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Evaluating stakeholder awareness and involvement in risk prevention of aquatic invasive plant species by a national code of conduct

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Abstract

In 2010, Dutch stakeholders signed a code of conduct to prevent the introduction and spread of aquatic invasive plant species. This voluntary agreement between the government and horticulture sector (i.e. plant nurseries and retailers) has the objective to ban the sale of invasive species and to increase public awareness and stakeholder involvement in measures to prevent new introductions of potential invaders. Public outreach campaigns included flyers and posters displayed in stores and labelling of non-native plant species with warning logos and messages on harmful effects and appropriate disposal. We evaluated several measures issued in the Dutch code of conduct by performing *ex ante* and *ex posterior* surveys and interviews with relevant stakeholder groups. Compliance of retailers and producers concerning species on sale and proper labelling was monitored annually by the Netherlands Food and Consumer Product Safety Authority. Interviews with aquarists and water gardeners provided the first quantitative evidence in the Netherlands that 2–3% of these hobbyists deliberately introduced non-native aquatic plants in surface water. A survey of retail professionals identified limited availability of information and lack of salesman's knowledge on the species lists issued in the code of conduct as major impediments for their engagement. Furthermore, low frequency of meetings and lack of guidance were major obstacles identified by the partners assembled in the code of conduct. Overall, compliance to species bans showed promising results, however, problems were identified with correct labelling of species. We conclude by listing opportunities to improve voluntary regulations for preventing non-native species introductions.

Key words: aquatic weeds, horticulture, non-native species, ornamental trade, policy evaluation, public perception

Introduction

The horticulture and ornamental trade are important pathways for the introduction and spread of non-native aquatic plants (Dehnen-Schmutz et al. 2007; Padilla and Williams 2004; Reichard and White 2001). Plants that 'escape' can cause severe ecological and economic impacts in the recipient area. The number of recorded introductions of non-native plant species appears to be significantly correlated with human related variables such as population size or proximity to urban areas (Dehnen-Schmutz et al. 2007; Hussner et al. 2010). The introduction of Pumpkinseed sunfish (*Lepomis gibbosus*) in isolated pools and lakes in the

Netherlands was traced back to public accessibility of these water bodies (Van Kleef et al. 2008). Thus, (intentional or unintentional) release of ornamental species into the environment creates new pathways for non-native species to spread. However, actual numbers of potential releases in relation to new species introductions in Europe are currently lacking, as well as information on potential groups of 'releasers' and their motivations.

In 2008, the European Union stressed the importance of codes of conduct, which they defined as voluntary agreements developed to enlist the cooperation of the horticultural trade and associated professionals in reducing and controlling possible introductions of non-native invasive

species (Heywood and Brunel 2008). Codes of conduct for the horticulture sector have become a popular policy instrument worldwide (Baskin 2002; Burt et al. 2007; Defra 2011, Halford et al. 2013; Kelly 2012; Peters et al. 2006), but assessments of their effectiveness are often lacking. Currently, decision makers have a specific need for this type of information to evaluate and improve policies on management of invasive species.

The Netherlands is one of the biggest plant importing countries in Europe (Brunel 2009) and has populations of at least 24 non-native aquatic plant species in various types of water bodies (Hussner 2012). Many of these species are listed as (potentially) invasive in Europe (<http://www.eppo.org>) and their multitude of ecological and socioeconomic impacts (e.g. obstruction of water discharge and navigation) were counteracted by costly management programs (Pot 2002). In 2010, stakeholders agreed on a code of conduct to reduce the introduction and spread of aquatic invasive plant species in the Netherlands (Anonymous 2010). This code of conduct develops partnerships between the government and the horticulture sector. It was initiated by the Ministry of Economic Affairs (Office for Risk Assessment and Research, Netherlands Food and Consumer Product Safety Authority) and the Association of Regional Water Authorities. The representatives from the horticulture sector include three national trade associations for garden centres, pet stores and plant nurseries, respectively. The number of aquatic plant nurseries in the Netherlands is limited and all of them were asked to join the code of conduct. The current participants account for more than 95 per cent of the Dutch trade volume in aquatic plants.

Two major agreements were made in the Dutch code of conduct. The first led to the compilation of two species lists. List 1 contains species that are banned from sale (i.e. *Crassula helmsii*, *Hydrilla verticillata*, *Hydrocotyle ranunculoides*, *Ludwigia grandiflora*, *Ludwigia peploides*, *Myriophyllum aquaticum* and *Myriophyllum heterophyllum*). List 2 species are allowed to be sold but only when additional information is provided for on a label. This warning label informs customers about the risks associated with plant invasiveness and instructions for ownership designed to reduce the risk of release of the plant to the environment (i.e. *Azolla* sp., *Cabomba caroliniana*, *Eichhornia crassipes*, *Egeria densa*, *Lagarosiphon major*, *Pistia stratiotes* and *Salvinia molesta*). The code of conduct became

effective February 2011. The partners also agreed to inform the general public about the harmful effects of the invasive plants listed, and how to dispose of plant waste. In 2010 and 2011, the government launched public outreach campaigns which included flyers and posters that were sent to all garden centres and pet stores in the Netherlands.

The objectives of this study are to evaluate the following measures issued in the Dutch code of conduct for aquatic invasive plants: (1) the effectiveness of public awareness campaigns developed to inform aquarists and water gardeners, (2) the effectiveness of awareness campaigns developed to inform retail professionals, (3) the commitment of code of conduct partners, and (4) sector compliance with species lists. Finally, options to improve voluntary regulations developed to prevent non-native species introductions are discussed.

Material and methods

Data collection

In order to fulfil our research aims, we performed *ex ante* and *ex posterior* surveys and interviews with relevant stakeholder groups (Table 1). Data were collected and analysed conform research guidelines and ensured anonymity of the respondents.

Aquarists and water gardeners

Aquarists and water gardeners were interviewed at garden centres and pet stores randomly distributed over the country. The selection of locations was based on the size of the store (in case of garden centres) and whether they were specialized in the sale of aquatic plants (in case of pet stores), and we requested permission from owners to interview people at their stores. In 2010, 13 locations in 7 provinces were visited, including 12 garden centres and one three-day aquaria event in a large pet store. In 2012, 15 locations were visited in 9 provinces, including 10 garden centres, 3 pet stores and the same three-day aquaria event. In order to effectively reach our target group, the first question addressed ownership of an aquarium or water garden, and if this was the case, the interview was continued. All questions were open ended, meaning that no answering categories were given, except for three statements with fixed categories. Data were collected in the months November and December of 2010 and 2012. The number of aquarists and

Table 1. Operationalization of research aims, including a reference to the actor(s) involved, methods, response rates and main variables.

Aim	Actor	Method	Number of respondents	Variables
1. Effectiveness of public awareness campaigns	Aquarists and water gardeners	Structured 5-minute interviews	2010: n = 230 2012: n = 239	Level of knowledge Level of awareness Reported behaviour
2. Effectiveness of awareness campaigns	Retail professionals	Postal questionnaires	2010: n = 164 2012: n = 207	Level of knowledge Level of awareness Corporate responsibility
3. Stakeholder engagement and involvement	Code of conduct partners	Semi-structured interviews	2010: n = 5 2012: n = 5	Commitment Division of tasks Communication
4. Compliance with species lists	Plant nurseries and retail professionals	Site visits and sampling	2010: n = 133 2011: n = 107 2012: n = 76	Compliance restricted sale Compliance labelling

water garden hobbyists interviewed was similar in both years (230 and 239 respondents, respectively).

Questions for aquarists and water gardeners addressed their purchasing strategies (e.g. how often do they make a new purchase, where do they purchase aquatic plants, and what do they consider important plant characteristics), ways of disposal of plant waste, level of knowledge about non-native species and possible impacts, and their attitudes towards non-native species and impacts. Special attention was paid to their motivations for displaying certain behaviour or opinions. Demographics included date of birth, gender and level of education. Additional questions in the 2012 interviews addressed their familiarity with warning labels and the governmental campaign. To avoid socially acceptable responses, the first part of the questionnaire consisted of general questions about their purchasing and disposal behaviour, before entering in the discussion of potentially invasive plants. An English translation of the questionnaire for aquarists and water gardeners is available from the authors upon request.

Retail professionals

In December 2010, postal questionnaires were sent to 600 garden centres using an extensive address list provided by the Netherlands Food and Consumer Product Safety Authority (NVWA). The number of pet stores in the Netherlands is about 1800, but these also include many stores that do not sell aquatic plants. First, all non-relevant pet stores were removed from the list, followed by a search with relevant key words which selected the most relevant ones (i.e. 'aqua(rium)', 'fish', 'water', 'koi' and 'water garden' or 'pond'). Of the remainder of the list

each fifth company was selected for a total of 300. Incorrect addresses were removed following the 2010 questionnaire and in 2012 the list was updated with newly opened stores. As a result, more questionnaires were sent in November 2012: 618 to garden centres and 313 to pet shops (total of 931).

The first part of the questionnaire for retail professionals included questions about their business (type of store, whether they sold water garden or aquarium plants (or both) and membership of a trade organization), their level of knowledge about non-native (plant) species and attitudes towards non-native species and their impacts. The second part addressed engagement in and compliance to the code of conduct and questions on corporate social responsibility. Finally, we inquired input on possible improvements that could be made to the code of conduct. Identical questionnaires were used in both years, however, in 2012 we added questions on general support for the measures in the code of conduct and their knowledge of the species lists and warning labels. An English translation of the questionnaire for retail professionals is available from the authors upon request. All respondents from this group were either the owner, director or a member of the permanent staff. Response rates of 18 and 22 per cent yielded 164 and 207 correctly filled in questionnaires from retail professionals that actually sold aquatic plants for 2010 and 2012, respectively.

Code of conduct partners

Face-to-face interviews were held with representatives from the five organizations comprising the code of conduct, i.e. the Dutch Ministry of

Economic Affairs, the Association of Regional Water Authorities, and the three national trade associations for garden centres (Tuinbranche Nederland), pet stores (Dibevo) and plant nurseries (Cultuurgroep Vasteplantenkwekers). Two interviews were held with each respondent, the first in the year the code of conduct was signed and the second two years later. The interviews took place in the office of the interviewee, lasted approximately one hour and were recorded. An interview guide was developed listing the themes to be addressed in the interviews.

The first interviews took place in the period November 2010 – January 2011 and included the following themes: personal engagement in problems with invasive aquatic plants, motivations for joining the code of conduct, expectations, division of tasks (or roles) and communication between partners. Themes addressed in the second interviews, held between November 2012 and January 2013, were public support for the measures, positive and negative developments, perceived effectiveness of the measures, and, again, division of tasks (or roles) and communication between partners. During the second interview the interviewees were also asked to respond to four statements about the effectiveness of the code of conduct (1) in general, (2) compared to a legal ban, (3) in changing behaviour of aquarists and water gardeners, and (4) regarding the warning labels specifically. Answering categories were: ‘strongly agree’, ‘agree’, ‘neutral’, ‘disagree’, ‘strongly disagree’.

Monitoring compliance with species lists

In 2010, prior to the date the code of conduct became effective, a survey was conducted to assess the availability of the species covered by the code of conduct. Based on the address list of the NVWA, used for general phytosanitary surveys, a random selection of 700 addresses was compiled. The site visits were performed by phytosanitary inspectors of the NVWA. In total 133 addresses selling aquarium or pond plants were visited, including garden centres, pet stores (especially aquarium shops) and production facilities distributed throughout the Netherlands. More locations were visited in densely populated areas than in less densely populated areas. The actual survey was conducted between July 10th and August 10th 2010, which is still considered low season for pond plants. During the first survey, species on sale were recorded as well as the use of the correct name for a given species. If the identity of a plant was in question, a sample

was sent to the National Reference Centre of the NVWA for verification by experts.

In 2011, 107 addresses were visited from January till June. These included 6 production facilities, 2 wholesalers, 98 garden centres and 1 aquarium shop. In 2012 data from 76 visits were available for analysis (1 production facility, 74 garden centres, and 1 florist). During the 2011 and 2012 surveys, records were made of the species on sale, the use of the correct name for a given species and the use of a label warning consumers not to dispose of the plants unwisely.

Data analyses

Quantitative data from the surveys for hobbyists and retail professionals were analysed with SPSS 19.0. Answers to open-ended questions were categorized and grouped for easy interpretation and representation. Independent samples t-tests were used to compare the results between both years or between groups (e.g. aquarists and water gardeners). Chi-square tests were used to compare the results between groups for categorical variables. A significance level of $P < 0.05$ was used to determine differences between the samples. Interview recordings were transcribed and analysed qualitatively, based on the themes outlined above. The NVWA records on compliance of production facilities and retail professionals with the species lists and labelling were analysed quantitatively, using MS Excel.

Results

Aquarists and water gardeners

In both years, the majority of the respondents was male (2010: 68% and 2012: 65%) and aged 40 years or older (2010: 80% and 2012: 68%). The percentage with a polytechnical or university degree was 36% and 41% for both years, respectively. In 2012, more aquarists (49%) than water gardeners (37%) were interviewed while the opposite was true for 2010 (30% aquarists and 56% water gardeners). There was no change in the percentage of respondents owning both an aquarium and water garden (2010: 14% and 2012: 13%).

Aquarists and water gardeners differed in purchasing strategies, with over 80 per cent of the water gardeners buying only once a year or less and usually in garden centres, compared to aquarium owners who buy more frequently and usually in pet or specialist stores (Table 2).

Table 2. Purchasing behaviour of the total number of respondents who participated in the 2010 and 2012 survey and owned either an aquarium or water garden (in %). Results for respondents who owned both (n = 64) were excluded from the analyses.

	Aquarium (n = 187)	Water garden (n = 216)
<i>Type of store^a</i>		
Garden centre**	36.9	86.6
Pet store**	42.2	6.0
Specialist store**	33.2	8.3
Plant nursery	2.7	1.8
Internet**	3.7	0.0
Does not buy	1.6	3.7
Other**	1.6	5.5
<i>Important plant characteristics^a</i>		
Aesthetics	57.2	59.2
Function**	27.8	49.5
Type*	16.6	24.8
Quality**	18.7	8.7
Size*	11.8	6.0
Advice**	6.4	0.0
Price	7.5	4.1
Origin	2.1	1.8
Other**	22.0	14.2
<i>Frequency</i>		
< 1 per year**	15.0	43.1
Once a year**	16.6	38.9
Few times a year**	54.5	15.3
Every month**	13.9	0.5

^a multiple answers allowed. * $P < 0.05$ and ** $P < 0.01$. Significance tests computed with independent samples t-tests.

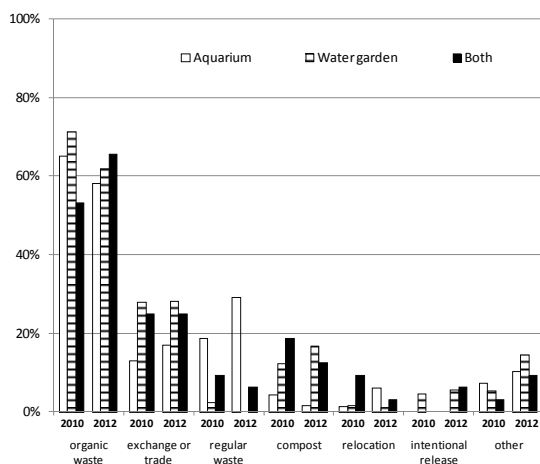


Figure 1. Methods of disposal reported by respondents who owned an aquarium, water garden or both in the 2010 and 2012 survey (multiple answers allowed).

When making a purchase, both groups reported priorities based upon plant aesthetics, type of plant (e.g. floating or submersed) and functional aspects. In general, water gardeners more often considered the function of the plant, while aquarists paid special attention to plant quality, size and personnel advice. Origin of the plant was mentioned to be decisive for buying by less than 3 per cent of the respondents with no difference between the two groups.

Disposal methods reported by the respondents could be categorized in 'waste' and 're-use' (Figure 1). Of the total group of respondents, the majority stated that they throw away surplus plants in the organic waste (2010: 61% and 2012: 67%) or regular waste (2010: 8% and 2012: 15%). Compost was also mentioned (2010: 11% and 2012: 9%). Exchanging plants with relatives or friends (2010: 23% and 2012: 22%) and relocating the plant to another pond or aquarium (2010: 3% and 2012: 4%) were popular ways to re-use a plant. In 2010 and 2012, 2 and 3 per cent of the respondents reported to release plants into open water in the environment, respectively. In 2010, this percentage consisted exclusively of water gardeners while in 2012 this also included people who owned both a water garden and an aquarium (Figure 1). Motivations for intentional release were related to respect for living things (e.g. "it is a waste to throw away living plants"), aesthetics (e.g. "I think it is nice to see beautiful plants and flowers in the ditch") or practicality (e.g. "it does not smell bad" or "it is easier").

The percentage of respondents that were able to give a correct definition of non-native species (either referring to the species being non-indigenous or not originally from or present in a country) was low (2010: 15% and 2012: 20%). The notion of the role of humans in the introduction of non-native species was generally lacking from the given definition. Many respondents thought that non-native species were species from 'abroad' or 'warm or tropical areas'. We found an increase in the level of awareness of the origin of the species sold in garden centres and pet stores from 28 to 37 per cent (period 2010-2012) ($P < 0.05$).

In 2010 and 2012, 21 and 17 per cent of the respondents gave a correct example of a non-native species name, respectively. Most often named species (summed up for both years) were the common carp or koi (*Cyprinus carpio*), American bullfrog (*Rana catesbeiana*), elodea (*Egeria densa*) and floating pennywort (*Hydrocotyle ranunculoides*).

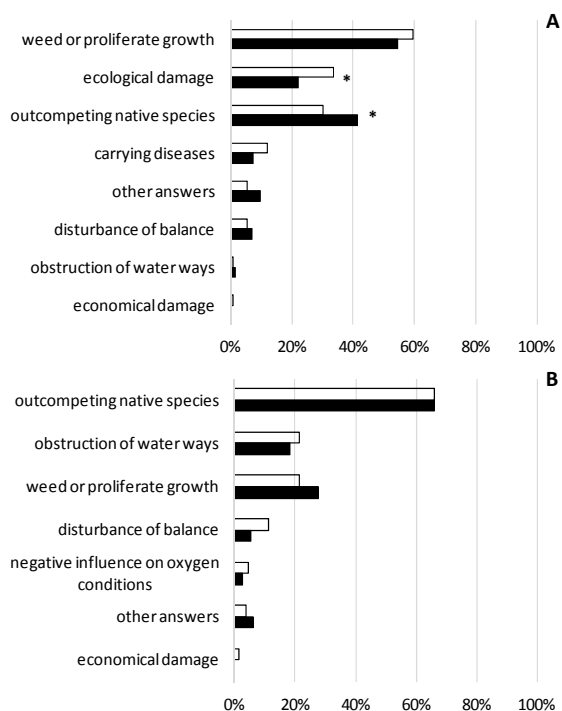


Figure 2. Known impacts of non-native aquatic plants reported by Dutch aquarists and water gardeners (A) and retail professionals (B) in the 2010 (open bars) and 2012 (filled bars) survey. * significantly different between years ($P < 0.05$). Significance tests computed with independent samples t-tests.

In both years, seven out of ten respondents (2010: 70% and 2012: 72%) could give examples of impacts of aquatic invasive plants. The most cited impacts were proliferate plant growth, loss of native species, ecological damage, risk of carrying diseases and disturbance of balance of nature, with only very few respondents mentioning economic impacts or obstruction of waterways (Figure 2A).

Hobbyists' attitudes towards ecological impacts of aquatic invasive plants were similar in both years (Table 3). The majority reported to care either much or very much about the loss of a native species (2010: 66% and 2012: 72%) or the loss of diversity in an area (2010: 84% and 2012: 87%) due to the introduction of a non-native species. Their motivations revealed that they considered (1) that conservation of native species and nature values are important, (2) that non-native species do not belong here or (3) that the balance in a natural system will be disturbed. An increase was found in the self-reported level of engagement of respondents (Table 3), however, levels of engagement remained low with an average score

of 3.1 on a five-point scale. In 2012, 39 per cent of the respondents reported not to be engaged, mainly because they do not think about the effects of aquatic invasive plants in their daily lives or because they do not think they personally play a role and therefore have no responsibilities. Other reasons were that they did not know about it or that they did not think they could do anything about it (i.e. no influence).

Hobbyists' familiarity with warning labels and the governmental campaign (only measured in 2012) was found to be low. Of the total group, 16 per cent recognized the campaign slogan and 12 per cent the warning logo for appropriate disposal of invasive species. For the latter, there was a difference between respondents who owned an aquarium or a water garden ($P < 0.05$), with aquarists being less informed (9% recognized the logo) compared to water gardeners (18% recognized the logo). In both surveys (2010 and 2012) only 4 per cent of the respondents claimed to have been informed about potential invasiveness when purchasing a new plant.

Retail professionals

In both years about two thirds of the retail professionals that were surveyed worked at a garden centre (2010: 65% and 2012: 60%). The other respondents owned or worked at a pet store (2010: 32% and 2012: 26%), specialist store (2010: 1% and 2012: 8%) or other businesses such as wholesale or a combination of a garden centre with professional gardening or flower shops. Stock size of aquarium and aquatic plants were similar in both samples. In both years, eight out of ten respondents was a member of a trade association (2010: 80% and 2012: 81%). In general, garden centres reported membership of Tuinbranche Nederland (tailored to the needs of garden centres) and pet and specialist stores were a member of Dibevo (an association for businesses that are concerned with selling pets).

The level of knowledge about the definition of non-native species among retail professionals was high, as nine out of ten reported to be either completely or largely familiar in 2010 (95%) and 2012 (96%). In 2012, 73 per cent could name examples of impacts of non-native aquatic plants compared to 78 per cent in 2010. The three most cited impacts were impacts on native species, weed or proliferate growth and obstruction of water ways (Figure 2B).

Similar attitudes of retail professionals towards ecological impacts of invasive species were found

Table 3. Response of aquarists and water gardeners to statements on potential ecological impacts of non-native species and their personal level of engagement in 2010 and 2012, including number of respondents (n), average scores, standard deviation (SD) and *P*-values.

	Year	n	Average score (scale 1–5) ^a	SD	<i>P</i> -value ^b
What if a native species would disappear as the result of the introduction of a non-native species. To what degree would you care about that?	2010	230	2.36	0.98	0.248
	2012	238	2.25	1.05	
What if a non-native species would grow so fast that it would reduce the variation of species in an area. To what degree would you care about that?	2010	228	1.90	0.92	0.717
	2012	238	1.93	0.82	
To what extent do you consider yourself to be personally engaged in problems caused by invasive species?	2010	229	3.47	1.25	0.005*
	2012	238	3.14	1.26	

^a: score 1-5: very much – not at all. ^b: independent samples t-test (*significant at $P < 0.05$).

Table 4. Response of retail professionals to statements on ecological impacts of non-native species and their personal level of engagement in 2010 and 2012, including number of respondents (n), average scores, standard deviation (SD) and *P*-values.

	Year	n	Average score (scale 1–5)	SD	<i>P</i> -value ^d
Non-native species pose a threat to biodiversity in the Netherlands	2010	163	3.76 ^a	1.01	0.580
	2012	205	3.82 ^a	1.02	
Presence of non-native species makes a nature area less valuable	2010	163	3.36 ^a	1.14	0.367
	2012	200	3.47 ^a	1.12	
Non-native species complement biodiversity in the Netherlands	2010	161	2.50 ^a	1.14	0.515
	2012	203	2.42 ^a	1.13	
Animals and plants that came to the Netherlands only because humans facilitated it, do not really belong here	2010	163	3.62 ^a	1.16	0.395
	2012	205	3.52 ^a	1.14	
Non-native species that spread quickly and compete with other species must always be controlled	2010	163	4.22 ^a	0.94	0.909
	2012	205	4.21 ^a	0.91	
Extent of personal engagement concerning the topic of non-native species	2010	163	2.58 ^b	1.12	0.256
	2012	206	2.71 ^b	1.10	
Relative importance of the topic of invasive aquatic plants in operational store management	2010	162	3.30 ^c	1.11	0.666
	2012	206	3.25 ^c	1.05	

^a: score 1–5: strongly disagree – disagree – neutral – agree – strongly agree; ^b: scores 1–5: high interest - moderate interest - neutral - little interest - no interest; ^c: scores 1–5: very important - important - neutral - little important - not important; ^d: independent t-test (significant at $P < 0.05$).

for both years (Table 4). The scores reflected recognition of declining nature values and other risks associated with non-native species. While in 2012 about half of the respondents (47%) reported to be personally engaged in the topic of invasive plant species, only one out of four (23%) claimed it to be an important topic within the company. For these two variables, no differences were found between 2010 and 2012 (Table 4). The percentage of retail professionals that reported to limit invasive plants in their stock increased over the two-year period from 55 to 61 per cent ($P < 0.05$).

In 2012, we asked retail professionals specific questions concerning their knowledge about the code of conduct. Only five per cent of the respondents considered him or her well informed about the agreements that were made in the code of conduct. About half of the respondents from garden centres (51%) reported to be reasonably

informed while six per cent reported to have no knowledge about it. For pet stores, only 25 per cent was reasonably informed, while one in three respondents (32%) reported to have no knowledge about the code of conduct. We asked the respondents who reported to be well or reasonably informed about the code of conduct additional questions about their compliance and support. A small number (16%) reported to have experienced troubles with compliance in the beginning but on the whole this was not considered a problem and the majority claimed to support the code of conduct.

In 2012, about 35 per cent of the respondents reported that the employees in their store were (largely) familiar with the species lists. This differed for garden centres and pet stores ($\chi^2 = 23.92$, $df = 3$, $P < 0.01$), with lower reported levels of knowledge for employees of pet stores (Table 5). With respect to warning labels, 41 per cent of the respondents stated that their employees were familiar with these

Table 5. Familiarity of employees of garden centres and pet stores with the species lists and warning labels as reported by the retail professionals who participated in our study (2012 survey).

	Garden centres (n = 130)	Pet stores (n = 68)
<i>Familiarity with species lists</i>		
Completely	2.3	2.9
Largely familiar	40.8	20.6
Largely unfamiliar	42.3	30.9
Unfamiliar	14.6	45.6
<i>Familiarity with warning labels</i>		
Yes	45.0	32.4
No	28.2	51.5
Do not know	26.7	16.2

labels. For this variable, no statistical differences were found between garden centres and pet stores, however, the results indicate that employees of pet stores tend to be less familiar with warning labels than employees of garden centres (Table 5).

In the 2012 survey, one in three (33%) of the retail professionals made suggestions for improving communication about the code of conduct. The three most cited improvements were (1) repetition of the message at the start of the season, (2) clear and more targeted communication about the species lists, and (3) use of visual aids in explaining impacts.

Code of conduct partners

Interviews with the five major partners involved in the code of conduct were qualitatively analysed with a focus on their opinions on the effectiveness of the measures, future perspectives and suggestions for improvement. By signing the code of conduct, all partners acknowledged that preventive measures are needed to stop the spread of invasive aquatic plants and made a commitment to take part in these measures. Their cooperation was founded on mutual recognition of the problems caused by invasive aquatic plants. In 2012, all partners agreed with the statement that “*the code of conduct contributes to tackling problems caused by invasive aquatic plants*”. From the interviews it became clear that the topic of invasive aquatic plants is framed as part of a ‘bigger picture’. The governmental parties consider it a species-specific measure in their policy strategy for invasive species. For the trade associations and production facilities it fits in the concept of corporate social responsibility to take environmental aspects of their products into account.

The role the interviewees assign to the other partners and themselves is closely related to their

tasks prescribed in the code of conduct. The trade associations are seen as ‘communicators’ and their main duty is to defend the stakes of their members (i.e. garden centres, pet stores and plant nurseries) and to inform them about the measures issued in the code of conduct. The Association for Regional Water Authorities (which represents the 24 water boards in the Netherlands) is regarded as the partner who has the most to gain. The water boards maintain the Dutch water ways and have a role in communicating with the public. The umbrella organization has to make sure that all water boards are informed about the communication strategy. The views on the role of the national government were most divergent, including both facilitating and leading roles. In general, the majority of the other partners agreed that both roles were insufficiently supported and spoke up for a more visible and accessible leading partner. This was, for example, the case when new partners wanted to sign the code of conduct but did not know about any procedure to do so. Another example was the lack of communication with and between the partners apart from a yearly meeting to discuss developments. While two partners did not find this problematic, the others thought it would positively contribute to the engagement of the partners throughout the year.

To measure the effects of the code of conduct it is important to evaluate which actions have been taken by the partners and whether these match their intentions. The second interviews showed that the intensity of efforts from all partners decreased between 2010 and 2012. Main reasons that were given were lack of time and man-hours, lack of a sense of urgency and the fact that certain actions needed to be done only once (e.g. label production for list 2 species). Overall, the partners remained supportive of the measures in the code of conduct, and this was also deemed to be the case for the members of the trade associations. There seemed to be no severe financial consequences for the production facilities and retail professionals, partly because of the one year intervening period to sell existing stocks, but also because there were enough alternatives for list 1 species. The impression of the representatives from the trade associations is that the lists are well-known within the production facilities but that this is not the case for salesmen at garden centres and pet stores.

Four out of the five interviewees agreed with the statement that “*warning messages on labels will increase public awareness*”. One partner disagreed

Table 6. Number of batches of code of conduct species found and number of sites where bunches of oxygenating plants were on sale during surveys of the National Food and Consumer Product Safety Authority (NVWA) in the period 2010–2012. Numbers between brackets indicate the number of batches of list 2 species found that were correctly labelled with a warning message or sites where oxygenating plant bunches were properly labelled.

	Regular (single) species sales (in batches)		Number of sites selling oxygenating plant bunches (containing <i>Cabomba caroliniana</i> or <i>Egeria densa</i>)	
	List 1 species	List 2 species	<i>C. caroliniana</i>	<i>E. densa</i>
2010	96	262 (n.a.)	n.a.	n.a.
2011	2	222 (69)	36 (5)	25 (2)
2012	3	261 (118)	43 (8)	40 (7)

stating that there are already too many labels fighting for attention and that the message may be too complex to depict. The majority of the interviewees did agree that increased public awareness will result in more responsible ways of disposal, but they note that this change will come slowly. One interviewee voted neutral for the statement that “*increasing public awareness about the impacts of invasive aquatic plants will automatically lead to a behavioural change*”. On the one hand gardeners and aquarium hobbyists were depicted as a ‘willing’ public and receptive of the message, but on the other hand they may be reluctant to throw away living materials out of respect for nature.

A legal ban can be considered as an alternative to a code of conduct if it proves to be unsuccessful. All partners recognized this option but they did not see a legal ban as the ultimate solution. The partners from trade would lose the opportunity to have a say in the matter, and the government would have to invest in legal enforcement. Two interviewees agreed to the statement that “*a legal ban is more effective than a voluntary agreement*”. However, they explained that this is only the case if there is proper reinforcement and that they remain supportive of the code of conduct when it yields positive results. In any case, external influences that impede the effectiveness of any measure must be ruled out before any changes are considered. Therefore, all partners stressed the importance of an evaluation after four years.

Compliance with species ban and labelling

The number of list 1 species found at plant nurseries and retail professionals in the Netherlands decreased tremendously and were found only incidentally

in 2011 and 2012 (Table 6). We did not find any changes in the detection of list 2 species, of which more than 200 findings were reported each year. In 2011, 31 per cent of the list 2 species were correctly labelled with a warning. In the following year, this was the case for 45 per cent of list 2 species. Oxygenating plants, such as *Cabomba caroliniana* and *Egeria densa*, are often sold in bunches containing several species. In 2011, *C. caroliniana* or *E. densa* were found in oxygenating plant bunches at 36 sites. At only 5 of these 36 sites, bunches were correctly labelled for presence of *C. caroliniana*, and *E. densa*. In 2012, the number of sites where *C. caroliniana* or *E. densa* were found as part of oxygenating plant bunches was 43 and 40, respectively (44 sites in total). Of these 18 per cent were correctly labelled.

Discussion

In this study, we evaluated several measures issued in the Dutch code of conduct for aquatic plants by performing *ex ante* and *ex posterior* surveys and interviews with relevant stakeholder groups. We used a three-tiered research approach in which quantitative analyses of survey data are combined with monitoring data and qualitative data from interviews. This is a common approach in evaluation studies since it provides valuable data on the effectiveness of a policy instrument as well as on the process of reaching these goals (Rowe and Frewer 2004). Because aquatic plants are sold seasonally, timing of surveys may influence the results. In this respect it was of vital importance to conduct both surveys in the same time period. Aquarists and water gardeners were surveyed in the winter period. Although off

season regarding the sale of pond plants, this was a convenient time to yield a high response because of high visitor rates for garden centres. We interviewed 230 and 239 aquarists and water gardeners in 2010 and 2012, respectively, at garden centres and pet stores randomly distributed over the country. Whether these samples are sufficient to make general statements about aquarists and water gardeners in the Netherlands is difficult to determine because of a lack of knowledge on the number of people that constitute this group and their population characteristics. The numbers of hobbyists interviewed are high compared to other studies (Gertzen et al. 2008; Halford et al. 2013; Martin and Coetzee 2011). The response rates for the retail professionals (16 and 22%) were similar to other studies about attitudes towards invasive plants in the horticultural sector (Burt et al. 2007; Halford et al. 2011; Peters et al. 2006).

Level of awareness among hobbyists

Empirical data on the modes and number of species introductions provide direct targets for policy intervention aimed at prevention of new introductions of invasive species. In this study, aquarists and water gardeners were identified as playing a significant role in the introduction and spread of invasive aquatic plants into natural water bodies (Figure 1). Studies conducted in North America reported similar modes of plant disposal, including waste, re-use and intentional release (Cohen et al. 2007; Marson et al. 2009a, 2009b). Intentional release by aquarists found in other studies ranged between 3 per cent for aquatic plants (personal comm. Dr. B. Leung March 19, 2011) and 7 per cent for ornamental fish (Gertzen et al. 2008; Strecker et al. 2011). However, plants, fragments or seeds may also be introduced unintentionally into the environment when complete contents of aquaria are emptied into water bodies (Duggan 2010; Van Kleef et al. 2008) or by composting of plant material (Duggan 2010; Rusterholz et al. 2012).

Increasing public awareness concerning their role in species introductions was expected to result in more responsible ways of handling plants and animals. One of the objectives of this study was to evaluate the effectiveness of public outreach campaigns in increasing public knowledge and awareness on invasive aquatic plants. In congruence with other studies, we found that the level of reported knowledge about the definition of non-native species was lower for the general public compared to professionals (Halford et al 2013),

and especially lacked the notion of the role of humans in introductions (Verbrugge et al. 2013). Compared to the level of factual knowledge, impacts of aquatic invasive plants were better known but were limited to ecological effects. Low levels of personal engagement found in this study contrasted somewhat with the high percentages of the respondents that reported to regret the loss of native species (> 65%) or the loss of diversity in an area (> 80%) resulting from the introduction of non-native species. Probably, the question design played a role here, and may have triggered socially acceptable responses. As a result, the respondents may, in fact, be less concerned about the effects of invasive aquatic plants than is indicated by the results. The level of awareness of the origin of plants sold in garden centres and pet stores among aquarists and water gardeners increased to just over one-third of the respondents over the period 2010–2012.

Overall, only limited effects of the campaign on public knowledge and awareness were found in this study. This implies that education of the public is not straightforward (see also Halford et al. 2013). Possible explanations reported by the code of conduct partners interviewed in this study include the fact that educating the public is a long term process, especially if it concerns behavioural change, and the low visibility of flyers and warning labels.

Analyses of purchasing behaviour of aquarists and water gardeners also pointed out some valuable considerations for the development of communication strategies, for example in terms of frequency and location of plant purchase. Generally, we can conclude that only informing the public at the time of purchase will not be sufficient to reach the target group. In order to reach non-frequent buyers, a more general strategy with a wider scope is needed. Recent studies expressed their concerns about increasing internet sales (Giltrap et al. 2009; Kay and Hoyle 2001; Martin and Coetzee 2011; Matthews et al. 2012). The internet was not a popular medium to purchase aquatic plants among the respondents included in our study (Table 2). However, this may be an underestimation due to our recruitment of respondents at garden centres and pet stores, creating a bias towards people who buy at stores.

Level of awareness among retail professionals

Several studies identified insufficient knowledge and awareness among crucial stakeholders, such as retail professionals, as major impediments for

successful risk prevention (Burt et al. 2007; Chang et al. 2009; Cohen et al. 2007). We found that store owners were quite well informed about the general topic and potential adverse effects of invasive species and supported the idea of responsible use of their products. Compared to the group of aquarists and water gardeners, retail professionals were more aware of socioeconomic impacts of invasive aquatic plants (Figure 2A-B), which may be explained by the information package that was sent to all garden centres and pet stores by the government. Moreover, self-selection among respondents may have resulted in an overestimation of the level of awareness and knowledge. However, the results from this study also showed that, despite their general knowledge on the effects of non-native species, specific knowledge about the code of conduct, species lists and warning labels was limited among retail professionals. This is particularly noted among employees of pet stores. Furthermore, less than five per cent of the aquarists and water gardeners that were interviewed in this study claimed to have been informed by employees when purchasing a plant. Thus, in order to maximize the use of seller-buyer interactions as a means for educating the public, more efforts are needed to increase the level of knowledge about the species lists and agreements in the code of conduct at the salesmen level.

No changes were found in personal engagement of respondents in retail and, in both years, only one out of four reported that potential invasiveness of plant species was an important topic within the company. The fact that more than half of the retail professionals included in this study reported to reduce invasive plants in their stock (with an increase between 2010 and 2012) then suggests that the availability at plant nurseries is a decisive factor here. Thus, in this case of restricted sale, cooperation of plant nurseries and wholesale businesses appears to be a more effective strategy than targeting individual stores.

Commitment of code of conduct partners

The role of ornamental species trade in the spread of non-native species represents a multi-stakeholder problem with different perceptions and interests. Therefore, the success of a code of conduct depends on many factors, such as participation of all relevant stakeholders and compliance to the proposed measures. The interviews held with the partners showed that they continually recognize the need for the code

of conduct. However, their efforts have decreased over time which has had a negative effect on the output and efficiency of its application. Explanations given by the respondents regarding their self-observed decrease in commitment included poor communication between partners, infrequent meetings and discrepancies about the roles and tasks assigned to each partner.

General concerns about voluntary policy instruments, also expressed by the interviewees in this study, relate to its permissiveness and lack of sanctions. A commonly considered solution is a trading ban for invasive species to reduce the risk of further entry (Drew et al. 2010). In Europe, free trade within the European Union and a lack of uniformity of invasive species policies are major barriers in effective policy and legislation (Brunel et al. 2013; Hulme 2010). This explains the recommended use of codes of conduct for self-regulation in the sector (Heywood and Brunel 2008). Currently, EU legislation is prepared for a limited number of species, including some invasive aquatic weeds (European Commission 2013). Our results show that, even though some partners may have preferred a ban initially, they are all supportive of the code of conduct. However, they stress the importance of performing an evaluation to measure its effectiveness.

Compliance with species lists

Involvement of the major producers and three national trade organizations representing 95 per cent of the trade volume has proven to be an effective strategy for restricted sale. Monitoring of compliance with species lists showed that list 1 species were found incidentally in 2011 and 2012 (Table 6) and in most cases these concerned companies that were not signatory of the code of conduct or plants that originated from old stock. The second list contained species which were allowed to be sold but only with a warning label. This strategy proved to be less effective as less than half of the plants that were found during the monitoring in 2011–2012 were correctly labelled. Differences were also found between pond and aquarium plants. Often not only list 2 species but all non-native pond plants were provided with a warning label, explaining the customer to dispose of excess material wisely in bins for organic waste and not to spread in public water bodies. Labelling of aquarium plants remains problematic, partly due to the smaller size of the product, and the extra costs involved in providing the labels, as is the case with plant bunches.

Mislabelling is a well-recognized problem in trade of ornamental species. This, in combination with limited taxonomic expertise of retail professionals, may result in the selling of a species for which trade is banned (Thum et al. 2012). Often, mislabelling of plants is justified using the argument that the customer is familiar with a particular name or that the correct name is too difficult. *Salvinia molesta* is consistently mislabelled as *Salvinia natans* and likewise *Cabomba caroliniana* as *Cabomba aquatica* (Brunel 2009). The high level of import of *C. caroliniana* under the name *C. aquatica* and possible confusion between the two species by hobbyists may result in its continued use in aquaria and ponds and potential disposal to the freshwater network, despite attempts by Dutch nature organizations and water boards to educate the public (Matthews et al. 2013). Proper labelling of *Myriophyllum* species requires a combination of morphological and molecular work of which first results can be found in the interactive identification key and molecular data available on Q-bank (<http://www.q-bank.eu/Plants/>) (Ghahramanzadeh et al. 2013; Van Valkenburg et al. 2013).

Concluding remarks

Voluntary policy instruments such as codes of conduct have gained popularity in invasive species management. This study evaluated the effectiveness of the Dutch code of conduct for aquatic invasive plants. The results show that aquarium and water garden hobbyists facilitate the introduction and spread of invasive aquatic plants into natural water bodies which demonstrates the need for increasing public awareness. Of the four measures evaluated in this study, the compliance with restricted sale of list 1 species was found to be most effective. For the other measures (including public outreach campaigns and labelling of list 2 species) the results are less univocal and stress the need for long term evaluation studies.

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