Nursery men were also asked if they feel their business would be threatened in case of withdrawing invasive plant(s) from sales (figure 6).

45% of nursery men think their business is not threatened in case of withdrawing invasive plant(s) from sales

Answers differ between regions (figure 7). Only 14% (4/29) of nursery men in Wallonia feel threatened, whereas 45% (18/40) does in Flanders.

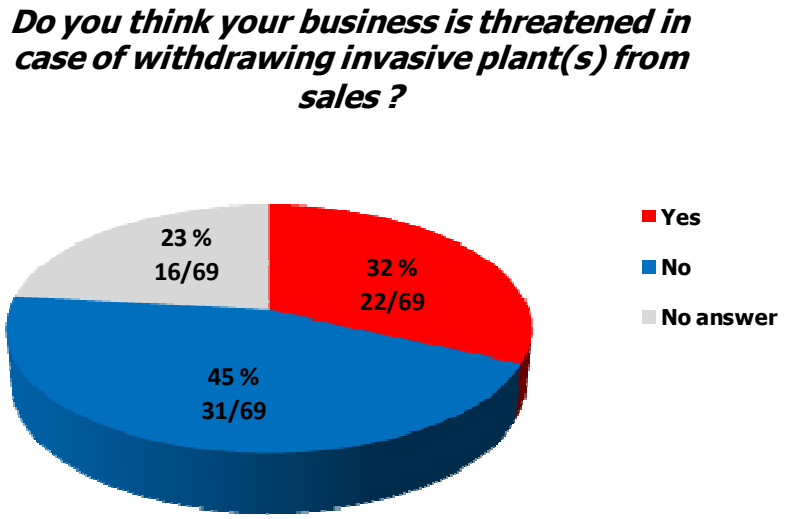

Figure 6: Impact of withdrawing invasive plant(s) from sales on economy of nurseries in Belgium (n=69)

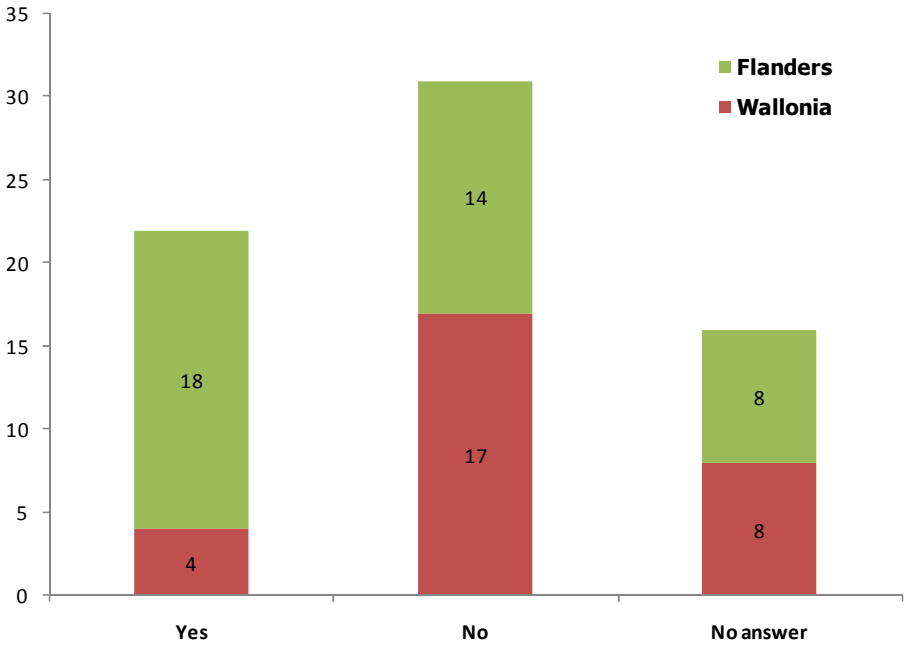

Figure 7: Impact of withdrawing invasive plants from sales on economy of nurseries in Wallonia and Flanders (n=69).

3.2. Social perception of invasive plants

3.2.1. Level of knowledge

Do you know what is an invasive plant (or invasive alien plant)?

Public target	Yes		No		No answer		Total	
	Nb	%	Nb	%	Nb	%	Nb	%
Nursery men	81	**71**	31	**27**	2	**2**	114	**100**
Public green managers	162	**93**	11	**6**	2	**1**	175	**100**
Private managers	49	**83**	8	**14**	2	**3**	59	**100**
Garden amateurs	246	**86**	38	**13**	2	**1**	286	**100**

If yes, what do you know? (several options possible)

Public target	Spatial origin		Introduced by men		Naturalization		Expansion, proliferation		Impact on biodiversity		No answer	
	Nb	%	Nb	%	Nb	%	Nb	%	Nb	%	Nb	%
Nursery men	48	**59**	19	**23**	7	**9**	32	**40**	30	**37**	13	**16**
Public green managers	103	**64**	48	**30**	14	**9**	77	**48**	101	**62**	19	**12**
Private managers	31	**63**	14	**29**	4	**8**	25	**51**	19	**39**	3	**6**
Garden amateurs	141	**57**	95	**39**	28	**11**	137	**56**	145	**59**	14	**6**

Do you know examples of invasive plants?

Public target	Yes		No		No answer		Total	
	Nb	%	Nb	%	Nb	%	Nb	%
Nursery men	72	**63**	28	**25**	14	**12**	114	**100**
Public green managers	165	**94**	9	**5**	1	**1**	175	**100**
Private managers	49	**83**	8	**14**	2	**3**	59	**100**
Garden amateurs	196	**69**	58	**20**	32	**11**	286	**100**

Correct examples of invasive plants quoted (species most quoted in bold)

Region	Examples
Wallonia and Brussels	***Fallopia* japonica*, Heracleum mantegazzianum, Impatiens glandulifera*, *Buddleja davidii*,** *Senecio inaequidens, Cotoneaster* spp.*, aquatic plants* (*Myriophyllum* spp.*, Elodea canadensis, Ludwigia* spp.)
Flanders and Brussels	***Prunus serotina, Hydrocotyle ranunculoides, Fallopia japonica, Heracleum mantegazzianum, Impatiens glandulifera***, *Buddleja davidii*, *Quercus rubra*, other aquatic plants (*Myriophyllum aquaticum*, *Elodea* spp.)

Other examples[1] (species most quoted in bold): *Betula pendula, Salix* spp.*,* ***Cyperus esculentus***, *Sambucus* spp., ***Cirsium* spp.**, *Urtica dioica, Epilobium* spp., **bamboos** (*Phylostachys* spp.), ***Aegopodium podragraria***, *Taraxacum officinale, Rubus fruticosus, Hedera helix, Ranunculus* spp., *Calystegia sepium*, ***Eichlornia crassipes***, *Humulus lupulus, Olea* spp.*,* palms.

[1] Native species and/or species not included in the list of invasive plants in Belgium (see annex 2).

What are the impacts of invasive plants? (several options possible)

Public target *	Ecological		Economic		Public health		Damages on infrastructures		No answer	
	Nb	%	Nb	%	Nb	%	Nb	%	Nb	%
Nursery men	64	**79**	2	**2**	7	**6**	0	**0**	16	**20**
Public green managers	141	**87**	10	**6**	26	**16**	5	**3**	18	**11**
Private managers	41	**84**	1	**2**	3	**6**	2	**4**	6	**12**
Garden amateurs	214	**87**	20	**8**	39	**16**	38	**15**	25	**10**

*: n=81 for nursery men; n=162 for public green managers; n=49 for private managers; n=246 for garden amateurs

3.2.2. Awareness and concern

Do you think it is an important issue? [2]

Public target	Yes		No		I don't know		No answer		Total	
	Nb	%	Nb	%	Nb	%	Nb	%	Nb	%
Nursery men	51	**74**	13	**19**	5	**7**	0	**0**	69	**100**
Public green managers	150	**94**	3	**2**	6	**4**	0	**0**	159	**100**
Private managers	36	**78**	4	**9**	6	**13**	0	**0**	46	**100**
Garden amateurs	184	**88**	2	**1**	20	**10**	3	**1**	209	**100**

Do you feel concerned by the issue?

Public target	Yes		No		I don't know		No answer		Total	
	Nb	%	Nb	%	Nb	%	Nb	%	Nb	%
Nursery men	37	**54**	28	**41**	3	**4**	1	**1**	69	**100**
Public green managers	139	**87**	9	**6**	10	**6**	1	**1**	159	**100**
Private managers	32	**70**	9	**20**	4	**9**	1	**2**	46	**100**
Garden amateurs	173	**83**	19	**9**	15	**7**	2	**1**	209	**100**

➔ Additional question for public green managers and gardeners: ***Do you have to face such a problem in your municipality*** *(for public green managers)* ***or in your garden*** *(for gardeners)****?***

Public target	Yes		No		I don't know		No answer		Total	
	Nb	%	Nb	%	Nb	%	Nb	%	Nb	%
Public green managers	127	**80**	23	**14**	7	**4**	2	**1**	159	**100**
Garden amateurs	115	**55**	66	**32**	23	**11**	5	**2**	209	**100**

[2] For questions related to perception, availability of information and solutions, only public targets with a high and a medium level of knowledge were taken into account (see discussion).

3.2.3. Availability of information

Do you feel enough informed about invasive plants?

Public target	Yes		No		I don't know		No answer		Total	
	Nb	%	Nb	%	Nb	%	Nb	%	Nb	%
Nursery men	22	**32**	41	**59**	6	**9**	0	**0**	69	**100**
Public green managers	70	**44**	78	**49**	7	**4**	4	**3**	159	**100**
Private managers	12	**26**	30	**65**	3	**7**	1	**2**	46	**100**
Garden amateurs	45	**22**	147	**70**	8	**4**	9	**4**	209	**100**

Have you already been informed about invasive plants?

Public target	Yes		No		No answer		Total	
	Nb	%	Nb	%	Nb	%	Nb	%
Nursery men	38	**55**	30	**43**	1	**1**	69	**100**
Public green managers	128	**80**	25	**16**	6	**4**	159	**100**
Private managers	20	**43**	23	**50**	3	**7**	46	**100**
Garden amateurs	129	**62**	63	**30**	17	**8**	209	**100**

Do you think you should be better informed about invasive plants?

Public target	Yes		No		I don't know		No answer		Total	
	Nb	%	Nb	%	Nb	%	Nb	%	Nb	%
Nursery men	52	**75**	4	**6**	11	**16**	2	**3**	69	**100**
Public green managers	138	**87**	7	**4**	9	**6**	5	**3**	159	**100**
Private managers	37	**80**	2	**4**	5	**11**	2	**4**	46	**100**
Garden amateurs	192	**92**	2	**1**	7	**3**	8	**4**	209	**100**

3.2.4. Solutions and preventive measures

Have you ever heard about codes of conduct on invasive plants and horticulture?

Public target	Yes		No		No answer		Total	
	Nb	%	Nb	%	Nb	%	Nb	%
Nursery men	7	**10**	59	**86**	3	**4**	69	**100**
Public green managers	21	**13**	132	**83**	6	**4**	159	**100**
Private managers	7	**15**	37	**80**	2	**4**	46	**100**
Garden amateurs	15	**7**	178	**85**	16	**8**	209	**100**

Do you think the problem should be regulated by legislation?

Public target	Yes		No		I don't know		No answer		Total	
	Nb	%	Nb	%	Nb	%	Nb	%	Nb	%
Nursery men	37	**54**	14	**20**	13	**19**	5	**7**	69	**100**
Public green managers	105	**66**	10	**6**	36	**23**	8	**5**	159	**100**
Private managers	26	**57**	8	**17**	10	**22**	2	**4**	46	**100**
Garden amateurs	151	**72**	11	**5**	33	**16**	14	**7**	209	**100**

Which preventive measures would you adopt voluntarily?

For nursery men (n=69)

Answer (several options possible)	Yes		No		I don't know		No anwer	
	Nb	%	Nb	%	Nb	%	Nb	%
Inform customers (about the risks of invasive plants)	56	**81**	2	**3**	2	**3**	9	**13**
Stop selling invasive plants (for sellers)	37	**54**	8	**12**	7	**10**	17	**25**
Stop producing invasive plants (for producers)	36	**52**	8	**12**	5	**7**	20	**29**
Use specific labeling for invasive plants	45	**65**	4	**6**	3	**4**	17	**25**
Use non invasive alternative plants	53	**77**	1	**1**	5	**7**	10	**14**
Apply good practices to avoid spreading invasive plants	49	**71**	0	**0**	9	**13**	11	**16**

➔ Additional question for nursery men: *Would you accept to endorse a code of conduct recommending voluntary adoption of those measures?*

Answer	Nb	%
Yes	42	**61**
No	8	**11**
I don't know	13	**19**
No answer	6	**9**
Total	69	**100**

For public green managers (n=159)

Answer (several options possible)	Yes		No		I don't know		No answer	
	Nb	%	Nb	%	Nb	%	Nb	%
Inform managers (about the risks of invasive plants)	146	**92**	1	**1**	2	**1**	10	**6**
Apply good practices to avoid spreading invasive plants	135	**85**	2	**1**	8	**5**	14	**9**
Control populations established in my municipality	128	**81**	0	**0**	14	**9**	17	**11**
Stop buying invasive plants	131	**82**	1	**1**	5	**3**	22	**14**
Stop planting invasive plants	133	**84**	0	**0**	5	**3**	21	**13**
Use non invasive alternative plants	137	**86**	0	**0**	4	**3**	18	**11**

For private managers (n=46)

Answer (several options possible)	**Yes**		**No**		**I don't know**		**No answer**	
	Nb	**%**	**Nb**	**%**	**Nb**	**%**	**Nb**	**%**
Inform customers (about the risks of invasive plants)	42	**91**	0	**0**	1	**2**	3	**6**
Apply good practices to avoid spreading invasive plants	35	**76**	0	**0**	3	**6**	8	**17**
Stop buying invasive plants	28	**61**	3	**6**	6	**13**	9	**20**
Stop planting invasive plants	30	**65**	3	**6**	5	**11**	8	**17**
Use non invasive alternative plants	40	**87**	0	**0**	3	**6**	3	**6**

➔ Additional question for private managers: *Would you accept to endorse a code of conduct recommending voluntary adoption of those measures?*

Answer	**Nb**	**%**
Yes	34	**73**
No	3	**7**
I don't know	6	**13**
No answer	3	**7**
Total	46	**100**

For garden amateurs (n=209)

Answer (several options possible)	**Yes**		**No**		**I don't know**		**No answer**	
	Nb	**%**	**Nb**	**%**	**Nb**	**%**	**Nb**	**%**
Inform gardeners (about the risks of invasive plants)	159	**76**	5	**2**	4	**2**	41	**20**
Apply good practices to avoid spreading invasive plants	172	**82**	1	**1**	1	**1**	35	**17**
Remove invasive plants out of my garden	150	**72**	6	**3**	4	**2**	49	**23**
Stop buying invasive plants	159	**76**	3	**1**	4	**2**	43	**21**
Use non invasive alternative plants	173	**83**	1	**1**	3	**1**	32	**15**

➔ Additional question for gardeners: *Would you prefer to buy your plants in nurseries which do not sell invasive plants (e.g. in nurseries engaged in codes of conduct on invasive plants)?*

Answer	**Nb**	**%**
Yes	179	**86**
No	3	**1**
I don't know	13	**6**
No answer	14	**7**
Total	209	**100**

4.1. Presence and economic value of invasive plants

In 2010, most invasive plants are present within the horticulture market. In average, considering results from horticultural catalogues and surveys, **80% of invasive plants are still available**. Surprisingly, even species not introduced for horticulture (e.g. *Senecio inaequidens*) are listed by nursery men. Table 7 presents the 10 species with higher occurrences (ranking from figure 3).

Table 7: The 10 species with higher occurrences in nurseries

Black list	Watch list
4. *Mahonia aquifolium* 6. *Rhododendron ponticum* 7. C*otoneaster horizontalis* 9. *Rosa rugosa*	1. *Amelanchier lamarckii* 2. *Robinia pseudoacacia* 3. *Prunus laurocerasus* 5. *Quercus rubra* 7. *Acer negundo* and *Buddleja davidii* 8. *Spiraea x billardii* and *Rhus typhina* 10. *Eleagnus angustifolia*

Logically species with higher occurrences are considered of economic value by nursery men (table 8). Despite those species of economic value, 44% of nursery men assess those plants globally represent less than 5% of their sales, which can be considered as a negligible part of sales according to comments from some nursery men during interviews. Identifying which species is economically important is essential for codes of conduct. Those results highlight which species could be easily banned from sales with minor impact for economy.

Table 8: The 10 species mostly considered of economic value

Black list	Watch list
5. *Rhododendron ponticum* 7. *Mahonia aquifolium* 9. *Rosa rugosa* 10. *Cotoneaster horizontalis*	1. *Prunus Laurocerasus* 2. *Buddleja davidii* 3. *Amelanchier lamarckii* 4. *Robinia pseudoacacia* 6. *Acer negundo* 7. *Quercus rubra* 8. *Spiraea* x *billardii*

Results in figure 3 could be compared to a similar survey conducted in 2006 with nursery men in Wallonia, where 34 invasive species were identified (figure 8). All invasive species identified in 2006 were still present in 2010, except *Lemna turionifera* (not assessed in the present study). Some results are compared in table 9.

Table 9: The 10 species with a higher occurrence in nurseries in 2006 and 2010

AlterIAS 2010 (Belgium, n=67)	Perinbel 2006 (Wallonia, n=102)
1. *Amelanchier lamarckii* 2. *Robinia pseudoacacia** 3. *Prunus laurocerasus** 4. *Mahonia aquifolium* 5. *Quercus rubra** 6. *Rhododendron ponticum* 7. *Cotoneaster horizontalis* 8. *Buddleja davidii* 9. *Acer negundo* 10. *Spiraea x billardii**	1. *Buddleja davidii* 2. *Amelanchier lamarckii* 3. *Acer negundo* 4. *Mahonia aquifolium* 5. *Rhododendron ponticum* 6. *Cotoneaster horizontalis* 7. *Aster novi-belgii* 8. *Ailanthus altissima* 9. *Prunus serotina* 10. *Myriophyllum aquaticum*

*: not assessed in 2006

Highly invasive plant species [3] are also still present in 2010 (table 10), but with lower occurrences for terrestrial plants. Differences in results could be due to differences in sampling design (species considered, answer rate, study area) between the two projects.

Table 10: Occurrence of highly invasive plant species (HIPS) in nurseries in 2006 and 2010

Species	% in 2010 (Belgium)	% in 2006 (Wallonia)
Prunus serotina	18	29
Fallopia spp.	17	20
Myriophyllum aquaticum	14	23
Hydrocotyle ranunculoides	8	16
Ludwigia grandiflora	8	4
Egeria densa	6	2
Lagarosiphon major	5	3
Heracleum mantegazzianum	3	15
Impatiens glandulifera	3	11
Solidago gigantea	3	6

4.2. Level of knowledge on invasive plants

Assessment of the global level of knowledge is presented in table 11. **Public green managers seem better informed**, with 91% having a correct knowledge (high and medium level) of invasive plants. Private managers and gardeners have a similar level of knowledge, whereas **nursery men are less informed**, with 40% having a low level of knowledge about the issue. More nursery men in Flanders (35/73 = 48%) are concerned as compared to Wallonia (10/41 = 24%).

Table 11: Global level of knowledge

Public target	High		Medium		Low		Total	
	Nb	%	Nb	%	Nb	%	Nb	%
Nursery men	5	**4**	64	**56**	45	**40**	114	**100**
Public green managers	43	**25**	116	**66**	16	**9**	175	**100**
Private managers	3	**5**	43	**73**	13	**22**	59	**100**
Garden amateurs	11	**4**	199	**70**	76	**27**	286	**100**

When analyzing how invasive plants are defined by the public target, **notions most quoted are (1) spatial origin, (2) impacts on biodiversity and (3) proliferation**. Notions "introduced by men" and "naturalization" are less known. **Ecological impacts are mainly mentioned by the public target.** Economic impact and damages on infrastructures are less quoted. Public green managers and gardeners also mentioned impacts on public health with the same percentage (16%).

Examples of invasive plants given in each region probably reflect species most widespread or detrimental in Wallonia or Flanders. *Prunus serotina* and *Hydrocotyle ranunculoides* are most quoted in Flanders, where they cause more damages. *Fallopia japonica, Impatiens glandulifera* and *Heracleum mantegazzianum* are widespread throughout Belgium. Lots of communication actions were conducted about those three invasive species, especially in Wallonia since 2006.

[3] Terminology used by Nijs *et al*. (2009). HIPS could also refer to species (1) occurring with large and well established populations in a large area in Belgium; (2) being invaders of habitats of high conservation value; (3) being invasive in contrasting types of habitats (Vanderhoeven *et al*., 2006).

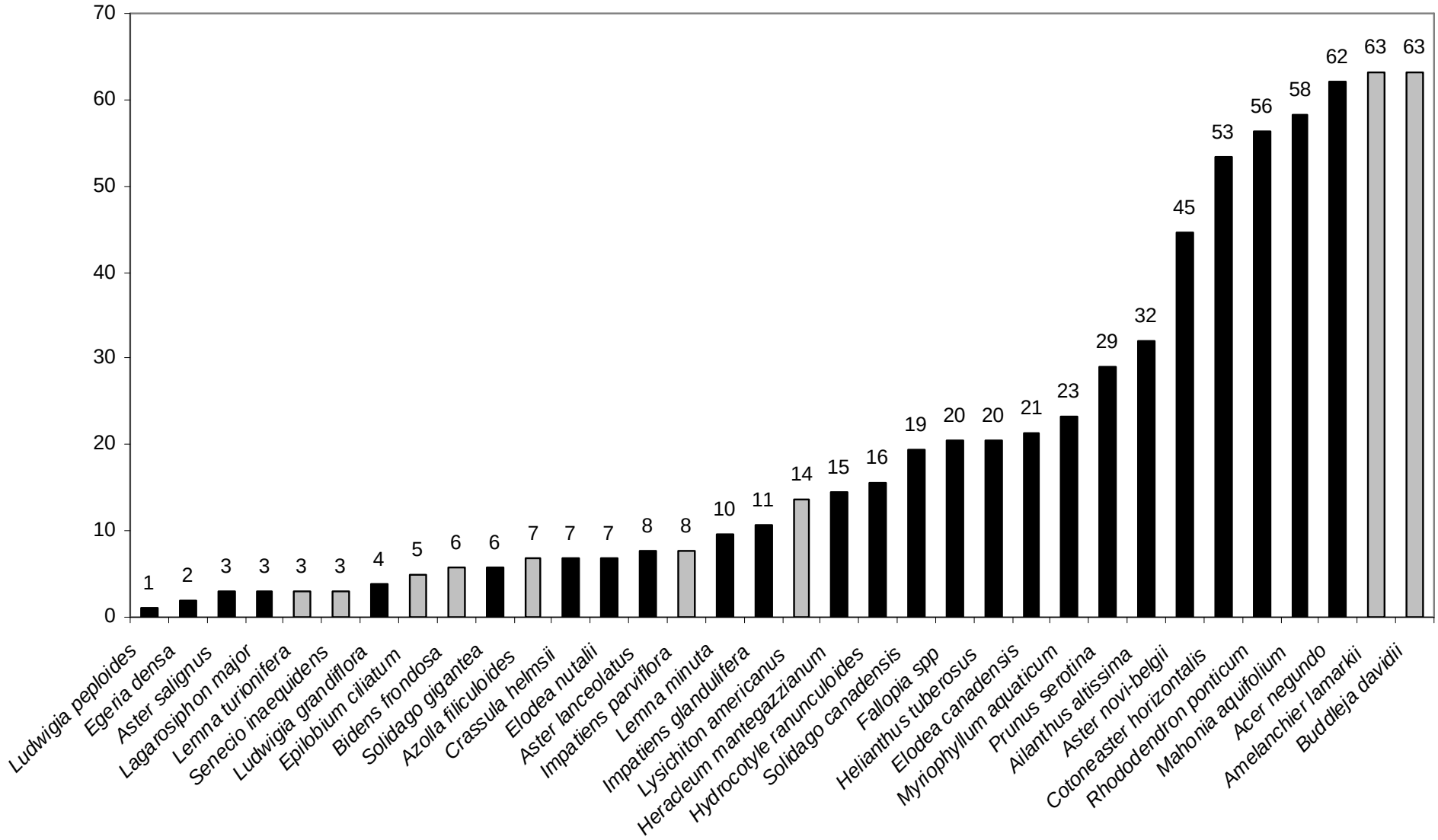

Figure 8: Occurence of exotic plants sold by nurseries in the walloon Region in 2006 (n=102). Black bars: black list species; Grey bars: watch list species. Results from the Perinbel survey (Vanderhoeven *et al.*, 2008 and 2011).

4.3. Awareness and concern

The **degree of awareness is generally high**. In average, 84% of horticulture professionals and gardeners think invasive plants are an important issue and 74% feel concerned with it. Among horticulture professionals, public green managers are more aware. But **only 54% of nursery men feel concerned by the issue**. More nursery men in Flanders do not feel concerned (19/38 = 50%) as compared to Wallonia (9/31 = 29%). Differences between groups could be linked to awareness campaigns already realized in the past, but could also be related to differences in nature perception (Vanderhoeven *et al.*, 2008 and 2011). Interesting to mention **80% of public green managers and 55% of gardeners have to face a problem with invasive plant** in their municipality (for public green managers) or in their garden (for gardeners). *Fallopia japonica* and *Heracleum mantegazzianum* are species most quoted by both groups.

4.4. Availability of information

The **lack of information is high**. Horticulture professionals and gardeners have already been informed about invasive plants at least once, but all of them agree they should be better informed. The need for information varies from 49% (for public green managers) to 70% (for gardeners). The availability and quality of information should be improved, especially for gardeners, with 92% of them claiming they should be better informed. When taking into account those who have a low level of knowledge, the need for information is even higher, with 94% for gardeners, 88% for public green managers and 85% for nursery men and private managers. Even public green managers, having the highest level of knowledge, still feel they should be better informed.

4.5. Solutions

Codes of conduct on invasive plants and horticulture are not known by the public target. The major part (more than 80%) has never heard about such a self-regulation tool. On the other hand, more than 50% think the issue should be regulated by legislation (ban on trade, plantation or importation), but with discernable nuances. Garden amateurs and public green managers seems more favorable to restrictive legislation (72% and 66% respectively), whereas private managers and nursery men are favorable in a smaller proportion (57% and 54% respectively).

For horticulture professionals, preventive measures to adopt are (1) inform customers or citizens; (2) use alternative plants; (3) apply good practices to avoid the spread of invasive plants and (4) limitation of use (stop selling/stop planting).

54% of nursery men would agree to stop selling invasive plants

Important to mention that withdrawing from sales was indicated with reservations related to species. Nursery men often agreed this measure with the following comment: "*it depends on which species*", meaning they would not blindly agree to stop the sales of all invasive plants. On the other hand, 84% of public green managers and 65% of private managers would agree to stop planting invasive species. Concerning self-regulation tools, 61% of nursery men and 73% of private managers would accept to endorse a code of conduct recommending the voluntary adoption of the measures quoted above.

For gardeners, preventive measure to adopt are (1) use alternative plants (83%); apply good practices to avoid the spread of invasive plants (82%); stop buying invasive plants and inform gardeners (76%). Even 72% of garden amateurs would agree to remove invasive plants out of their garden.

86% of gardeners would accept to buy their plants in nurseries which do not sell invasive plants.

5. CONCLUSION

Main results of this survey could be summarized as followed:

- 80% of invasive plants in Belgium are available within the ornamental horticulture market.
- Some invasive plants (mostly trees and shrubs) are considered of economic value for the horticultural sector, specially trees and shrubs.
- 45% of nursery men feel their business is not threatened in case of withdrawing invasive plant(s) from sales.
- Most horticulture professionals and gardeners have a correct knowledge about invasive plants. Nevertheless it is necessary to increase information for nursery men, as a non negligible part (40%) still do not know what is an invasive plant or has a wrong knowledge on the issue (specially in Flanders as compared to Wallonia).
- The degree of awareness is globally high.
- The lack of information is also high. The need for information is higher for gardeners, private managers and nursery men. Public green managers are better informed and have a higher level of knowledge.
- Most horticulture professionals and gardeners are ready to adopt preventive measures for reducing introductions of invasive plants.
- 84% of public green managers would agree to stop planting invasive species.
- 61% of nursery men and 73% of private managers would accept to endorse a code of conduct on invasive plants.
- 86% of gardeners would agree to buy their ornamental plants in nurseries engaged in codes of conduct.

Andreu J., Vilà M. & Hulme P.E. (2009). An assessment of stakeholder perceptions and management of noxious alien plants in Spain. Environmental Management 43: 1244-1255.

Bell C.E., Wilen C.A., Stanton A.E. (2003). Invasive plants of horticultural origin. Hortscience, 38: 14-16.

Branquart E. (2007). Guidelines for environmental impact assessment and list classification of non-native organisms in Belgium.

Bremmer A., Park K. (2007). Public attitudes to the management of invasive non-native species in Scotland. Biological Conservation 139: 306-314.

Burt J.W., Muir A.A., Piovia-Scott J., Veblen K.E., Chang A.L., Grossman J.D., Weiskel H.W. (2007). Preventing horticultural introductions of invasive plants: potential efficacy of voluntary initiatives. Biological Invasions, 9: 909-923.

Convention on Biological Diversity (2002) Decision VI/23* of the 900 Conference of the Parties to the CBD, Annex, footnote to the 901 Introduction. In: Diversity CoB (ed). The Hague.

Dehnen-Schmutz K., Touza J., Perrings C., Williamson M. (2007). The horticultural trade and ornamental plant invasions in Britain. Conservation Biology, 21: 224-231.

Gagliardi J.A., Brand M.H. (2007). Connecticut nursery and landscape industry preferences for solutions to the Sale and use of invasive plants. HorTechnology January-March 17(1): 39-45.

Genovesi P., Shine C. (2004). European strategy on invasive alien species. Nature and Environment 137. Council of Europe Publishing, Strasbourg, France. 68 pp.

Heywood V., Brunel S. (2008). Code of conduct on horticulture and invasive alien plants. Council of Europe, Convention of the Conservation of European wildlife and natural habitats. T-PVS/Inf 2.

Nijs I., Verlinden M., Meerts P., Dassonville N., Domken S., Triest L., Stiers I., Mahy G., Saad L., Lebrun J., Jaquemart A-L., Cawoy V. (2009). ALIEN IMPACT: Biodiversity impacts of highly invasive alien plants: mechanisms, enhancing factors and risks assessment. Science for a sustainable development (SSD). Final report phase I, 50 pp.

Peters W., Meyer Hockenberry M., Anderson N. (2006). Minnesota horticultural industry survey on invasive plants. Euphytica 148: 75-86.

Reichard S.H., White P. (2001). Horticulture as a pathway for invasive plant introductions in the United States. BioScience, 51: 103-113.

Vanderhoeven S., Pieret N., Tiebre M-S., Dassonville N., Meerts P., Rossi E., Nijs I., Pairon M., Jacquemart A-L., Vanhecke L., Hoste I., Verloove F., Mahy G. (2006). INPLANBEL: Invasive plants in Belgium: Patterns, processes and monitoring. Scientific support plan for a sustainable development policy SPSD 2. Final report, 94 pp.

Vanderhoeven S., Nulens G., Vincke J., Mahy G. (2008). PERINBEL: public perception of invasive species in Belgium. Scientific support plan for a sustainable development policy SPSD 2, contract OA/00/24. Final report, 64 pp.

Vanderhoeven S., Piqueray J., Halford M., Nulens G., Vincke J., Mahy G. (2011). Perception and understanding of invasive alien species issues by nature conservation and horticulture professionals in Belgium. Environmental Management *in press*.

Annex 1: Questionnaires (French version)

Informations générales

Type de production (*)	
Sexe (M ou F)	
Age	
Age de l'entreprise	

(*) Répondre parmi les types de production suivants : plantes en pot, annuelles, vivaces, arbres et arbustes, producteurs spécialisés (azalées, chrysanthèmes etc.), pépinière généraliste, plantes aquatiques ou autre.

Rubrique 1

		Oui	Non	Ne sais pas
1	Savez-vous ce qu'est une plante invasive ou plante exotique envahissante ?			
	Si oui, que savez-vous ?			
		Oui	**Non**	**Ne sais pas**
2	Pourriez-vous me donner un ou plusieurs exemple(s) de plante invasive ?			
	Si oui, le(s)quel(s) ?			
3	Selon vous, quels sont les impacts liés aux plantes invasives ?			
		Oui	**Non**	**Ne sais pas**
4	Considérez-vous qu'il s'agisse d'une problématique importante ?			
5	Vous sentez-vous concerné par le problème des plantes invasives ?			

Rubrique 2

		Oui	Non	Ne sais pas
1	Considérez-vous être suffisamment informé sur le sujet ?			
	Si autre remarque, l'indiquer ici :			
2	Avez-vous déjà été informé sur le sujet ?			
	Si non, passer à la question 3 Si oui, à quelle fréquence ? (à une reprise, à plusieurs reprises, fréquemment ou je ne sais pas)			
		Oui	**Non**	**Ne sais pas**
	Considérez-vous qu'il s'agissait d'une information de qualité (fond, forme) ?			
	Si autre remarque, l'indiquer ici :			
	Vous souvenez-vous qui vous a dispensé cette information ? (milieu associatif, scientifique, administrations, presse écrite, radio ou TV, autre ou je ne sais pas)			
	Quel était le moyen d'information utilisé ? (conférence, Internet, article, brochure, dépliant, DVD, Media, autre ou je ne sais pas)			
		Oui	**Non**	**Ne sais pas**
3	Selon vous, est-il nécessaire de sensibiliser davantage les professionnels de l'horticulture ?			
	Si autre remarque, l'indiquer ici :			

Rubrique 3

		Oui	Non	Ne sais pas
1	Connaissez-vous des solutions qui sont mises en œuvre actuellement en Belgique pour lutter contre le problème des plantes invasives ?			
	Si oui, lesquelles ?			
2	A l'heure actuelle, pensez-vous que les moyens pour lutter contre les plantes invasives soient suffisants?			
3	A propos des plantes invasives, avez-vous déjà entendu parler des codes de bonne conduite en horticulture?			
4	Pensez-vous qu'il faudrait légiférer en matière de plantes invasives en Belgique et/ou dans les pays voisins (législation visant à interdire l'importation, le commerce) ?			
	Si autre remarque, l'indiquer ici :			
5	Afin de résoudre le problème, devrait-il exister un réseau d'information à l'attention des professionnels de l'horticulture ?			
6	Quelles mesures seriez-vous prêts à mettre en œuvre volontairement parmi les propositions suivantes (plus d'une réponse possible) :			
	a) Informer les clients			
	b) Stopper la commercialisation d'une ou plusieurs espèces			
	c) Ne plus en produire			
	d) Utiliser un étiquetage spécifique pour avertir le client des éventuels risques liés à certaines espèces, dans certains milieux			
	e) Privilégier le commerce d'espèces non invasives (plantes dites alternatives)			
	f) Eviter la dispersion des plantes invasives par de bonnes pratiques sur la gestion des terres et des déchets verts			
	g) Aucune			
	h) Je ne sais pas			
	Si autre remarque, l'indiquer ici :			
7	Seriez-vous disposé à vous engager volontairement dans un code de conduite qui préconiserait l'application d'une ou plusieurs de ces mesures ?			
8	Etes-vous actuellement attaché à ce que votre entreprise s'inscrive dans une perspective durable et soucieuse de l'environnement ?			
9	En ce sens, seriez-vous désireux de promouvoir une telle image de votre entreprise ?			

Rubrique 4 Les questions qui suivent se réfèrent à la liste de plantes indiquée ci-dessous

1 Quelles espèces commercialisez-vous parmi les plantes de la liste (= les espèces qui font partie de votre catalogue) ? Cocher dans la colonne 1 si vous vendez seulement l'espèce et cocher dans la colonne 2 si vous vendez des variétés ou des cultivars

2 Quelles espèces sont économiquement importantes pour votre entreprise? Cocher dans la colonne 3

3 Quelle part de votre chiffre d'affaire représente l'ensemble de ces espèces (moins de 5 %, entre 5 et 10%, entre 10 et 20 %, entre 20 et 30 %, entre 30 et 50%, plus de 50% je ne sais pas ou autres) ? (Estimation « grosso modo »)

	Oui	**Non**	**Ne sais pas**
4 Pensez-vous que votre entreprise soit menacée en cas de retrait du commerce d'une ou plusieurs de ces plantes?			

Nom latin	**Nom français**	**1**	**2**	**3**	**Nom latin**	**Nom français**	**1**	**2**	**3**
Acer negundo	Erable négundo				*Impatiens parviflora*	Balsamine à petites fleurs			
Acer rufinerve	Erable jaspé de gris				*Lagarosiphon major*	Elodée à feuilles alternes			
Ailanthus altissima	Faux-vernis du Japon				*Lemna minuta*	Lentille d'eau minuscule			
Amelanchier lamarckii	Amélanchier d'Amérique				*Lemna turionifera*	Lentille d'eau rouge			
Aster lanceolatus	Aster lancéolé				*Ludwigia grandiflora*	Jussie à grandes fleurs			
Aster novi-belgii	Aster de Virginie				*Ludwigia peploides*	Jussie rampante			
Aster x salignus	Aster à feuilles de saule				*Lupinus polyphyllus*	Lupin vivace			
Azolla filiculoides	Azolle				*Lysichiton americanus*	Faux-arum			
Baccharis halimifolia	Séneçon en arbre				*Mahonia aquifolium*	Mahonia faux-houx			
Bidens frondosa	Bident à fruits noirs				*Mimulus guttatus*	Mimule tacheté			
Buddleja davidii	Arbre aux papillons				*Myriophyllum aquaticum*	Myriophylle du Brésil			
Carpobrotus spp.	Griffes de sorcières				*Myriophyllum heterophyllum*	Myriophylle hétérophylle			
Cotoneaster horizontalis	Cotonéaster horizontal				*Oenothera spp.*	Onagres			
Cornus sericea	Cornouiller soyeux				*Parthenocissus spp*	Vigne vierge			
Crassula helmsii	Crassule des étangs				*Persicaria wallichii*	Renouée à nombreux épis			
Cyperus eragrostis	Souchet vigoureux				*Prunus laurocerasus*	Laurier cerise			
Duchesnea indica	Fraisier des Indes				*Prunus serotina*	Cerisier tardif			
Egeria densa	Egéria				*Quercus rubra*	Chêne rouge			
Elodea canadensis	Elodée du Canada				*Rhododendron ponticum*	Rhododendron			
Elodea nuttalii	Elodée à feuilles étroites				*Rhus typhina*	Sumac			
Eleaginus angustifolia	Olivier de boheme				*Robinia pseudoacacia*	Robonier faux-acacia			
Epilobium ciliatum	Epilobe cilié				*Rosa rugosa*	Rosier rugueux			
Fallopia spp (F.japonica, F. sachalinensis, F. xbohemica.	Renouées asiatiques				*Rudbeckia laciniata*	Rudbeckie laciniée			
Fraxinus pennsylvanica	Frene rouge ou frene de Pennsylvanie				*Senecio inaequidens*	Séneçon sud-africain			
Helianthus tuberosus	Topinambour				*Solidago canadensis*	Solidage du Canada			
Heracleum mantegazzianum	Berce du Caucase				*Solidago gigantea*	Solidage glabre			
Hyacinthoides hispanica et hybride H. x massartiana	Jacinthe d'Espagne				*Spiraea alba*	Spirée blanche			
Hydrocotyle ranunculoides	Hydrocotyle fausse renoncule				*Spiraea douglasii*	Spirée de douglas			
Impatiens glandulifera	Balsamine géante				*Spiraea x billardii*	Spirée de billard			

Annex 2: The black list and watch list of invasive plants in Belgium [4]

Black list	Watch list
Terrestrial plants	
Ailanthus altissima	*Acer negundo*
Aster lanceolatus	*Acer rufinerve*
Aster x salignus	*Amelanchier lamarckii*
Baccharis halimifolia	*Aster novi-belgii*
Cornus sericea	*Bidens frondosa*
Cotoneaster horizontalis	*Buddleja davidii*
Fallopia japonica	*Cyperus eragrostis*
Fallopia sachalinensis	*Duchesnea indica*
Fallopia x bohemica	*Elaeagnus angustifolia*
Helianthus tuberosus	*Fraxinus pennsylanica*
Heracleum mantegazzianum	*Hyacinthoides hispanica*
Impatiens glandulifera	*Impatiens parviflora*
Mahonia aquifolium	*Lupinus polyphyllus*
Prunus serotina	*Lysichiton americanus*
Rhododendron ponticum	*Mimulus guttatus*
Rosa rugosa	*Parthenocissus* spp.*
Solidago canadensis	*Persicaria wallichii*
Solidago gigantea	*Prunus laurocerasus*
Spiraea alba	*Quercus rubra*
Spiraea douglasii	*Rhus typhina*
	Robinia pseudoacacia
	Rudbeckia laciniata
	Senecio inaequidens
	Spiraea x billardii
Aquatic plants	
Crassula helmsii	*Azolla filiculoides*
Egeria densa	*Lemna minuta*
Elodea canadensis	
Elodea nuttallii	
Hydrocotyle ranunculoides	
Lagarosiphon major	
Ludwigia grandiflora	
Ludwigia peploides	
Myriophyllum aquaticum	
Myriophyllum heterophyllum	

*: including *Parthenocissus inserta* and *P. quinquefolia* (not assessed in this study)

[4] E. Branquart (2011), Alert, black and watch lists of invasive species in Belgium. Harmonia version 1.2, Belgian Forum on Invasive species, accessed on 11/02/2011 from: http://ias.biodiversity.be