

Investigating the efficacy of voluntary initiatives for reducing horticultural introductions of invasive species

by

Heather Crochetiere

A thesis
presented to the University of Waterloo
in fulfilment of the
thesis requirement for the degree of
Master of Environmental Studies
in
Environment and Resource Studies

Waterloo, Ontario, Canada, 2012

© Heather Crochetiere 2012

Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

The horticultural industry is responsible for approximately half of the invasive plant introductions in North America. To reduce these introductions, voluntary initiatives are generally preferred over government regulations. This thesis aims to critically evaluate the effectiveness of two types of voluntary initiatives. I focused on both gardeners and industry professionals to obtain a broad understanding of the retail side of the horticultural industry. At the gardener level, I investigated the effectiveness of alternative species promotion campaigns, commonly called “Grow Me Instead” programs. Adult gardeners visiting the Royal Botanical Gardens in Hamilton, Ontario, as well as customers at two garden centres, participated in a conjoint analysis which measured their preferences for various traits of potential ground cover species, including traits associated with invasiveness (spread, nativeness, maintenance requirements, and hardiness) and additional traits (flower colour, price, and sun/shade requirements). Results showed that gardeners generally prefer plant species having invasive characteristics, suggesting these programs may not be as effective as initially believed. At the retailer level, this study aimed to build upon the work done by Burt and colleagues (2007) to obtain further understanding of the relative strength of internal (ethical motivations) and external (legislation, stakeholder pressures and economic opportunities) factors for motivating participation in voluntary initiatives. Telephone interviews were conducted with 30 industry professionals from southern Ontario to assess their adoption of the St. Louis Voluntary Codes of Conduct (a set of example voluntary codes of conduct). Results found that participation rates of industry professionals in southern Ontario were lower for every specific initiative than those interviewed by Burt et al. (2007). Industry professionals indicated that they presently experience the most pressure to participate from a sense of personal responsibility and the desire to create a green business image. Pressure

was significantly higher from these sources than from pressure from employees. There were no significant differences in the amount of pressure felt from other sources. With respect to the future, interviewees identified that their desire to create a green business image, a sense of personal responsibility, customer demand, and pressure from community groups will be the greatest influencing factors. Together these two studies identified several barriers to the efficacy of voluntary initiatives as well as some reasons for optimism. Awareness was generally high among both gardeners and industry professionals, suggesting that past educational efforts have been successful. Unfortunately, at this time, awareness is not translating into action; however, the results from both groups suggested an openness to change behaviour in the future. To ensure the success of future voluntary initiatives, efforts must be made to encourage these two groups to work together. A standard set of voluntary codes of conduct within Ontario would be beneficial for encouraging retailer participation. Additionally, educational campaigns designed to improve consumer's awareness of how individual actions contribute to invasive species introductions could increase consumer pressure on plant retailers. As retailers become more aware of voluntary options available to them and increase their participation levels, they will be able to create a green business image and further educate consumers about invasive species. Understanding how both retailers and gardeners respond to voluntary initiatives will assist in the development of more effective programs and lead to fewer horticultural invasive species introductions in the future.

Acknowledgements

First I would like to sincerely thank my supervisor, Brendon Larson, for his continuous support and guidance throughout the course of developing this Master's thesis. Without his insight, diligent effort, and invaluable experience, my research would not have been possible.

I acknowledge research support through a SSHRC Standard Research Grant (B. Larson). I would also like to thank the management and staff at all of the garden centres for their time and for the two garden centres allowing us to survey at their retail locations. Additionally I would like to thank the management at RBG, in particular D. Galbraith, for their assistance throughout the course of the study. I am also extremely grateful to the visitors of the two garden centres and the RBG who took the time to participate in this study.

Species thanks go to G. and J. Crochetiere for their contributions throughout the development and completion of this thesis, in particular G. Crochetiere for her assistance with polishing the final product. Thanks also go to N. Mikhail for his assistance throughout the course of this thesis.

I would also like to thank S. Wolfe for her insight and contributions. Finally, I would like to sincerely thank B. L. Campbell for his continuous support and help with methodology and statistical analysis throughout the course of this study; without which, portions of this study would have been unsuccessful.

Table of Contents

Author’s Declaration	ii
Abstract	iii
Acknowledgements	v
List of Figures	viii
List of Tables	ix
List of Abbreviations.....	x
1.0 CHAPTER 1 – INTRODUCTION.....	1
1.1 Invasive Species.....	1
1.2 Plant Invasion Pathways and the Horticulture Industry	4
1.3 Preventing Horticultural Invasive Species Introductions	6
CHAPTER 2 – ASSESSING THE EFFICACY OF “GROW ME INSTEAD” CAMPAIGNS FOR REDUCING INVASIVE PLANT INTRODUCTIONS	11
2.1 Methods	13
2.1.1 Study Location and Sampling	13
2.1.2 Awareness	14
2.1.3 Conjoint Analysis	15
2.1.4 Statistical Analysis.....	19
2.2 Results	21
2.2.1 Awareness	21
2.3 Discussion.....	25
2.4 Conclusions.....	29
CHAPTER 3 – EVALUATING THE RELATIVE IMPORTANCE OF INTERNAL AND EXTERNAL INFLUENCES ON HORTICULTURE INDUSTRY MEMBERS’ PARTICIPATION IN VOLUNTARY INITIATIVES.....	30
3.1 Methods	35
3.1.1 Study Area and Sampling.....	35
3.1.2 Interviews	36
3.1.3 Data Analysis.....	37
3.2 Results	38
3.3 Discussion.....	47

3.4	Conclusions.....	53
4.0	CONCLUSIONS	58
4.1	Reasons for Optimism.....	61
4.2	Application of Theory	62
4.2.1	The Norm Activation Model	64
4.2.2	The Theory of Planned Behaviour.....	67
4.2.3	The Behavioural Perspective Model.....	69
4.3	Benefits of Horticulture.....	71
	REFERENCES	73
	APPENDIX 1 – SURVEY INSTRUMENTS FOR CHAPTER 2.....	83
	APPENDIX 2 – SURVEY INSTRUMENTS FOR CHAPTER 3.....	86

List of Figures

Figure 1: Percent responses of sources of information about invasive species for Ontario gardeners.....	22
Figure 2: Comparison of respondents' perceptions of invasive species between this study and Burt et al. 2007.....	41
Figure 3: Levels of participation of interviewees in the St. Louis Voluntary Codes of Conduct.	43
Figure 4: Comparison of participation levels in specific initiatives between this study and Burt et al. 2007.....	44
Figure 5: Comparison of "openness to participation" for each specific initiative of the St. Louis Declaration between this study and Burt et al. 2007.....	45
Figure 6: Visual representation of the Theory of Planned Behaviour (TPB) from Ajzen, 1991. .	68

List of Tables

Table 1: Factors and levels used in the conjoint analysis..	18
Table 2: Results of conjoint analysis of respondent preferences for various horticultural traits.	23
Table 3: External and internal motivating factors for participation in voluntary environmental initiative	33
Table 4: Weighted mean of interview responses indicating the amount of pressure currently felt from each internal or external source..	46
Table 5: Industry professional indications on each factor's influence on future participation.	47

List of Abbreviations

BMPs – Best Management Practices

BPM – Behavioural Perspective Model

CFIA – Canadian Food Inspection Agency

CNLA - Canadian National Landscape Association

IUCN – International Union for the Conservation of Nature

NAM – Norm Activation Model

NGIA - Nursery & Garden Industry Australia

OALA – Ontario Association of Landscape Architects

RBG – Royal Botanical Gardens

TPB – Theory of Planned Behaviour

TRA – Theory of Reasoned Action

1.0 CHAPTER 1 – INTRODUCTION

This thesis concerns invasive plant species. Within the following chapters, I attempt to evaluate voluntary initiatives at the retailer and the consumer level, to reduce horticultural invasive species introductions. Additionally, I attempt to compare results of industry professionals from southern Ontario to those from a study conducted in the San Francisco Bay area to determine if the current practices of southern Ontarians equate to those professionals in other regions. By understanding the issues surrounding invasive species and examining the retail side of the horticulture industry at two levels, I aim to gain insight into the current potential for success of voluntary initiatives and to determine what steps may be taken to increase effectiveness in the future.

1.1 Invasive Species

An invasive species is one that is generally, but not always, non-native to a designated area. The species can spread in areas far from the site of introduction and proliferate to become abundant (Richardson et al. 2000; Pyšek et al. 2004). Once in an ecosystem, invasive species can reduce biodiversity and species abundance (Mack et al. 2000; Hejda et al. 2009; McGeoch et al. 2010). They have been identified by the International Union for the Conservation of Nature (IUCN) as a leading threat to biodiversity and can be detrimental to human enterprises and health (Wittenberg and Cock 2001). Based on available data, Colautti and colleagues (2006a) estimated that the costs associated with just 16 invasive species in Canada range anywhere from \$13.3 and \$34.5 billion annually. In Canada, invasive species' locations correlate with areas of high population density - primarily the southern areas of the country near the border with the United States.

These areas are also facing significant habitat loss and degradation and are home to many nationally and provincially rare species (Haber 2002). Threats from invasive species impact 22% of Canadian species at risk; at least a portion of those species are also impacted by habitat loss (Venter et al. 2006). While invasive species are considered less of a threat than other pressures, they can add an additional stress to already fragile populations (Government of Canada 2004). For that reason, it is important that future invasions are reduced where possible in order to prevent added pressures to the populations of our species at risk and to rare habitats.

When developing strategies to prevent future invasions, it is critical to note that not every species that is introduced into a new ecosystem will become invasive. Of the species that do establish, most do not have any impact on native species (Williamson and Brown 1986). Williamson and Brown created a popular rule used to describe the incidences of invasions called the tens rule (Williamson and Brown 1986). The tens rule states that only 10% of all introduced species become established and of those, only 10% become invasive; the upper and lower confidence limits of the tens rule are 5% and 20% (Williamson 1992; Lockwood et al. 2007). There is some debate as to the accuracy of the tens rule; however this rule is generally true for plant taxa (Jasche and Strayer 2005). Boudouresque and Verlaque (2002) found that for all the plant taxa introductions studied, invasion rates fell between the upper and lower confidence limits. The tens rule should be thought of as a helpful generalization rather than a precise estimate (Richardson and Pysek 2006).

The small proportion of species that become invasive makes it extremely difficult to predict which of the species that have been introduced will become destructive (Williamson and Fitter 1996); even a single invader can be extremely damaging (Niemiera and Von Holle 2009). Many studies have attempted to determine the invasive potential of species (Holdgate 1986;

Williamson and Fitter 1996; Ellstrand and Schierenbeck 2000; Caley et al. 2008; Hanspach et al. 2008). They have generally concluded that the most important factor in invasion success is propagule pressure (Colautti et al. 2006b; Simberloff 2009). A propagule is an individual or group of individuals of a species being introduced to a new area; the number of individuals in a propagule makes up propagule size. Propagule number refers to the rate at which propagules are arriving within a new ecosystem. The propagule number multiplied by propagule size gives the total propagule pressure of a newly introduced species; increased propagule pressure leads to greater chance of invasion success (Simberloff 2009).

The probability of a species to become a successful invader also depends on both the characteristics of the invader and the characteristics of the ecosystem (Lonsdale 1999; Westphal et al. 2008). In terms of invader characteristics, a species demonstrating invasive behaviour in other areas is generally a strong indication of invasion potential (Reichard and Hamilton 1997; Mack et al. 2002). Having a large capacity for reproduction is also an important invader characteristic (Holdgate 1986). As for ecosystem characteristics, climate is very important; an introduced species has a higher likelihood of becoming a successful invader if the climate of its new habitat is similar to the habitat where it originated, (Holdgate 1986; Williamson and Brown 1986). Despite being helpful in explaining trends in invasion success, these factors are only generalizations; predicting invasion success is still extremely difficult.

Further complicating the challenge of understanding invasion success is the relationship between climate change and invasion success. Due to the role of climate in plant establishment, climate change may hold significant implications for the future of plant distributions (Van der Veken et al. 2008). As climate and temperature ranges shift, plants may become invasive in areas where they had previously been benign and pre-existing invaders may become even more

harmful (Dukes and Mooney 1999). A review conducted by Smith and colleagues (2012), identified that while there has been an increase in studies investigating the relationship between invasive species and climate change in recent years, there are still significant knowledge gaps. In particular, most studies focused on natural sciences rather than social implications of climate change and invasive species interactions. Additionally, they found that very few (11%) of the studies involved primary research; most studies were literature reviews. The current gap in knowledge on the relationship between climate change and invasive species can lead to outdated invasive species legislation (Smith et al. 2012). New threats from changing climate further underline the importance of understanding and preventing future invasions.

National strategies are required to accurately assess and respond to the threats associated with invasive species (Wittenberg and Cock 2001). The *Invasive Alien Species Action Plan for Canada* outlines four strategies for dealing with harmful invasive species (Government of Canada 2004). They are ranked from most to least desirable as follows: prevention of new invasions, early detection of new invasions, rapid response to new invasions, and management of already established and spreading invaders. Because management and eradication of established invasive species is difficult and costly, prevention is the most cost effective strategy (Leung et al. 2002).

1.2 Plant Invasion Pathways and the Horticulture Industry

In this thesis, I focus on specific provincial and local management initiatives related to invasive plant species. Plant species have moved around the globe throughout evolutionary history. They have moved by various natural routes (called “pathways”) such as atmospheric, ocean and river currents. These currents provide means for expansion of plant habitats within the air/water

course; there is very little possibility of range expansion outside of these paths (Mack 2003). Plant ranges expand outside of these natural courses via human-mediated pathways. While humans have been moving plants around the globe for millennia, recent globalization has dramatically increased the rate of both intentionally and accidental plant introductions worldwide through higher trade frequency and advances in transportation technology (Mack 2003; Hulme 2009). Accidental plant introductions occur when plant material inadvertently gets into other global shipments (Mack 2003). Increases in trade frequency lead to higher levels of propagule pressure and therefore invasion success. Increases in transportation technology allow viable plant material to be transported far outside its natural range, leading to introductions into areas where there have previously been none (Mack 2003).

While plants often spread accidentally as a result of global trade, deliberate actions are currently the major modes of plant introductions. In particular, plants introduced for ornamental and landscaping purposes make up the largest percentages of all plant invasions (Mack 2003). Due to the high frequency of plant introductions, both accidental and intentional, it is critical that plans are in place to try and stem the impact of possible plant invasions. Prevention strategies at the pathway level are far more effective than species-specific efforts (Wittenberg and Cock 2001). Regulations and initiatives for whole industries would be more efficient than individual regulations for many different species.

Through this thesis, I aimed to investigate the potential effectiveness of initiatives to prevent invasive plant introductions through horticultural pathways. This is a critical pathway to investigate because the horticulture industry is a major contributor to the problem of invasive species (Mack 2003; Peters et al. 2006; Dehnen-Schmutz et al. 2007; Gagliardi and Brand 2007; Niemiera and Von Holle 2007; Drew et al. 2010). The rate of invasion for plants introduced for

ornamental purposes is much higher than the 10% predicted by the tens rule because they have been selected to succeed in the area where they are being sold (Harrington et al. 2003). Furthermore, the very nature of the horticultural industry is conducive to invasive species introductions (Niemiera and Von Holle 2009). In order to supply large quantities of plants for sale, breeders look for methods to increase reproduction rates, which increases invasion potential (Peters et al. 2006). Popular plants are bought and planted at high rates leading to high propagule pressure and therefore increased chance of invasion success (Coluatti et al. 2006b; Simberloff 2009). To keep up with customer demands, retailers are always looking for new products; the number of cultivars available to consumers in Canada and the United States more than tripled between 1987 and 2008 (Drew et al. 2010). In recent years, gardening has become more popular and in response, accessibility to plant material has increased, therefore, further increasing the risk of invasive plant introductions (Drew et al. 2010; Marco et al. 2010; McGeoch et al. 2010). Large horticultural retailers are very common and provide access to a wide variety of species. The advent of online seed sales and chain garden centres has further increased the ease with which consumers can buy exotic plants. These retailers create a completely de-localized market where supply decisions are made at central headquarters, which means that exotic species are travelling farther than they have in the past (Drew et al. 2010). These trends suggest that there could be an increase in invasive plant introductions if preventative actions are not taken.

1.3 Preventing Horticultural Invasive Species Introductions

As previously indicated, *An Invasive Alien Species Strategy for Canada* was developed in 2004. In 2008, the Canadian Food Inspection Agency (CFIA) evaluated the progress of the Invasive Alien Species Program. They found that the program had taken several years to start

producing significant and evident outcomes and that future success of the program faced several major challenges, including a lack of integrated program management (CFIA 2008).

Furthermore, this evaluation found that the majority of the resources of the Invasive Alien Species program were being devoted to invasive plant pests and diseases rather than invasive plants themselves (CFIA 2008). The *Ontario Invasive Species Strategic Plan* outlines plans to evaluate federal and provincial legislations to determine the advantages/disadvantages of provincial vs. federal legislation and to identify regulatory gaps, including those surrounding new avenues for introductions such as online plant sales (Government of Ontario 2011). This evaluation could lead to provincial regulations in the future but it is likely that any such legislation would take several years to produce. Due to the current lack of strong legislation dedicated to preventing invasive plant species introductions, it would seem that current Canadian regulatory mechanisms may not be successful in reducing horticultural invasive species introductions at this time.

Many industry professionals believe that voluntary standards, rather than regulations are the best approach to dealing with invasive species introductions (Baskin 2002; Harrington et al. 2003). Because of this fact, I focused on investigating voluntary initiatives at industry professional and consumer level to determine how likely they are to be successful in Ontario. It is within the horticultural industry's best interest to take action to prevent biodiversity loss because all of the products sold in this industry are derived from genetic resources; high biodiversity leads to more genetic resources, i.e. sources of diversity within wild plants (Kate and Laird 2000). Some examples of voluntary initiatives at various levels within the industry include removing invasive species from inventory, implementing labelling systems, education campaigns and/or the promotion of alternative species (Peters et al. 2006; Gagliardi and Brand

2007). In some instances these voluntary actions can be even more successful than regulations. For example, encouraging industry professionals to voluntarily stop selling potentially harmful species is much easier than creating legislature mandating plant bans (Peters et al. 2006). However, horticultural professionals rarely remove potentially invasive species voluntarily, so this seems unlikely to be a successful path forward (Drew et al. 2010). Labelling systems could be more effective. Customers generally make plant selections based on criteria such as their personal preferences for novelty, desirable characteristics, fashion and price (Drew et al. 2010). If a labelling system was put into place, customers might include invasive qualities as one of their selection criteria. Along with effective labelling, customer education campaigns could increase customer awareness, which may lead to customer demand for alternative species. For many potentially invasive species, there are non-invasive alternatives available that possess similar desirable characteristics (Burt et al. 2007). Drew et al. (2010) suggest that the promotion of these alternative species should be heavily pursued as a strategy for reducing the introduction of invasive species through horticulture.

The first objective of this thesis is to examine initiatives at the consumer level, specifically those designed to promote alternative species and evaluate the potential success of these programs. These alternative species promotion campaigns are commonly called “Grow Me Instead” programs and are found in many Canadian provinces (Invasive Plants Council of British Columbia 2009; Alberta Invasive Plants Council 2011; Invasive Species Council of Manitoba 2011; Ontario Invasive Plant Council 2011). These programs aim to encourage customers away from invasive species by recommending alternatives. While it seems that these programs should be successful, there have been no studies conducted to test this assumption. Chapter 2 describes a study wherein I sought to determine whether the promotion of alternative plants in garden

centres is likely to be an effective way to reduce the sale of invasive species. A conjoint analysis study was designed to determine if invasive characteristics are important to consumers when making a ground cover plant selection. Gardeners from Southern Ontario were surveyed to gain insights on their current awareness levels and perceptions of issues surrounding invasive species. Additionally, they were asked to indicate how likely they would be to purchase plants described in hypothetical profiles. Profiles were made up of combinations of invasive (spread, nativeness, maintenance requirements, hardiness) and general (flower colour, price, sun/shade requirements) ground cover characteristics. Response data was then used to evaluate 1) which plant characteristics are most important to gardeners and 2) if invasive characteristics are favoured over less invasive ones.

At the industry professional level, some horticultural professionals have demonstrated awareness and concern about invasive species introductions and some have taken action to prevent them. The St. Louis Declaration was developed in 2001 and represents an industry wide effort to develop a standard set of voluntary codes of conduct, with consultations from ecologists, and representatives from retail and wholesale nurseries, botanic gardens, arboreta, government, landscape architects and the public (Fey 2001; Reichard 2004). These codes are now the best-known set of voluntary codes of conduct, (Burt et al. 2007) and would make an excellent base-line for the development of a Canadian horticultural industry-wide voluntary initiative to reduce invasive species introductions.

The second objective of this thesis is to examine the current status of southern Ontario industry professionals' awareness and participation in voluntary initiatives. Chapter 3 describes a study where I interviewed industry professionals using the St. Louis Voluntary Codes of Conduct as an example set of codes of conduct to gain insights in to current participation levels and

perceptions on horticultural invasive species. I compared these results to those found by Burt et al. (2007) in the San Francisco Bay area. Additionally, I sought to determine the relative importance of from internal (ethical motivations) and external (government legislation, stakeholder pressure, economic opportunities) motivating factors in encouraging horticultural industry professionals to participate in voluntary initiatives to reduce invasive species introductions. Finally, I aimed to gain insights into how internal and external motivating factors will influence participation rates in the future. The results provided insight into the current retailer attitudes and practices associated with invasive species as well as identified areas for future improvement.

In the concluding chapter, I revisit some of the broader themes related to invasive species prevention touched upon in these two chapters. Additionally I use the information gained from observations made at the gardener and plant retailer levels to make conclusions regarding the current status of voluntary initiatives within the horticultural industry of southern Ontario. Finally, I will make several recommendations relating to the future of voluntary initiatives to reduce horticultural invasive species introductions. By examining the horticultural industry at both the gardener and garden centre owner/manager levels, I aim, through this thesis, to gain insight into the possible future of voluntary initiatives for the retail side of the horticultural industry.

Chapters 2 and 3 within this thesis are presented as stand-alone journal articles, therefore some repetition will occur.

CHAPTER 2 – ASSESSING THE EFFICACY OF “GROW ME INSTEAD” CAMPAIGNS FOR REDUCING INVASIVE PLANT INTRODUCTIONS

Approximately half of the invasive plant species found in North America were originally introduced as garden ornamentals (Randall and Marinelli 1996; Mack 2003). Horticultural activities may introduce more invasive plant species than other activities because many aspects of the horticultural trade are conducive to invasiveness. First, popular plants within the industry must be mass produced, so breeders constantly seek ways to increase reproduction rates (Peters et al. 2006), which contributes to a tendency of these plants to spread (Holdgate 1986). Second, species that are sold are chosen to be well adapted to local conditions and climate, thus making them more likely to naturalize and spread if they escape into natural areas (Theoharides and Duke 2007; Marco et al. 2010). Third, successful plants are frequently purchased, which increases propagule pressure and thus the probability of spread (Colautti et al. 2006b; Simberloff 2009). Recent trends also suggest that gardening is gaining in popularity, further increasing the propagule pressure of popular garden species (Drew et al. 2010). Finally, many of the characteristics that contribute to the popularity of garden species, such as requiring little maintenance and being resistant to pests/diseases, increase probability of spread (Dehnen-Schmutz et al. 2007; Dawson et al. 2008; Drew et al. 2010). Because of the high probability of introductions through the horticultural trade, reducing or preventing them has become a priority (Lodge et al. 2006).

The horticultural industry would prefer voluntary over regulatory methods to reduce invasive species introductions (Baskin 2002). The Government of Canada also supports voluntary initiatives and industry agreements, as indicated within its *Invasive Alien Species Action Strategy* (Government of Canada 2004). Some industry members have proactively begun

to put these preferences into practice. In 2001, the Missouri Botanic Garden and the Royal Botanic Gardens, Kew, hosted an international workshop in St. Louis, Missouri to develop codes of conduct to help guide the horticultural industry in preventing introductions of potentially invasive plant species (Fey 2001). The result was a set of draft codes called the St. Louis Voluntary Codes of Conduct, with alternatives developed for government, nursery professionals, the gardening public, landscape architects, and botanic gardens and arboreta. These codes have been widely promoted through various American horticultural societies (Center for Plant Conservation 2012).

Of particular interest to this study is the set of codes for nursery professionals, and specifically the common theme of promoting alternative plant species (Fey 2001). Programs to encourage the use of alternative species promotion have been initiated worldwide. In Australia, the Nursery and Garden Industry Australia (NGIA), in collaboration with the federal government, has developed a national “Grow Me Instead” program that provides information to gardeners about regional invasive species and appropriate alternatives (NGIA 2009). Similar programs have been initiated in Canada through various provincial invasive plant councils, including the Invasive Plants Council of British Columbia (2009), the Alberta Invasive Plants Council (2011), the Invasive Species Council of Manitoba (2011), and the Ontario Invasive Plant Council (2011). These campaigns also occur at a regional level; in Southern Ontario, for example, alternative species promotion campaigns have been initiated by conservation authorities such as the Credit Valley Conservation Authority (2010). These guides often promote both native and non-native alternatives to species that tend to spread (“invasive”), though they emphasize native species.

Consumers will always want to purchase garden plants, so promoting alternatives to

invasive species may be a good way to reduce introductions of invasive species (Drew et al. 2010). By purchasing non-invasive alternatives, gardeners would reduce the propagule pressure of potentially invasive species and help to prevent future invasions. Promoting alternatives could also be profitable for the horticultural industry because customers who have been encouraged to remove an invasive species from their garden will need replacement species (Reichard and White 2001). While promoting alternative species seems like an excellent strategy, there have been no studies to evaluate whether these campaigns are likely to be successful; specifically, would people purchase these alternatives? This study seeks to determine whether the promotion of alternative plants in garden centres is likely to be an effective way to reduce the sale of invasive species.

2.1 Methods

2.1.1 Study Location and Sampling

I conducted the study in three locations in southern Ontario, Canada. The first was the Royal Botanical Gardens (RBG) in Hamilton, Ontario (www.rbg.ca), which is a popular attraction for people who are interested in gardening. I also interacted with consumers at two different garden centres in Southern Ontario, one in Waterdown and the other in Kitchener, in order to sample a wider range of gardeners. One garden centre was part of a large company that has multiple locations across the region. This garden centre is a higher end retailer which attracts wealthier patrons who prefer higher quality items. The other garden centre is smaller with only three retail locations, two of which are local.

At each location, visitors were offered a ballot to win a \$50 gift card as a participation incentive. One gift card was awarded per location; the gift cards were for the individual garden

centres and RBG. To be included, individuals had to be 18 years of age or older and indicate that they had some gardening experience. The survey instrument included a section where respondents indicated preferences for hypothetical ground cover species and awareness questions to establish an understanding of current awareness and concern levels. The survey is described in more detail below. This project received approval from the Office of Research Ethics at the University of Waterloo.

2.1.2 Awareness

To assess respondents' overall knowledge level and opinions about invasive garden species, I asked them several questions in the surveys conducted at RBG and the smaller garden centre. Management at the larger garden centre requested that the awareness questions not be included. The awareness portion of the survey was presented after the plant preference questions to ensure that choices were not biased. These questions addressed whether or not respondents had a general awareness of issues surrounding invasive species to help explain plant preferences which were assessed through the conjoint analysis. The first awareness questions asked if respondents were familiar with the term "invasive species" and if so, where they had learned about invasives. Next they were asked to provide a definition to determine if their understanding of invasive species was accurate. They were also asked a yes or no question to determine if they were familiar with invasive species in a horticultural context. Finally, they were asked to indicate on a five point Likert scale the extent to which they agree with certain behaviours associated with invasive species: educating themselves, planting only natives, planting only non-invasives, planting any species they choose or discouraging others from planting invasive species. These questions were included to evaluate if gardeners believe they should behave in ways that reduce invasive species introductions and to aid in the explanation of the conjoint analysis results.

2.1.3 Conjoint Analysis

To understand consumer plant preferences, and to determine if consumers would be likely to purchase alternative species, I used a conjoint analysis. Conjoint analysis can help researchers identify the impact of multiple factors on consumer preference and evaluates their relative importance in decision making (Green and Wind 1975; Green and Srinivasan 1978). This technique has been used to measure consumer preferences within horticultural activities (DeBossu 1988; Gineo 1990; Townsley-Brascamp and Marr 1995; Behe et al. 1999; Zadegan et al. 2008). In this study, conjoint analysis was employed to evaluate the potential success of alternative species promotion campaigns; these campaigns are unlikely to be successful if customers favour plant features that are characteristic of invasive species. Furthermore, nursery and landscape industry professionals may wish to promote alternatives but do not know which plants would make acceptable alternatives, as found in a study of 114 members of the Connecticut Nursery and Landscape Association (Gagliardi and Brand 2007). The results of this analysis indicate which characteristics are most important to consumers when making purchasing decisions. Retailers can use this information to choose alternatives that possess those characteristics or to advertise more clearly against undesirable invasive traits.

To address these questions, I chose to focus on ground cover garden species. This choice was made for several reasons. First, within guides (e.g. “Grow Me Instead”) providing recommendations for alternative garden species in Ontario, there were more invasive ground cover species discussed than other growth forms (tall flowering plants, vines, aquatic plants, etc.) (Ontario Invasive Plant Council 2011; Credit Valley Conservation 2010). Second, ground cover species are generally used to carpet areas of a garden; an ideal ground cover would be one that successfully spreads, which would increase the likelihood of it becoming invasive.

Conjoint analysis involves presenting hypothetical product options based on different combinations of characteristics, called factors (Hair et al. 1998). For example, when investigating horticultural species, different factors could be flower colour, leaf colour or plant health. Each of these factors is then assigned levels; for example, different levels of the factor flower colour could be red, blue and white. When beginning a conjoint analysis, the first step is to determine which factors to include. In order to eliminate researcher bias, I surveyed consumers to determine which characteristics were most important to them when purchasing a ground cover species and used the results to select the factors to include. These elicitation surveys were done using a method similar to the one used by Townsley-Brascamp and Marr (1995) and were carried out at RBG. Respondents were asked to list and rank characteristics of ground covers that are most important to them when selecting a species. The most frequently listed characteristics were included in the conjoint analysis.

Based on the results of the elicitation surveys and personal knowledge, I selected eight factors, which is within an acceptable range for a traditional conjoint analysis (Hair et al. 1998). The elicitation surveys gave us flower colour, hardiness, maintenance, attractiveness, spread, and shade tolerance. I added nativeness and price to ensure that all important factors were included. Nativeness was added because of the preference given to natives in the alternative species information guides (Credit Valley Conservation 2010, Ontario Invasive Plant Council 2011). I added price because the demographics of the elicitation survey sample indicated that a high percentage of people surveyed (37.3%) had household incomes greater than the 2009 Canadian average (\$74,700, [Statistics Canada 2011]).

Levels were defined for each factor through a variety of means. For colour, three levels – “white”, “blue”, and “pink” - were chosen by determining which flower colours were most

common among ground cover species listed in garden catalogues and in the Ontario “Grow Me Instead” guide (Ontario Invasive Plant Council 2011). I excluded a fourth colour, yellow, because it had lower representation within the Ontario “Grow Me Instead” guide (Ontario Invasive Plant Council 2011) and because the relative importance of a factor can be inflated if it is represented by more levels than other factors in a conjoint analysis (Hair et al. 1998). I determined the levels for price by visiting several local garden centres and making observations on the common costs of ground cover species. Observations showed that prices generally fell within a range from \$3.99 - \$12.99. When conducting conjoint analysis, it is common to slightly exaggerate the range of a factor to ensure that the entire range is represented, so long as the levels remain believable (Hair et al. 2006); so I selected low, medium and high levels of “\$2.99”, “\$9.99” and “\$13.99”. The medium level was defined as “\$9.99” rather than a more intermediate value because it more closely resembled actual plant prices. Careful consideration went into defining the remaining levels to ensure that they accurately represented the different possibilities available to consumers (Table 1).

The amount of time required for a respondent to complete a conjoint analysis can quickly become unacceptable; as the number of levels and factors increases, so does the number of possible combinations and therefore, respondent burden. To address this, I defined two, rather than three, levels whenever it was possible while still accurately representing the factor. I used three levels for colour, attractiveness, shade tolerance and price because they could not be accurately represented with only two. I also used a fractional factorial design to reduce respondent burden because this study was a full profile conjoint analysis, meaning that the respondents were asked to consider the different options based on all the factors (Gineo 1990). Based on the number of factors and levels I used, the total number of possible combinations was

1296: four factors at three levels each, times four factors at two levels each, or $3^4 \times 2^4$. This is clearly an unacceptable number of combinations for respondents to evaluate. An orthogonal array generated by SPSS Statistics (Version 20, 2011) and the resulting number of combinations, or profiles, was 27.

Table 1: Factors and levels used in the conjoint analysis. Parentheses designate variables for the Ordinary Least Squares regression equation.

<i>Factor</i>	<i>Level 1</i>	<i>Level 2</i>	<i>Level 3</i>
Colour	White (C2)	Blue (C1)	Pink (C3)
Hardiness	Delicate (H2)	Hardy (H1)	
Maintenance	Requires frequent maintenance (M1)	Requires no maintenance (M2)	
Attractiveness	Has showy flowers with unattractive foliage (A2)	Has attractive foliage with non-showy flowers (A3)	Has showy flowers and attractive foliage (A1)
Spread	Little spread (SP1)	Spreads quickly and may escape garden (SP2)	
Shade Tolerance	Full shade (S2)	Partial shade (S3)	Full sun (S1)
Nativeness	Naturally found in Ontario (native) (N2)	Introduced to Ontario (non-native) (N1)	
Price	\$2.99 (PR2)	\$9.99 (PR1)	\$13.99 (PR3)

Each one of the 27 different profiles was displayed on an information card to represent a hypothetical ground cover species. I used three sets of colour coded cards to randomize the order in which the profiles were presented. Respondents were asked to review the cards and to indicate their preference for each hypothetical ground cover species on a scale from 0 (definitely would not buy) to 10 (definitely would buy). Additionally, respondents were asked to answer demographic questions, including age, gender, whether or not they are employed in an

environmentally related field and the number of years they have been gardening as well as the number of hours per week they spend gardening during the growing seasons.

The surveys were pretested twice to ensure that the proper number of factors was included and that the questions were clear. Results from the three garden centres were lumped together. For the complete survey, including the awareness questions, see Appendix 1.

2.1.4 Statistical Analysis

The analysis follows that of similar conjoint studies [e.g., Campbell et al. (2004)]. Independent variables, in this case the levels, were coded using mean deviation coding, whereby coefficients become deviations from the intercept instead of deviations from a reference profile (Campbell et al. 2004). My reference profile was based on the levels appearing in the first profile of the blue set of information cards: a ground cover that has a blue flower, is hardy, has both showy flowers and attractive foliage, spreads quickly and may escape the garden, requires full sun, is introduced to Ontario (non-native), requires frequent maintenance and costs \$9.99. Depending on the situation the variables are coded with -1, 0, 1, with the reference variable always coded as -1 and a non-reference variable taking on 1 if shown in a profile, 0 if another non-reference variable is shown, or a -1 if the reference variable is shown (Campbell et al. 2004; Wirth et al. 2011). Coding the independent variables allows the willingness to purchase rating to be regressed against the product profiles seen by consumers; I used SAS Version 9.2 (SAS Institute Inc. 2008) to run this analysis. Ordinary Least Squares (OLS) regression was used to determine preference coefficients for each level for each consumer. Preference coefficients indicate the extent to which each level was preferred by respondents; higher coefficient indicates stronger preference. A positive value indicates preference for an attribute. A negative value does not necessarily mean

preference against an attribute but simply means that it was not as preferred as the other options (Orme 2010). The OLS regression was defined by:

$$R_i = P_0 + P_1(C2) + P_2(C3) + P_3(H2) + P_4(A2) + P_5(A3) + P_6(SP2) + P_7(S2) + P_8(S3) + P_9(N2) + P_{10}(M2) + P_{11}(PR2) + P_{12}(PR3) + E_i$$

where R_i is the rating on a scale from zero to ten the likelihood of purchase for respondent i , and P_n is the preference coefficient. See Table 1 for remaining variables. Because the levels of the reference profile were always coded as -1, they do not appear in the equation.

The sum of the preference coefficients of the levels for each factor must equal zero; therefore the coefficients of the reference profiles were easily calculated by subtracting the sum of the other preference coefficients from zero for each factor (Campbell et al. 2004). Once the coefficients of each level for each factor were calculated, relative importance of each factor was determined using the following equation:

$$\text{Relative Importance} = (\text{range}_i \times 100) / \sum(\text{range}_i),$$

where range_i is the range of coefficients for a particular factor (Campbell et al. 2004).

Relative importance refers to the amount that each characteristic plays in the decision making process; a higher relative importance value indicates that the attribute played more of a role in the decision making process than a lower relative importance value.

I conducted a two-tailed t-test using SAS Version 9.2 (SAS Institute Inc. 2008) to determine significant difference from zero. A preference coefficient with a value of zero would indicate that respondents did not have a preference for or against the corresponding factor; therefore, significant difference from zero would indicate significant preference.

2.2 Results

Data were pooled together from all locations and analysed as one data set (n=87). The ratio of male to female respondents was 38% to 51%; the remaining proportion of respondents declined response. Most respondents fell within the ages of 50-64 (43.7%). Few respondents (14.9%) had experience in an environmentally related field either through their employment or studies. Most respondents had been gardening for more than twenty years (56.3%) and spent 3-5 hours per week in their garden during the growing season (32.2%).

2.2.1 Awareness

Of the respondents who answered the awareness questions, i.e. respondents from RBG and the smaller garden centre (n=47), 93.9% were familiar with the term “invasive”. 69.4% of respondents were aware that some horticultural species could become invasive. Most respondents indicated learning about invasive species from the media (42.9%) followed by garden centres/nurseries (32.7%); school was least frequently indicated (14.3%). “Other” responses were specified as books, friends and family members, the internet, personal experience and landscapers/designers. Responses for all sources of information are presented in Figure 1.

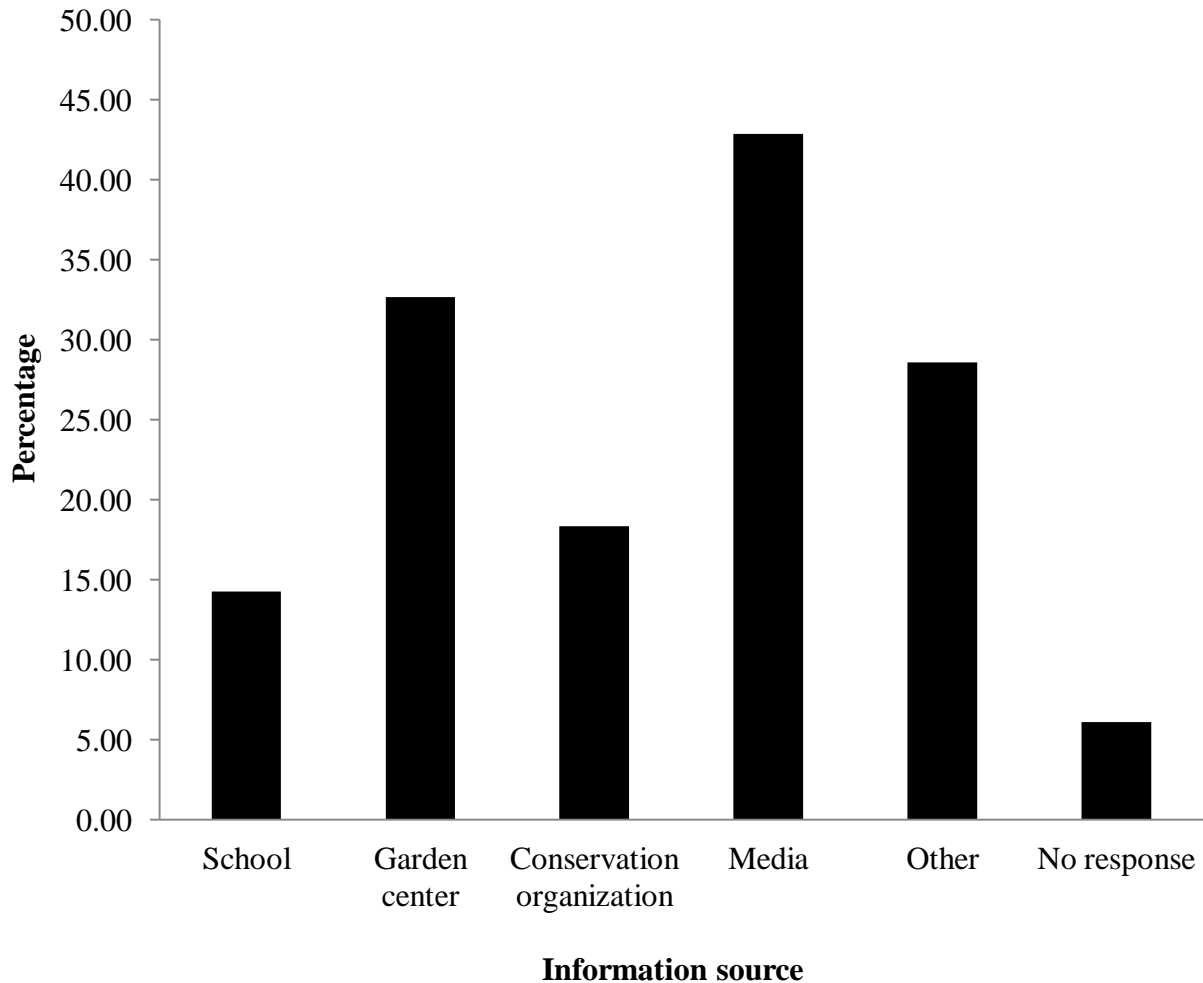


Figure 1: Percent responses of sources of information about invasive species for Ontario gardeners.

Most of the respondents (85.7%) were able to identify at least one aspect of a correct invasive species definition: non-native, spread, or negative impact to surrounding systems (Richardson et al. 2000; Ricciardi and Cohen 2007). Many respondents (32.7%) were able to identify two of these characteristics and approximately one quarter of respondents identified all three of these characteristics (24.5%).

The next set of questions addressed survey respondents' view of the gardener's role in preventing invasive species introductions. Most respondents (77.6%) agreed that gardeners

should educate themselves on the subject of invasive species. When asked about the types of species that gardeners should plant, 24.5% of respondents agreed that only native species should be planted whereas 69.4% of respondents agreed that only non-invasive, not necessarily native, species should be planted. The majority of respondents (55.1%) disagreed that gardeners should be able to plant any species they choose and a similar proportion of respondents (59.2%) agreed that they should discourage others from planting invasive species.

2.2.2 Conjoint Analysis

The preference coefficients for most of the levels were found to be significantly different from zero, with those being not significantly different from zero having a lower relative importance value (Table 2). Maintenance was the most important attribute with “requiring little maintenance” being the most preferred level. The preference coefficient for “little maintenance” was 0.253 whereas the preference coefficient for requiring frequent maintenance was -0.253; a larger, more positive, preference coefficient indicates greater preference. The second most important attribute was price with “\$13.99” being the most preferred level followed by “\$9.99” and “\$2.99”, indicating that the least expensive level was actually the least preferred option. The third most important attribute was hardiness; “hardy” was preferred over “delicate”. Nativeness was found to be the fourth most important attribute. Being native to Ontario was preferred over being non-native. Spread was found to be the second least important attribute however preference was given to the ability to spread quickly with the potential to escape the garden. Overall, the order of attributes from most to least important was maintenance, price, hardiness, nativeness, flower colour, shade tolerance, spread and attractiveness.

Table 2: Results of conjoint analysis of respondent preferences for various horticultural traits. The attributes are listed in order of preference based on relative importance values. For each level, preference coefficients and standard errors (in parentheses) are provided. *** denotes significant difference from zero at $p < 0.01$, ** denotes significant difference from zero at $p < 0.05$.

Attributes and levels	Preference coefficients
Maintenance	
Frequent maintenance required	-0.25***(0.77)
Little maintenance required	0.25***(0.77)
Relative importance (%)	16.44
Price	
\$2.99	-0.29*** (0.06)
\$9.99	0.10 (0.06)
\$13.99	0.19*** (0.06)
Relative importance (%)	15.61
Hardiness	
Hardy	0.19*** (0.47)
Delicate	-0.19*** (0.47)
Relative importance (%)	12.64
Nativeness	
Naturally found in Ontario (native)	0.19*** (0.06)
Introduced to Ontario (non-native)	-0.19***(0.06)
Relative importance (%)	12.11
Flower colour	
Blue	-0.18** (0.68)
Pink	-2.00E-3 (0.73)
White	0.18** (0.67)
Relative importance (%)	11.40
Shade Tolerance	
Requires full sun	0.15 (0.83)
Requires partial sun/shade	-0.20** (0.75)
Requires full shade	0.05 (0.75)
Relative importance	11.26
Spread	
Spreads quickly, may escape garden	0.17 (0.99)
Spreads slowly	-0.17 (0.99)
Relative importance (%)	10.81
Attractiveness	
Showy flowers with unattractive foliage	-0.14 (0.76)
Non-showy flowers with attractive foliage	0.16 (0.80)
Both showy flowers and attractive foliage	-0.03 (0.85)
Relative importance (%)	9.71
R ² value	0.52

2.3 Discussion

The results show that customer purchasing decisions do not consistently reflect their indicated level of concern surrounding invasive species. Overall, awareness of invasive species is very high. Almost all respondents were familiar with the term “invasive” and were able to provide at least a partially accurate definition. The majority of respondents were also aware that horticultural species could become invasive. Additionally, approximately one third of respondents were initially informed about invasive species from a garden centre or nursery. These results show that not only were respondents aware of invasive species, but many first learned about them in a horticultural context. Based on the indicated amount of time per week spent in the garden and the number of years experience, one could assume that most of the respondents are passionate gardeners. Generally they agreed that they should behave in ways that reduce invasive species introductions: educating themselves, planting non-invasive species, and discouraging others from using invasive plant material, and did not agree that gardeners should be able to plant whatever they want. Presumably this knowledge and awareness would translate to purchasing decisions; however, the results of the conjoint analysis contradict this assumption. If passionate gardeners who are generally aware and concerned about invasives are still purchasing species with invasive qualities, it is even less likely that the average gardener would select non-invasive alternatives.

For the most part, the preference coefficients of each level were significantly different from zero indicating that these factors do play a role in the decision making process and therefore can be considered to accurately make up the components of a purchasing decision for a ground cover species. Knowing that, one can proceed to analyse the results to determine if gardeners prefer more or less invasive qualities. As previously discussed, many factors that make

a plant species an ideal garden plant also make them ideal invaders. In the conjoint analysis, attributes that are characteristic of invasive species include being non-native, having the ability to spread quickly, and having the ability to thrive in an environment without assistance (requiring little maintenance and being hardy). The total conjoint analysis results show that two of these – maintenance and hardiness– were most important for gardeners’ decisions. Preference was given to the more invasive levels over the less invasive options. Combined, these characteristics indicate that a plant would be able to thrive in an ecosystem without assistance, suggesting that if it escaped it would likely become naturalized and potentially invasive.

In contrast to those invasive preferences, respondents indicated a preference for native species over introduced species; nativeness was the fourth most important attribute in the decision making process. It is intermediately important to gardeners’ purchasing decisions, which indicates that it may be taken into consideration when making plant selections. This preference for native species may make gardeners willing to purchase alternatives if they are marketed towards them. However, in a study outlined below in Chapter 3, wherein garden centre owners and managers were interviewed, some respondents indicated that native species do not do as well in urban landscapes. While it may seem logical to assume that native plants would require less maintenance because they should be adapted to the local environment, many are not capable of succeeding in harsh urban environments and may therefore require more maintenance than other non-native varieties. Furthermore, despite vocal native plant enthusiasts, garden centre owners noted that there have been no increases in the sale of native plants (Crochetiere and Larson, unpublished). Despite best intentions, it appears that native plants may not make the best alternatives to popular invasive garden species.

The last characteristic relating to invasion potential included in this study was spread; respondents did indicate a preference for spreading quickly with the potential to escape the garden. Fortunately, spread was the second least important attribute and the preference coefficient was not found to be significantly different from zero. Nevertheless, the preference for spreading capability is cause for some concern for the possible success of “Grow Me Instead” programs. This preference, combined with preference for other invasive characteristics such as being hardy and requiring little maintenance, may make it difficult to convince gardeners to choose alternatives over past favourites, especially if the native alternatives do not thrive in urban landscapes. Additionally, if a native species that does thrive and begins to spread aggressively, it can also become invasive. It is for these reasons that the preference for spread cannot be overlooked despite its low relative importance value. Based on these results, it seems that there may be limited success with alternative species promotion in preventing invasive species introductions.

Possible reasons for the lack of connection between awareness and the choices made during the conjoint analysis may be that people live in areas removed from natural lands and do not believe that plants they put in their garden could cause any environmental harm. While this may be true in certain instances, it would be extremely difficult to ensure that persons purchasing potentially invasive species did not live close to natural lands, or give plants from their gardens to friends who live close to natural lands. Additionally, invasive plants can reach natural lands through improper garden waste disposal, as they are able to escape compost heaps or dumpsites (Foxcroft et al. 2008). If alternatives can be effectively promoted and gardeners purchase those alternatives instead of potential invasive species, the overall chance of invasive introductions decreases without gardeners missing out on enjoyable garden species.

These results also indicate which characteristics are commonly preferred by southern Ontario gardeners; it is likely that these results could translate to other locations. For example, it is logical that gardeners in any area would appreciate hardy plants that require little maintenance, as species that have those characteristics may be more likely to survive. While these traits are both characteristics of potentially invasive species, not all species possessing these characteristics will become invasive; ensuring that alternatives possess these characteristics will increase the likelihood of their successful sale. For example, plant breeders may develop sterile cultivars of popular, potentially invasive plants, thus maintaining the hardiness and low maintenance qualities of the plant while reducing the capacity to spread (Drew et al. 2010). In most cases, native plants should be promoted as alternatives, as they were preferred over non-native species; however, given that they may not perform as well in urban areas, non-native species should also be promoted as acceptable alternatives. This study found that alternative species should have white, rather than blue or pink flowers, as it was the most preferred flower colour; however, a wide range of flower colours should be made available to accommodate for different tastes. Additionally, alternative ground covers should always have attractive foliage as this was valued more than showy flowers. Alternatives should be made available for all shade tolerances so as to be suitable for all different types of gardens. Results showed that customers preferred the most expensive price and that it was fairly important to their decision making processes. This is likely due to the fact that some of the sampling was completed at the higher end garden centre where gardeners would be willing to pay higher prices for an increase in perceived value. Evidence suggests that people shopping at independent garden centres are more willing to pay premium prices than those shopping at big box stores (Satterthwaite et al. 2006). It is possible that gardeners believe that cheap plants would be of a lower quality; perhaps

gardeners surveyed at a large box store would indicate preference for cheaper species. The results of this analysis provide valuable information as gardeners would be more likely to purchase alternative species if those species possessed the most desirable characteristics.

2.4 Conclusions

Overall, it seems that there may be some challenges in encouraging gardeners to purchase alternatives promoted through “Grow Me Instead” campaigns. Gardeners indicated that they agree they should behave in ways that reduce invasive species introductions, however, the conjoint analysis determined that invasive factors are still preferred when customers are forced to make tradeoffs. Perhaps there needs to be more education to connect the concept of invasive species with horticultural purchases in the minds of gardeners. Without further education and the development of interesting alternative plants it seems unlikely that alternative species promotion would have dramatic impacts on the rate of horticultural invasive species introductions. Further studies should investigate if targeted marketing campaigns would make a difference in customer plant selection.

CHAPTER 3 – EVALUATING THE RELATIVE IMPORTANCE OF INTERNAL AND EXTERNAL INFLUENCES ON HORTICULTURE INDUSTRY MEMBERS’ PARTICIPATION IN VOLUNTARY INITIATIVES

Invasive species can be ecologically, socially and economically damaging (Mack 2003; Head and Muir 2004; Pimental et al. 2005). In Canada, the costs created by only 16 invasive species range from \$13.3 and \$34.5 billion annually (Colautti et al. 2006a). To try to reduce the negative impacts caused by invasions, Environment Canada developed the *Invasive Alien Species Action Plan for Canada*, which outlines four strategies for dealing with harmful invasive species: prevention of new invasions, early detection of new invasions, rapid response to new invasions and management of already established and spreading invaders (Government of Canada 2004). Strategies to prevent invasions should be the priority, because once a species has invaded a natural area it is extremely difficult and costly to remove (Leung et al. 2002).

This investigation focuses on methods to reduce plant invasions, specifically those introduced for horticultural purposes. The first objective of this study is to determine industry members’ awareness levels and perceptions of issues surrounding horticultural invasive species introductions in Ontario. Horticultural species make up the largest proportion of invasive plants in North America (Mack 2003). Horticultural species are selected to be sold in areas where they are well adapted to the local conditions, such as climate and soil type, therefore if they escape into natural areas, they are more likely to naturalize than randomly introduced species (Marco et al. 2010; Theoharides and Duke 2007). Furthermore, many desirable garden species characteristics are also those that make species more invasive, for example: easy care, wide climatic tolerance and resistance to pests/diseases (Dawson et al. 2008; Dehnen-Schmutz et al. 2007; Drew et al. 2010). To further compound the issue, recent trends suggest that gardening is

becoming more popular (Drew et al. 2010). This increase in popularity could lead to increased invasive species introductions therefore underlining the importance of preventative measures.

There are several different ways to address the issues associated with horticultural invasive species. Many industry members believe that voluntary standards are the best approach (Harrington et al. 2003). In 2001, efforts were taken to develop a large-scale, industry-wide set of voluntary codes of conduct for the horticultural industry. Ecologists, as well as representatives from retail and wholesale nurseries, botanic gardens, arboreta, government, landscape architects and the public, attended a workshop hosted by the Royal Botanical Garden Kew and the Missouri Botanic Garden entitled, “The Workshop on Linking Ecology and Horticulture to Prevent Plant Invasions” (Fey 2001; Reichard 2004). The product of this conference was the St. Louis Declaration, which contained two significant components. The first was a set of overarching findings and principles; the findings describe the problems associated with invasive species and provide the necessary context for the principles, which intend to direct the industry in rectifying those problems. The second was a draft set of voluntary codes of conduct developed separately for government, nursery professionals, the gardening public, landscape architects and botanic gardens and arboreta (Fey 2001). A follow-up meeting in Chicago allowed attendees to finalize the codes (Fey 2002). The codes found in the St. Louis Declaration are now the best-known set of voluntary codes of conduct (Burt et al. 2007).

The second objective of this chapter is to determine the current level of participation in individual initiatives of the St. Louis Voluntary Codes of Conduct of southern Ontario garden centres and compare them to participation levels of industry professionals discovered by Burt et al. (2007) in the San Francisco Bay area. Burt and colleagues (2007) surveyed 50 industry professionals in the San Francisco Bay area to examine the possible efficacy of voluntary

initiatives to reduce horticultural invasive species introductions. The authors sought to understand industry professionals' perceptions of invasive species, to determine their levels of participation in voluntary initiatives, to explore several possible predictors of participation, and to assess which incentives and obstacles were most important to participation. They used the voluntary codes of St. Louis Declaration as a set of example voluntary initiatives and developed various metrics to analyse the data. The dependent variable was participation and predictor variables were developed based on questions pertaining to awareness, responsibility, and involvement. "Responsibility" referred to acceptance of the role of the horticultural industry in invasive species introductions and "involvement" referred to involvement in trade organizations. The results showed that higher levels of awareness and participation in trade associations led to higher levels of participation, yet there was not a significant relationship between participation and perception of responsibility. When asked what would motivate them to participate, respondents most frequently indicated personal concern for the environment or greening the image of their business. The most commonly cited obstacles to participation included a lack of awareness, limited personnel, and their perception that participation would be too time-consuming. Burt et al.'s (2007) study was a first step in determining the potential effectiveness of voluntary initiatives to reduce horticultural invasive species introductions. The Burt et al. (2007) study was an excellent preliminary examination of the effectiveness of voluntary initiatives, however, one cannot simply assume that the results from the San Francisco Bay area would apply to Canadian industry professionals.

Generally, for a voluntary initiative to be effective, the perceived or actual payoff for the business must be at least as much as the costs of the program (Alberini et al. 2002). Bansal and Roth (2000) identified four major drivers for participation which can further be broken down into

internal and external factors; external factors refer to influences from outside the business and include legislation, stakeholder pressure, and economic opportunities, whereas internal factors refer to influences from within the business and include ethical motives (Table 3).

Table 3: External and internal motivating factors for participation in voluntary environmental initiatives.

	Factors (Bansal and Roth 2000)	Factors included in interviews in this study
External	Legislation	- Government regulations
	Stakeholder pressure	- Pressure from community groups - Customer demand - Pressure from other industry professionals
	Economic opportunities	- Competing with other garden centres/nurseries - Creating a green business image
Internal	Ethical motives	- Sense of personal responsibility - Pressure from employees

Internal pressures come from within the organization whereas external pressures come from regulators, contractors/suppliers and the public (Henriques and Sadorsky 1996). Some examples of economic opportunities that may influence participation in voluntary initiatives are market drivers, pressure from customers, marketing opportunities, potential to gain a competitive advantage, and cost cutting/revenue building strategies (Darnall 2010). The last driver, ethical motives, would be considered an internal pressure wherein the views and values of management and employees align, or not, with environmental voluntary initiatives; businesses participate

because the decision makers feel it is the right thing to do (Bansal and Roth 2000). These generalizations can be applied to the horticultural industry; by understanding what motivations and barriers are currently being felt by the horticultural industry, one can better understand if voluntary initiatives to reduce invasive species introductions are likely to be effective.

The third objective of this study was to build upon the work completed by Burt et al. (2007) and determine the relative influence of internal and external pressure sources on current levels of participation among garden centres/nurseries in southern Ontario. From personal observations, I found very little evidence of initiatives taken to reduce invasive species introductions within garden centres and nurseries in Southern Ontario, therefore, participation rates were expected to be low. *The Canadian Action Plan to Address the Threat of Invasive Alien Plants and Plant Pests* (CFIA 2009) focuses most of its resources on preventing the introduction of plant pests and diseases rather than plants themselves. The Government of Ontario (2011) is aiming to review legislation to identify current gaps; however if new legislation were to be developed as a result of this review, it would likely take years to produce. It therefore seems unlikely that plant retailers are currently feeling significant pressure from a threat of future legislation. Additionally, a recent study conducted by Crochetiere and Larson (see Chapter 2) found that despite being aware of issues surrounding invasive species, garden centre customers still prefer plants that possess invasive characteristics. For these reasons, it was hypothesized that few external pressures would be motivating garden centres and nurseries to participate, and internal factors would be more influential to participation at this time.

The fourth and final objective of this study was to determine how internal and external motivating factors would motivate participation in the future. These results can potentially be used to direct where future efforts should be focused.

3.1 Methods

3.1.1 Study Area and Sampling

I conducted telephone interviews with owners, managers or other employees with decision making responsibilities, working in garden centres and nurseries throughout southern Ontario, henceforth referred to as industry professionals. Using yellowpages.ca (Pages Group Co. 2011) and the Landscape Ontario (2011) websites, I searched for “garden centres” and “nurseries” within southern Ontario. I started with the Burlington/Hamilton area and expanded out towards Toronto, Kitchener/Waterloo and Niagara Falls. Wherever possible, garden centres were further investigated by visiting a website to determine the size of the business as I wanted to ensure that a variety of business sizes were represented in the sample. Phone calls were made during regular business hours. Preliminary phone calls were conducted to initiate contact with the industry professional, to explain the research study, and to set up a mutually convenient telephone interview time. Some industry professionals requested additional information about the study; in these instances, I emailed them a detailed information letter. Others requested to have the questions emailed to them so they could answer them at their leisure; in these cases the questions were emailed and follow up phone calls were made three weeks later for those who had not returned them yet. The telephone interviews were recorded with the participant’s consent to ensure accuracy and were completed during the month of October 2011. Based on the timeline and available resources, I aimed to complete 30 interviews. This project received approval from the Office of Research Ethics at the University of Waterloo.

3.1.2 Interviews

The interview script is provided in Appendix 2. The first questions addressed formal and informal education history, job title and responsibilities, and length of time in the position. To qualify for the interview, respondents had to hold a position which granted them authority to make decisions on behalf of the business. Additionally, I included the questions from Burt et al. (2007) about the business, addressing its size, type, (e.g. franchise vs. independent, retail vs. wholesale), and purchasing/growing behaviour. Business size was used as the standard to ensure that a variety of businesses were represented; the goal was have approximately equal representation from both small and large businesses. The remaining business characteristics were included to aid in understanding responses to later questions. The next portion of the interview was also modeled after Burt et al. (2007) and addressed awareness and perceptions of invasive species. Respondents were asked if they were familiar with invasive species, and to indicate the amount to which they agreed with several statements on a five-point Likert scale. These statements addressed the impact of invasive species, the role of the horticulture trade in invasive species introductions and the acceptability of garden centres and nurseries selling species known to be invasive. The next question asked them to define “invasive species.” The final portion of the interview addressed the voluntary initiatives. Respondents were asked if they were familiar with any initiatives and if so, to describe them. Next they were asked if their business had ever considered implementing any initiatives and if so, to describe them. At this point internal and external motivating factors were examined, specifically:

- potential government regulations
- customer demand

- competing with other garden centres/nurseries
- creating a “green” business image
- pressure from other industry professionals
- pressure from employees, a sense of personal responsibility
- pressure from community groups.

Respondents were asked to indicate the amount of pressure they currently felt to participate in voluntary initiatives from each factor. Responses were ranked on a scale of 1 to 5, with 1 being no pressure and 5 being significant pressure. Questions found in Burt et al. (2007) about current levels of participation using the St. Louis Voluntary Codes of Conduct were replicated to facilitate comparison. Respondents were asked to indicate if they have participated in each initiative and, if not, would they participate. Respondents were then given the same list of internal and external motivating factors as earlier in the interview and asked to indicate the amount that each factor would motivate them to participate in voluntary initiatives in the future; the options were low, moderate or high. The interview finished with two open ended questions addressing any possible motivating factors that were not included in the interview and if they had any additional comments about any part of the interview. The entire interview generally took about 10-15 minutes to complete. Interviews were recorded and transcribed for analysis.

3.1.3 Data Analysis

Simple percentages were used to analyse current perceptions about invasive species and current participation rates to facilitate comparison between the results from my study and those from Burt et al. (2007). I compared the percentage of industry professionals who indicated that they

are already participating in specific initiatives. I did not compare the percentage of respondents who indicated they would participate. If I looked only at these responses, it would be impossible to know if a low value was because there was a large proportion of respondents that are already participating, or because they were not interested. To compensate, I compared an overall “openness to participation”. To calculate overall “openness to participation”, I added the percentages of responses indicating that an industry professional is already participating with the percentage of respondents indicating that they would participate. This value allowed me to more accurately compare the percentage of respondents at each location who would be willing to participate in specific initiatives.

A weighted mean was used to understand the amount of current pressure from each factor. It was calculated as:

$$\text{Mean} = [1f_1 + 2f_2 + 3f_3 + 4f_4 + 5f_5]/n$$

where f_n represents the frequency of responses for each value on the Likert scale and n represents the total number of responses. Responses of “not applicable” or “not sure” were not included in the weighted mean. These weighted means allowed us to determine how much pressure was being felt from each source by the group of respondents as a whole. To determine if there were any significant differences between the sources of pressure, I completed an ANOVA followed by a Tukey-Kramer HSD test using JMP Version 9 (SAS Institute Inc. 2010).

3.2 Results

I contacted garden centres until I had the target of 30 interviews. I was able to successfully reach an acceptable respondent at 52 of the 66 garden centres I attempted to contact. Of those 52 industry professionals, 33 agreed to participate but only 30 interviews were completed due to

scheduling conflicts or technical difficulties. This was a response rate of 57%. This was lower than the 73% response rate of Burt et al. (2007). The centres were distributed across southern Ontario: North to South from Keswick, to Stoney Creek and East to West from St. Jacobs to Kingston.

Questions addressing information about the individual found that job commonly included manager, owner, president, vice-president, etc. When asked what their primary duties were, many respondents replied with “everything” and qualified that as including advertising, administrative work, buying, selling, customer service, landscape design, labelling, signage, dealing with personnel. 83% of respondents had held their current position for more than 5 years and approximately 1/3 had been in their current position for greater than 25 years.

Moving from individual to business characteristics, two thirds of garden centres indicated that they grow some of the plants they sell. Addressing the portion of plant stock that is not grown in house, 57% of garden centres indicated that they purchase some plant material from suppliers outside of Canada. However, the majority of those indicated that plants purchased from outside of Canada made up less than 15% of their stock. Other business characteristics investigated included participating in industry groups; 80% of the garden centres interviewed were members of various industry associations. It is important to note that these results may be biased because the Landscape Ontario website was used to locate potential respondents. This was also evident when investigating which industry associations businesses commonly belonged to; many were Landscape Ontario members. Other industry associations commonly mentioned were the Canadian National Landscape Association (CNLA), Flowers Canada, and the Ontario Association of Landscape Architects (OALA).

The next questions addressed awareness of invasive species and perceptions on issues surrounding them. All but one respondent indicated that he/she was familiar with invasive species. When asked to define “invasive species”, most respondents (90%) were able to identify at least one aspect of a correct invasive species definition: non-native, spread, or negative impact to surrounding systems (Richardson et al. 2000; Ricciardi and Cohen 2007). While many respondents (46.7%) were able to identify two of these characteristics, only one respondent identified all three of them. In terms of perceptions of invasive species, 83% and 80% of respondents, respectively, agreed that invasive plants damage native species and are an important environmental concern; however, only 60% believed that the horticulture industry plays a role in the introduction of invasive species. These results are compared with those from Burt et al. (2007) in Figure 2; responses from southern Ontario are presented in black and responses from the San Francisco Bay area are presented in grey.

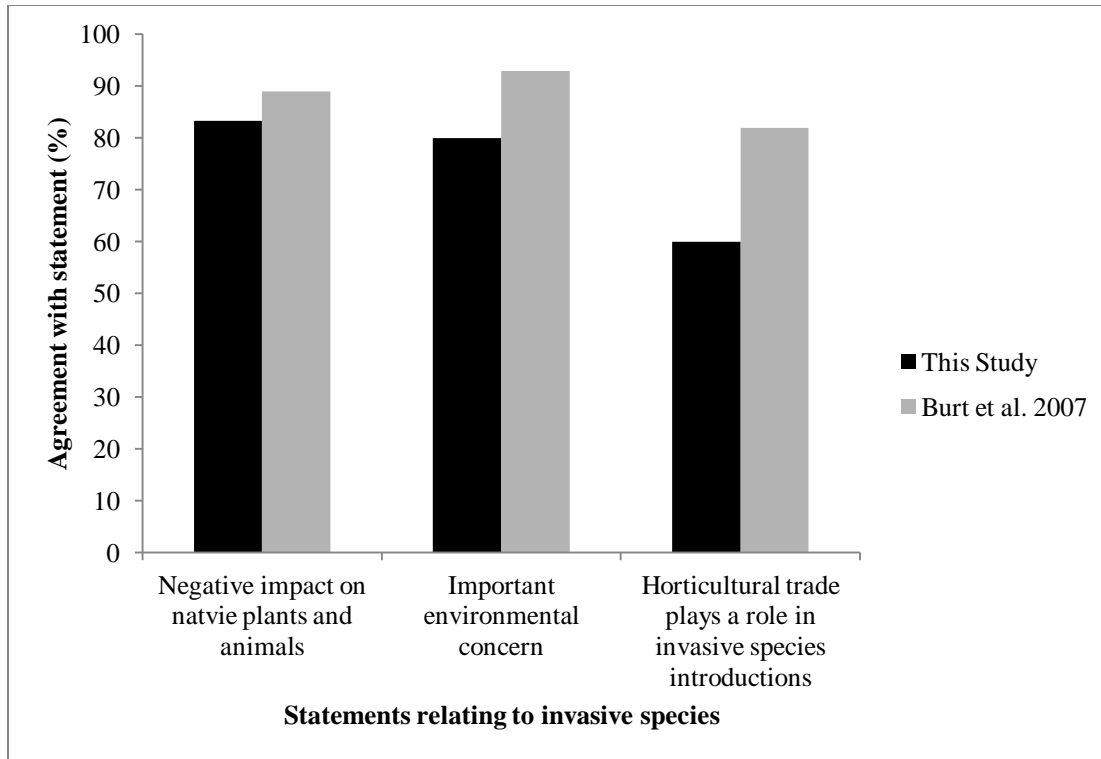


Figure 2: Comparison of respondents’ perceptions of invasive species between this study and Burt et al. 2007. Percent agreeing with each statement are presented in black from this study and grey from Burt et al. (2007).

Agreement was higher from respondents in the San Francisco Bay area than those in southern Ontario for all statements. Additionally, one third of respondents from southern Ontario indicated that it is acceptable to sell species known to be invasive. These results are not compared because the data relating to this statement from the study completed by Burt et al. (2007) was not available.

When asked about voluntary initiatives, only one third of respondents indicated being familiar with specific initiatives to reduce invasive species introductions. The examples they provided included the provision of educational materials for customers, discussions at trade shows, and restricting the sale of certain perennials (e.g., ash and barberry). 36.7% of

respondents indicated that they had considered implementing voluntary initiatives to reduce invasive species introductions. In contrast, 10% of respondents indicated that they do not believe they need to implement any initiatives, as they do not sell any materials that are on the federal or provincial invasive species list.

Of all the specific voluntary initiatives outlined in the St. Louis Declaration, respondents most frequently (40%) indicated that they are already encouraging customers to use non-invasive plants, and others (23%) indicated that they are phasing out those species that scientists/experts or other industry members determine to be invasive. Despite not doing it currently, 50% and 43% of respondents, respectively, said they would interact with experts to determine which species are invasive and which would make good alternatives. Very few (3%) respondents indicated that they would breed alternatives to invasive species because it was not applicable to their business. Responses indicating that they are already participating (black), would participate (grey) and would not participate (light grey) are shown in Figure 3; declined responses and responses of “not applicable” are not included in the figure.

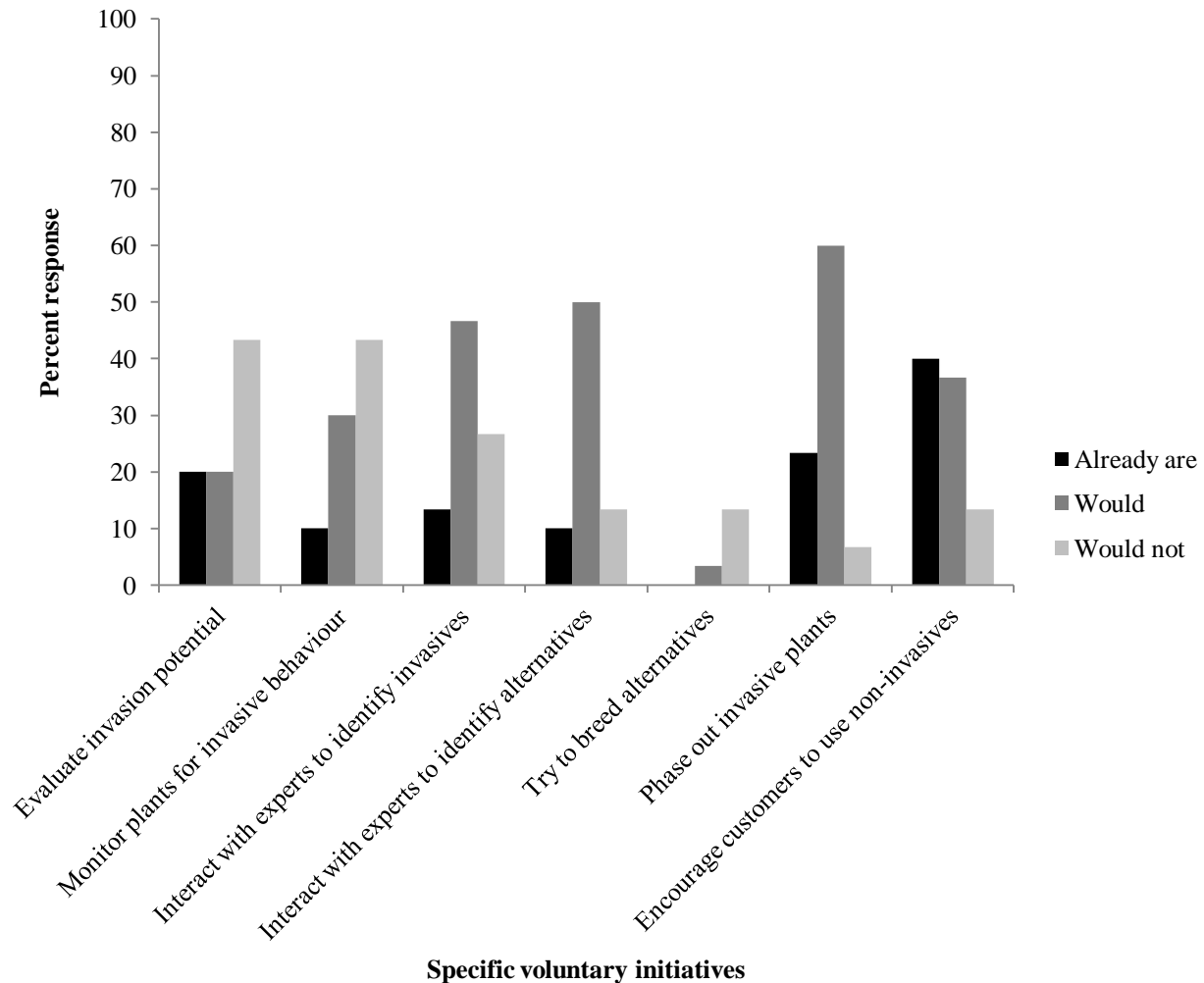


Figure 3: Specific initiatives of the St. Louis Voluntary Codes of Conduct with interview responses indicating if they already are participating or would participate in each initiative. Respondents already participating are depicted in black, those that indicated they would participate are shown in grey and those that indicated they would not participate are shown in light grey. Remaining percentages for each initiative are made up of respondents who declined response, indicated that the initiative was not applicable to their business, or that they weren't sure.

Making a comparison between this study and the study conducted by Burt et al. (2007), it is clear that San Francisco Bay area is ahead of southern Ontario in both current participation and overall openness to participate. Current participation rates are presented in Figure 4; participation

was lower in southern Ontario (black) than in the San Francisco Bay area (grey) for every specific initiative of the St. Louis Declaration.

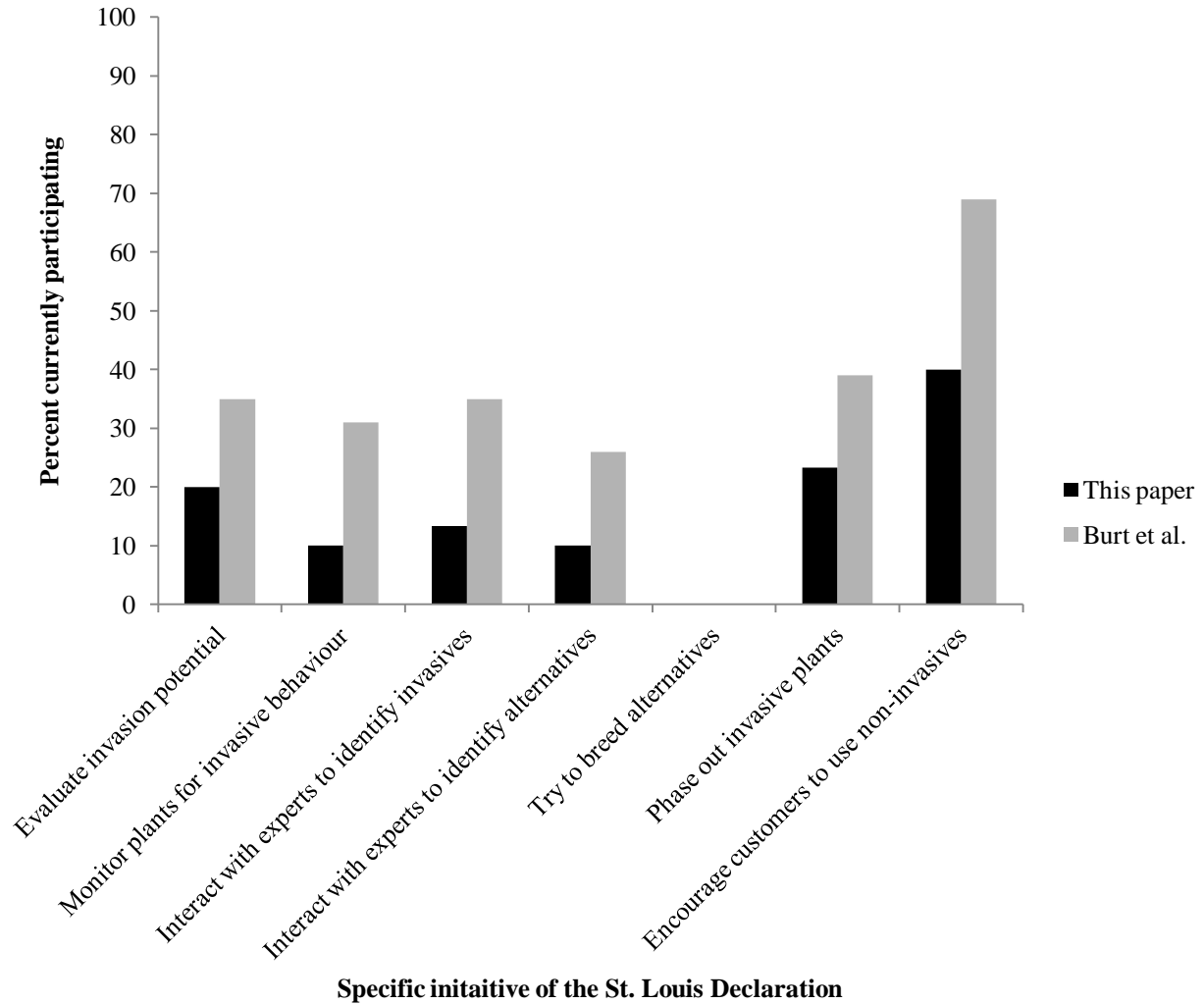


Figure 4: Comparison of industry professionals already participating in specific initiatives. Respondents from southern Ontario are presented in black and respondents from the San Francisco Bay area are presented in grey.

Total “openness to participate” is presented in Figure 5, again industry professionals from southern Ontario (black) demonstrated overall lower “openness to participate” for every initiative than industry professionals from the San Francisco Bay area (grey).

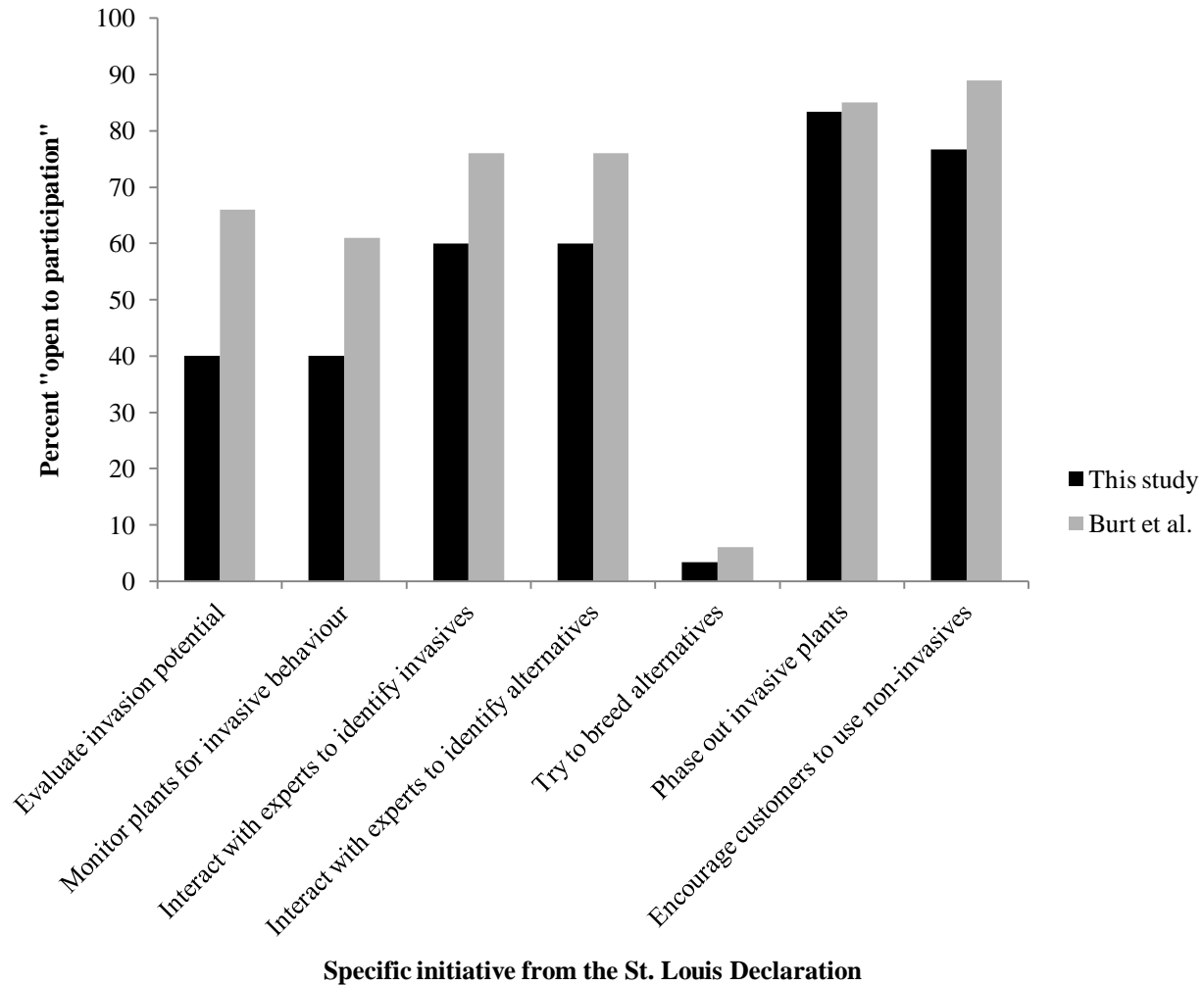


Figure 5: Comparison of "openness to participation" for each specific initiative of the St. Louis Declaration. Openness to participate is the sum percentage of respondents who indicated they “already are” or “would” participate. Respondents from southern Ontario are represented in black and respondents from the San Francisco Bay area are represented in grey.

To help explain current participation behaviour in southern Ontario, I looked to the current levels of internal and external pressure being applied to industry professionals. Results revealed that respondents are feeling the most pressure to participate in voluntary initiatives from a sense of personal responsibility, and creating a green business image (Table 4). The mean response for government regulations (3.2) and consumer pressure (2.9), were intermediate, likely because the frequency of responses for each level of pressure were approximately equal. Respondents indicated feeling less pressure from community groups, from competing nurseries and from other industry professionals; the least amount of pressure was felt from employees. In general, respondents are not feeling significant pressure from any source, internal or external, as the highest mean indicates just slightly more than intermediate pressure (Table 4).

Table 4: Weighted mean of interview responses indicating the amount of pressure currently felt from each internal or external source. Sample sizes ranged from 27-30 (depending on number of declined or “not sure” responses, and standard errors ranged from 0.23-0.27).

Pressure Sources	Mean (+/- SE)
Sense of personal responsibility	3.4
Creating a green business image	3.3
Government Regulations	3.2
Consumer pressure	2.9
Competing nurseries are participating	2.5
Pressure from community groups	2.4
Pressure from other industry professionals	2.4
Pressure from employees	2.1

The results of the ANOVA ($F_{7,23} = 3.60, p < 0.001$) and Tukey-Kramer HSD test ($p < 0.05$) indicated that pressure being felt from a sense of personal responsibility and from creating a green business image were significantly higher than pressure from employees. There were no significant differences in the level of pressure being felt among any of the other pressures sources.

Responses indicate that future participation in voluntary initiatives would be most strongly influenced by: creating a green business image, consumer pressure, a sense of personal responsibility and pressure from community groups. Pressure from competing nurseries would be an intermediate pressure source for future participation. The least motivating factor in the future was cited as pressure from employees (Table 5).

Table 5: Industry professional indications on each factor’s influence on future participation.

Pressure Source	Influence on future participation (%)		
	Low	Moderate	High
Creating a green business image	16.7	16.7	60
Consumer pressure	13.3	40	43.3
Sense of personal responsibility	13.3	40	40
Pressure from community groups	20.0	36.6	36.7
Competing nurseries are participating	20.0	40.0	33.3
Government Regulations	33.3	33.3	26.7
Pressure from other industry professionals	33.3	36.7	23.3
Pressure from employees	50.0	36.7	6.7

3.3 Discussion

Based on the job titles and descriptions of duties provided by the respondents, I determined that in all cases I was speaking to an acceptable person in each garden centre. All of the respondents had at least some role in the decision making process of their business and were therefore equipped to answer the interview questions.

Overall, awareness of invasive species was very high. Interviewees were familiar with invasive species and able to provide at least a partially accurate definition. Furthermore, the majority of respondents agreed that invasive species can have a negative impact on native species and that they are an important environmental concern. Fewer respondents agreed that the

horticultural industry played a role in the introduction of invasive species. Compared to the results from Burt and colleagues (2007), levels of concern from industry members in southern Ontario were lower than those in the San Francisco Bay area. The differences in the level of agreement that invasive species can have a negative impact on native species were small; there was a slightly larger discrepancy in the percentage that agreed that invasive species were an important environmental concern. Most notably was the difference in agreement that the horticultural industry plays a role in the introduction of invasive species; only 60% of Ontario industry members agree with the previous statement vs. 82% of San Francisco Bay area industry professionals. It is possible that more respondents from the San Francisco Bay area are in agreement with the previous statements because the region is known for its environmental activism (Burt et al. 2007). Perhaps this vocal environmental movement has communicated the possible impacts of horticultural invasive species more effectively to industry professionals in the San Francisco Bay area than information is being communicated to industry professionals in southern Ontario.

That almost half of the horticultural industry professionals interviewed from southern Ontario do not agree that the industry plays a role in invasive species introductions can have serious implications for the success of voluntary initiatives. If industry members do not believe in, or acknowledge their roles, or influence, their awareness and concern may not translate into participation. If they do not feel it is their responsibility, they may not be willing to alter their current business practices. Additionally, one-third of all respondents indicated that they believe it to be acceptable to sell species known to be invasive. This response further suggests that industry professionals may be resistant to participation in voluntary initiatives. In fact, several respondents indicated that they were not selling invasive species because they were not selling

any that have been banned in Ontario or Canada; all the species they sell are considered “acceptable” garden species. Before any voluntary initiatives could be successful, regardless of what factors are providing influence, it will be necessary for the industry to acknowledge that while not officially on federal or provincial invasive species lists, some acceptable horticultural species display invasive tendencies and can become problematic if they escape into natural areas.

Currently, respondents indicated feeling the most pressure from first, a sense of personal responsibility and second, the desire to create a green business image. As I expected, an internal pressure, namely that resulting from a sense of personal responsibility, was one of the most important motivating factors. Creating a green business image was less expected as it is an external pressure, but is somewhat unsurprising, as there is growing customer demand for environmentally friendly products (Yue et al. 2009). These two pressure sources were also determined to be important by Burt and colleagues (2007).

The third source of pressure, pressure from a threat of government legislation, was indicated as being more influential than expected. While the distribution of responses was almost equal across all levels (1-5), 40% of respondents ranked pressure from potential government regulations on the higher end of the scale (a 4 or 5). Aside from the fact that it is an external pressure, as previously discussed, there is little evidence of any impending threat of regulation. One participant likened this type of voluntary initiative to the recent pesticide ban in Ontario and indicated that most industry members who were involved had a poor experience with the negotiations. Perhaps due to this prior experience, some industry professionals are concerned that the government would impose similar regulations on the sale of invasive species.

The next greatest sources of pressure were indicated to be: consumer pressure, pressure from competing nurseries, and, pressure from community groups. Pressure from other industry professionals and pressure from employees were considered less often/important. Only pressure from a sense of personal responsibility and a desire to create a green business image were significantly more important than pressure from employees. The fact that there were not significant differences in the levels of pressure currently felt among any of the other factors suggests that most factors are equally influencing participation. This result contradicts my expectations as there were no differences between internal and external pressure sources. However, since none of the factors were identified as high pressure sources, there is potentially some room for increased motivation in the future.

In terms of current participation, only 37% of respondents indicated that they had generally considered implementing voluntary initiatives within their business to reduce invasive species introductions; however, when asked about specific initiatives from the St. Louis Declaration, 50% of respondents indicated that they are already participating in at least one specific initiative. Again, this result is much lower than the participation rates found in the San Francisco Bay area; Burt and colleagues determined that 83% of their respondents were already participating in at least one specific initiative. Initially, I suspected that this difference in participation rates may be due to a higher level of familiarity with the St. Louis Declaration of the respondents from the San Francisco Bay area; none of the respondents from southern Ontario mentioned the St. Louis Declaration when asked if they were familiar with any initiatives to prevent invasive species introductions. However, Burt and colleagues (2007) indicated that only 7% of respondents had heard of the St. Louis Voluntary Codes of Conduct. That level of

familiarity would not account for the difference in participation rates that is observed; there are likely other factors involved.

In Ontario, the participation level presents some reasons for optimism. The fact that some garden centres are unknowingly participating indicates that information about what is involved in participating in voluntary programs is not being effectively communicated to industry professionals. More familiarity with voluntary initiatives may help them find ways to achieve invasive species prevention without loss of revenue. Many respondents who are not already participating indicated that they would be open to participating in at least some of the specific initiatives, suggesting that if more owners and managers were aware of them, participation rates may increase. Businesses must be aware of the initiatives they are participating in to effectively communicate these actions to the customer as part of creating a green business image. Knowing that creating a green business image is important to industry professionals, effective communication is paramount to the success of these voluntary programs.

Looking more specifically at each individual initiative also provides insight into where efforts should be focused. No respondents indicated that they are trying to breed alternatives to invasive species; this is unsurprising because no respondents indicated that their business engages in plant breeding. 43% of respondents said they would not evaluate species for invasive potential or monitor plants to determine if they would become invasive. Several respondents indicated that these types of responsibilities fall more with the growers and are not generally within the work done in a garden centre. To achieve success in these areas, efforts should be made to work with breeders and growers. Initiatives that were generally more acceptable to owners and managers included i) interacting with experts to have a better understanding of the invasive potential of their plants and finding alternatives to invasive species, ii) encouraging

customers to choose non-invasive plants, and iii) phasing out plants that are indicated to be invasive. Working with experts could help the industry reach a consensus on what is considered invasive and would increase the level of success of voluntary initiatives. If garden centres only phase out plants that appear on federal or provincial invasive lists, it is unlikely that this would result in a large impact in the number of horticultural invasive species introductions.

Collaborative efforts with experts would not only identify invasive species to target with initiatives, but also identify non-invasive species that could replace them, thus preventing any loss of revenue through phasing out invasive species. Overall, it seems that despite not currently feeling high levels of internal or external pressure to participate, many industry professionals are at least open to the idea of implementing some of the specific initiatives.

Looking to the future, respondents indicated that sources that would be the most influential to participation were consumer demand, creating a green business image, a sense of personal responsibility, and pressure from community groups. To increase pressure levels from the external factors (consumer demand, creating a green business image and pressure from community groups), public education could be an effective strategy. This education may raise awareness among community groups and cause them to apply pressure. With this increase in public concern about invasive species, businesses will strive even harder to create a green business image. This overall increase in external pressure would likely compel higher levels of participation in voluntary initiatives.

To increase internal pressure, industry professionals must feel an increased sense of personal responsibility. While this factor was identified as applying more pressure than other factors at the present time, it was still only intermediate. Some industry professionals indicated feeling significant pressure from a sense of personal responsibility, however, others indicated

feeling none. This result may be due to the fact that some respondents do not believe the horticultural industry plays a role in the introduction of invasive species. Perhaps trade organizations could aim to address issues of horticultural invasions with their members and therefore increase the overall sense of personal responsibility to prevent future introductions. Any increase in a feeling of personal responsibility would likely increase the likelihood of participation in voluntary initiatives.

3.4 Conclusions

An interesting outcome of this study is the observation that participation and overall “openness to participation” is lower in southern Ontario than in the San Francisco Bay area for every initiative within the St. Louis Declaration. Recall that Burt and colleagues (2007) concluded that awareness of the problems associated with invasive species was a major factor in participation rates. The respondents from the study by Burt et al. (2007) demonstrated higher awareness levels than respondents from this study; this could provide some explanation for the difference in current participation rates and overall “openness to participate” between respondents from southern Ontario and those from the San Francisco Bay area.

Another possible explanation for the higher levels of participation in the San Francisco Bay area is the environmental activism within the study region (Burt et al. 2007). Perhaps this vocal environmental movement has increased a sense of personal responsibility among industry professionals and raised consumer awareness, therefore putting higher pressure on businesses to behave in ways that create a green business image. These two motivating factors were found to be important in both the study conducted by Burt et al. (2007) and in this study. A stronger

environmental movement is one theory to explain the higher rates of participation in San Francisco but there are likely other factors involved that should be investigated.

Focusing specifically on southern Ontario, the results of this study do suggest there are some reasons to be optimistic about the potential success of future initiatives. In particular, participation rates in voluntary initiatives are higher than originally anticipated and often done informally, as no respondents indicated being familiar with the St. Louis Declaration. This informal participation suggests that if a formal program, like the St. Louis Declaration, became more widely recognized, many industry professionals would be prepared to participate. With increased pressure from key sources, industry professionals would likely be even more willing to participate.

This study found that the differences between the amount of influence currently being felt from internal and external factors were not significant, which was contrary to the expected results. Additionally, the mean influence for all factors studied was no higher than intermediate, which indicates that there are opportunities for growth. Efforts should be made to target both internal and external pressure sources to increase future participation rates; in particular, respondents indicated that significant motivating factors will be creating a green business image, consumer pressure, a sense of personal responsibility and pressure from community groups. By increasing the amount of pressure felt by industry professionals from these key sources, it increases the likelihood of success of future initiatives.

Before there can be industry wide success in southern Ontario, however, there are several potential barriers to future success that may need to be overcome. This study identified that some industry professionals only consider those species that appear on federal or provincial lists

invasive. They believe that as long as a plant is an accepted horticultural species, regardless of if it displays invasive tendencies, it is acceptable to sell. Furthermore, the fact that almost half of the industry professionals interviewed did not believe that the horticultural industry plays a role in the introduction of invasive species is another potential roadblock. Industry professionals will not feel the need to participate in voluntary initiatives now or in the future because they do not feel they are contributing to a problem.

In addition to an interesting contrast between voluntary behaviour of industry professionals in southern Ontario and the San Francisco Bay area, these results offer some excellent insights into the current and future state of participation in voluntary initiatives throughout southern Ontario. Based on the outcomes of this study, the following recommendations can be made:

- 1) To better understand the differences found between San Francisco and southern Ontario, I recommend a large-scale, standardized study looking at participation rates and motivating factors in many Canadian and American areas. Without standardization, one can only speculate as to the reasons behind differences observed. A large scale study would locate areas where voluntary initiatives are currently more successful. Analysis could be aimed to understand similarities between areas of high participation rates and make recommendations on how to apply effective strategies elsewhere.
- 2) The openness to work with experts suggests that trade associations might be an excellent way to disseminate information about invasive horticultural species and voluntary initiatives to avoid their introductions, especially since almost all the garden centres interviewed are already members of at least one industry association. Ontario Ministry of

Natural Resources plans to strengthen ties with the Ontario Horticultural Association in order to more effectively disseminate information about invasive species (Government of Ontario 2011). The Ontario Horticultural Association could then pass that information onto its members, thus reaching a large and appropriate audience. One respondent indicated that there is very little information readily available on which species are invasive and should be avoided. Because industry professionals are not currently willing or able to make these observations themselves, it is important that there are ample opportunities to interact with experts. Furthermore, as most respondents indicated being open to phasing out invasive species and encouraging their customers to use non-invasive plants, it is critical that they are getting the most current information. Greater understanding of voluntary initiatives would allow many industry professionals who are already unknowingly participating to capitalize on their eco-friendly behaviour by communicating it to the public, thus aiding in the creation of a green business image. Additionally, increased knowledge may lead to a greater sense of personal responsibility; industry professionals may find it more difficult to do nothing once they have more awareness about specific invasive species and the options available to reduce introductions.

- 3) Efforts must be made to increase public desire to purchase non-invasive species and encourage community groups to become more vocal. Public awareness campaigns could be effective in motivating community groups to encourage better practices from industry professionals. In response to community groups raising pressure levels, industry professionals may feel an increased desire to portray a green business image. For these reasons, public education should be pursued. However, evidence suggests that awareness

does not necessarily translate in to preference for non-invasive species (Chapter 2); therefore public awareness campaigns must be run in combination with other strategies to shift customer demand. An example of an alternative strategy could be encouraging writers from popular garden magazines/blogs to endorse non-invasive species (Baskin 2002).

Voluntary initiatives do not appear to be widely successful in southern Ontario at the current time. However, this study found that there is certainly potential for the future. Efforts should be aimed to increase pressure from both internal and external sources. By these findings and incorporating the recommendations into future efforts, it is possible that industry-wide voluntary initiatives could become more effective and lead to reductions in invasive species introductions.

4.0 CONCLUSIONS

This study challenges the assumption that voluntary initiatives will be effective in reducing horticultural invasive species introductions. By surveying two key groups to the horticultural industry, gardeners and plant retailers, I was able to gain insights into the voluntary initiatives' current and future likelihood of success.

The thesis results indicate that the current voluntary efforts to reduce horticultural invasive species introductions are not as effective as they could be. Chapter 3 demonstrated that southern Ontario industry members have lower rates of participation voluntary initiatives compared to other areas, specifically the San Francisco Bay area. While this difference in adoption levels could be due to many factors, for example differences in the level of environmental activism within the regions, it inspires deeper investigation into the differences between American and Canadian industry attitudes about invasive species reduction. The St. Louis Voluntary Codes of Conduct have been identified as the most widely known industry initiative to reduce invasive species introductions (Burt et al. 2007). This set of codes is endorsed by dozens of American industry associations, including the American Nursery and Landscape Association (Center for Plant Conservation 2012). As far as Canadian endorsements, the St. Louis Codes of Conduct were referenced by the Invasive Plant Council of BC (Invasive Plant Council of British Columbia 2007), but I could not find evidence of widespread endorsements of these or other industry-wide voluntary initiatives. Within Ontario, the Ontario Invasive Plant Council presents the "Grow Me Instead" guides to combat invasive species introductions but as discovered in Chapter 2, these initiatives might not be sufficient. Through searching within Invasive Plant Councils and the industry associations that participants indicated being members of, I did not find evidence of a standard set of codes of conduct similar to the St. Louis Voluntary Codes of

Conduct.

Therefore, a first step in increasing participation in voluntary initiatives within Ontario would be the development of a standardized provincial or national set of codes of conduct. The *Ontario Invasive Species Strategic Plan* identifies the need to work with municipalities, industry, partners, and user groups to develop best management practices (BMPs) for horticultural practices (Government of Ontario 2011). Voluntary codes of conduct could be included within these BMPs. Perhaps the St. Louis Voluntary Codes of Conduct are sufficient, or perhaps Ontario industry members would prefer to have more input into the development. These efforts to work with a variety of stakeholders could be initiated by industry organizations, perhaps the CNLA, Landscape Ontario, the Ontario Horticultural Association or as a collaborative effort involving several industry organizations. Through developing a set of codes of conduct or using the St. Louis Declaration as acceptable codes of conduct, a standard would be set for all Ontario (or Canadian) garden centres. Standardization would facilitate communication of responsible retailer behaviour through industry associations. It would also make it easier for plant retailers to communicate their behaviour to the public: if the codes of conduct became public knowledge, retailers could advertise their participation, thus contributing to their green business image. Additionally, if gardeners are able to observe the collaborative effort of plant retailers, they may be encouraged to take invasive characteristics into their plant purchasing. Seeing the industry lead by example may encourage gardeners to shift their preferences to non-invasive species. A standard set of codes could impact behaviour at both the plant retailers and gardener level and will likely result in a larger reduction of invasive species introductions than continuing with the status-quo.

In the absence of an industry-wide initiative, individual garden centres/nurseries are left to

develop their own initiatives. These cases of individual participation may be enough to prevent future government regulations therefore benefiting the whole industry and creating the potential for “free-riders” – businesses that reap all the benefits but do not assume any of the costs (Koehler 2007). For example, if a garden centre chooses to participate in an initiative such as phasing out an invasive plant, customers who desire said plant may seek it out at a different plant retailer, resulting in a loss of business for the participating garden centre. Additionally, if enough garden centres continue selling and promoting invasive species, the propagule pressure of certain invasive species might remain high enough that they invade natural lands regardless of efforts taken on by other garden centres. For these reasons, it is critical that industry professionals agree on which species are invasive and work towards developing industry wide agreements.

A critical barrier to participation in voluntary initiatives of particular importance to garden centres in Ontario is the memory of the negotiation process for the pesticide ban. As briefly mentioned, one owner expressed that many industry professionals were left with a “sour taste in their mouth” after participating in the efforts to reduce the use of pesticides. This owner also expressed that it will likely be difficult to find industry professionals willing to participate in voluntary initiatives to reduce invasive species because of the poor experience they had when working with environmental groups and governments on that initiative as many industry professionals experienced financial losses. This owner indicated that other industry professionals will likely be hesitant to participate in any campaigns they feel might result in further losses. Any individuals aiming to work with the industry in attempts to develop industry-wide voluntary initiatives must be cognisant of the fact that there will be mistrust and strive to gain the confidence of industry professionals in order to develop successful campaigns.

Industry-wide agreements must be run in concert with other publicly targeted initiatives

such as the “Grow Me Instead” and other alternative promotion programs. Unfortunately, the study results indicated that gardeners are still drawn to plant species that display invasive characteristics despite the fact that they believe they should behave in ways that reduce the possibility of invasions. This calls into question the effectiveness of the program in its current form. Some alternative species guides, such as the one put out by the Credit Valley Conservation Authority, identify natives as the best alternatives. The OIPC “Grow Me Instead” guide includes both native and non-native alternatives. However, of the alternatives presented for invasive ground covers, which were the focus of Chapter 2, most were native. One industry professional indicated that the results of native species being planted in urban environments have shown that they do not perform as well as the exotics that have traditionally been used. It is perhaps for this reason that despite the fact that gardeners indicated that they prefer native over non-native characteristics, industry professionals interviewed stated that there has been no increase in sales of native plant species. Additionally, some interviewees called into question the availability of adequate alternatives. One industry member stated, “In the absence of species that act in a suitable manner, [garden centres and nurseries] continue to use [invasive species] primarily because there are no alternatives.” To make alternative species promotion campaigns more effective, the focus should be less on native species only, and more on finding non-invasive alternatives that will thrive in urban environments.

4.1 Reasons for Optimism

This study did identify some reasons to be optimistic about the future of voluntary initiatives in southern Ontario. Firstly, awareness at both the gardener and industry professional level was very high and many gardeners indicated that they first learned about invasive species from garden centres/nurseries, suggesting that plant retailers are already taking part in consumer

education. For those that learned about invasive species elsewhere, it seems that public education campaigns are effectively communicating this information. Furthermore, many gardeners indicated that they believe they should behave in ways to reduce invasive species introductions. While currently their plant preferences still lean toward more invasive species, that belief shows a potential willingness to change their behaviour if they are shown how to do so. As for industry members, participation rates in specific voluntary initiatives are higher than expected. Many garden centres and nurseries are already taking actions to prevent invasive species introductions on an informal basis. With a more comprehensive, provincial or national industry-wide initiative perhaps industry members will agree to participate.

4.2 Application of Theory

To further understand these results, one can look to environmental psychology theory, and social psychology theory. These fields can aid in the understanding the disconnect between customer beliefs and behaviour as well as understanding how plant retailers' sense of responsibility in the role of invasive species introductions will impact their decisions to participate in voluntary initiatives. Additionally, theories from the field of social marketing can aid in understanding how marketing can impact purchasing decisions related to ecologically beneficial behaviour and how to develop future educational campaigns which will effectively target behaviours that results in invasive species introduction.

Environmental behaviour is generally considered to be prosocial (Kaiser & Shimoda, 1999), which means that behaving in an ecologically advantageous way is beneficial to society (Stürmer & Snyder, 2010). In the case of this thesis, prosocial behaviour would be gardeners purchasing less invasive species and plant retailers participating in voluntary initiatives to reduce

invasive species introductions. Environmental prosocial behaviour is thought to be unique from other types of prosocial behaviour because there are often no direct benefits to the individual (De Groot and Steg, 2009). By understanding how and when prosocial behaviour occurs, one can attempt to influence citizens to engage in these types of activities.

Encouraging behavioural changes is most effective when one follows the “DO IT” process (Geller, 2002). First, one must “DEFINE” which specific behaviours should be targeted (Geller, 2002; Steg and Vlek, 2009). In the case of this thesis, behaviours to be changed at the gardener level would include purchasing and planting invasive species. At the plant retailer level, the targeted behaviour would be selling and distributing invasive plant material.

The second step in the process is to “OBSERVE” (Geller, 2002). Efforts should be taken to understand the factors that cause behaviours that are targeted to be changed (Geller, 2002; Steg and Vlek, 2009). Understanding the factors that cause gardeners to purchase invasive species could be the focus of a future study. Because I did not design my study to try to understand what influences gardeners to purchase invasive species, I can merely speculate as to the causes. One possible explanation is that invasive species fulfill their garden’s needs and tend to require less effort than non-invasive species. Also, it is possible that gardeners continue to buy invasive species because they are popular and proven favourites. Further studies should also be designed to comprehensively understand what influences retailers to continue to sell and distribute invasive plant material. I was, however, able to gain some insights into this behaviour based on the telephone interviews I completed. Some industry professionals indicated that their primary goal is to make a profit and felt that removing invasive species may result in a financial loss. The study completed by Burt et al. (2007) identified some reasons for continuing to distribute invasive plant material through a lack of participation in voluntary initiatives. These reasons

included a lack of information about voluntary initiatives, as well as feelings that participation in these types of initiatives would be too time consuming. There are likely other factors involved, and influences on Ontario retailers may be different than those in the San Francisco Bay area. For this reason, it is important that further studies are completed.

The step in the process is to “INTERVENE” (Geller, 2002). One must apply targeted initiatives to change the relevant behaviour and its antecedents (Geller, 2002; Steg and Vlek, 2009). This thesis addresses two targeted initiatives that are already in place. “Grow Me Instead” guides are an example of a targeted initiative designed to change gardener behaviour and encourage the purchase of non-invasive species. The St. Louis Voluntary Codes of Conduct are an example of initiatives targeted towards industry professionals to encourage less sale and distribution of invasive plant material.

The final step in the process is to “TEST” (Geller, 2002). One must follow up to determine if the initiatives targeting certain behaviours have had an impact on the behaviour itself, the antecedents of the behaviour or on the overall quality of life. If the initiatives have not been widely successful, efforts must be taken to re-evaluate and refine future strategies. (Geller, 2002; Steg and Vlek, 2009). This thesis is an example of this final step, seeking to determine if “Grow Me Instead” campaigns and promotion of the St. Louis Voluntary Codes of Conduct have been successful in changing gardener and retailer behaviour. In the case of this thesis I did identify that these initiatives are not currently as successful as initially hoped therefore identifying that some refining needs to occur.

4.2.1 The Norm Activation Model

When striving to understand prosocial environmental behaviour in order to effectively

design targeted initiatives, one can consult several theories (Vining and Ebreo, 2002). One theory that is commonly used is Schwartz's Norm Activation Model (NAM). This theory helps to explain the differences between reported beliefs and behaviour (Schwartz, 1970; Van Liere and Dunlap, 1978). The NAM suggests that in order for an individual to behave in a way that is environmentally beneficial, preserving the environment must be a personal norm, which is generally a result of two conditions. First, individuals must be aware of the fact that their actions have consequences for other people and the environment. Second, individuals must accept responsibility for their actions and these consequences (Schwartz, 1970; Van Liere and Dunlap, 1978; Kaiser and Shimoda, 1999; Vining and Ebreo, 2002). Kaiser and Shimoda (1999) completed an investigation to further understand the role of responsibility in environmentally prosocial behaviour. They suggest that responsibility can be felt in two ways: as a result of morality or of convention. Responsibility due to morality occurs when the individual feels a sense of welfare or fairness. Responsibility due to convention is a result of traditions, social customs or appealing to authority. The NAM assumes a sense of moral obligation, however, Kaiser and Shimoda (1999) point out that people can feel moral responsibility inherently, or they can ascribe moral responsibility to themselves. Moral responsibility is ascribed when an individual is aware that distress of another person or the environment is caused by an action they intentionally committed based on a decision made with free will (causality, intentionality, freedom of choice). Results of the study by Kaiser and Shimoda (1999) found that in general people feel more moral responsibility than conventional responsibility. Additionally, they found that causality played the largest role in responsibility judgement over intentionality and freedom of choice. Finally they found that ascribed responsibility plays a larger role in environmental behaviour than feelings of inherent responsibility.

This theory is directly applicable to the results of this thesis. The NAM is an excellent theory to apply to the discrepancy between gardener's beliefs relating to invasive species introductions and their indicated plant preferences. Results from the awareness questions showed that generally gardeners believe they should behave in ways that reduce the threat of invasive species introductions, however, the results of the conjoint analysis suggested that they generally prefer species that display invasive characteristics. The NAM would suggest that the reason for this disconnect is because gardeners either are not aware that their purchasing an invasive species has direct consequences for the surrounding environment and people within the community, or gardeners do not accept responsibility for these consequences. In chapter 2, I indicated that I suspect that gardeners do not feel that their actions result in horticultural invasions because they live in urban environments and feel removed from natural areas. If this is the case, it would violate the first assumption of the NAM: the fact that their actions have consequences. I recommend that future research frame the question of gardener behaviour using the NAM. This type of study would allow researchers to understand if lack of behaviour is due to a lack of awareness of consequences or a lack of acceptance of responsibility. The results of such a study would equip researches to better target campaigns to encourage gardeners to purchase less invasive species.

The NAM can also be directly applied to the results of this thesis relating to the participation rates of industry professionals. Recall that in chapter 3, I found that while generally industry professionals indicated that they believe invasive species are an important environmental concern and were aware of issues surrounding invasive species, many did not believe that the horticultural industry played a role in the introduction of invasive species and some indicated that they believe it to be acceptable to sell a species known to be invasive. In this

instance, it appears that the lack of ecological behaviour (participation in voluntary initiatives) is due to a lack of acceptance of responsibility. Again, additional studies which investigate industry professional behaviour regarding participation in voluntary initiatives should be framed using the NAM to determine if this is actually the case. Steg and Vlek (2009) identified that NAM is successful in explaining low-cost behavioural changes. It is possible that participation in voluntary initiatives is perceived by industry professionals as a high-cost behavioural change. Therefore, other theories may be required to assist in the understanding of what encourages these types of environmental prosocial behavioural changes.

4.2.2 The Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) is more effective when the costs of behavioural changes are high (Steg and Vleck, 2009). It is possible that this theory is more appropriate for looking at behavioural changes among industry professionals. This theory is an extension of the Theory of Reasoned Action (TRA), which states that behaviour is determined by: attitudes towards the behaviour and perceived norms (Fishbein and Ajzen, 1975; Steg and Vlek, 2009). The TPB, showing in Figure 6 (Ajzen, 1991), also states that behaviour is due to attitudes towards the behaviour and perceived norms, but adds that behaviour is also due to perceptions of behavioural control (Ajzen, 1991; Steg and Vlek, 2009). Because in many circumstances there are factor's that are beyond one's control, failure to include perceptions of behaviour control in the TRA made predictions of ecological behaviour seem inconsistent. Therefore, the TPB more consistently predicts environmental behaviour (Kaiser et al. 1999).

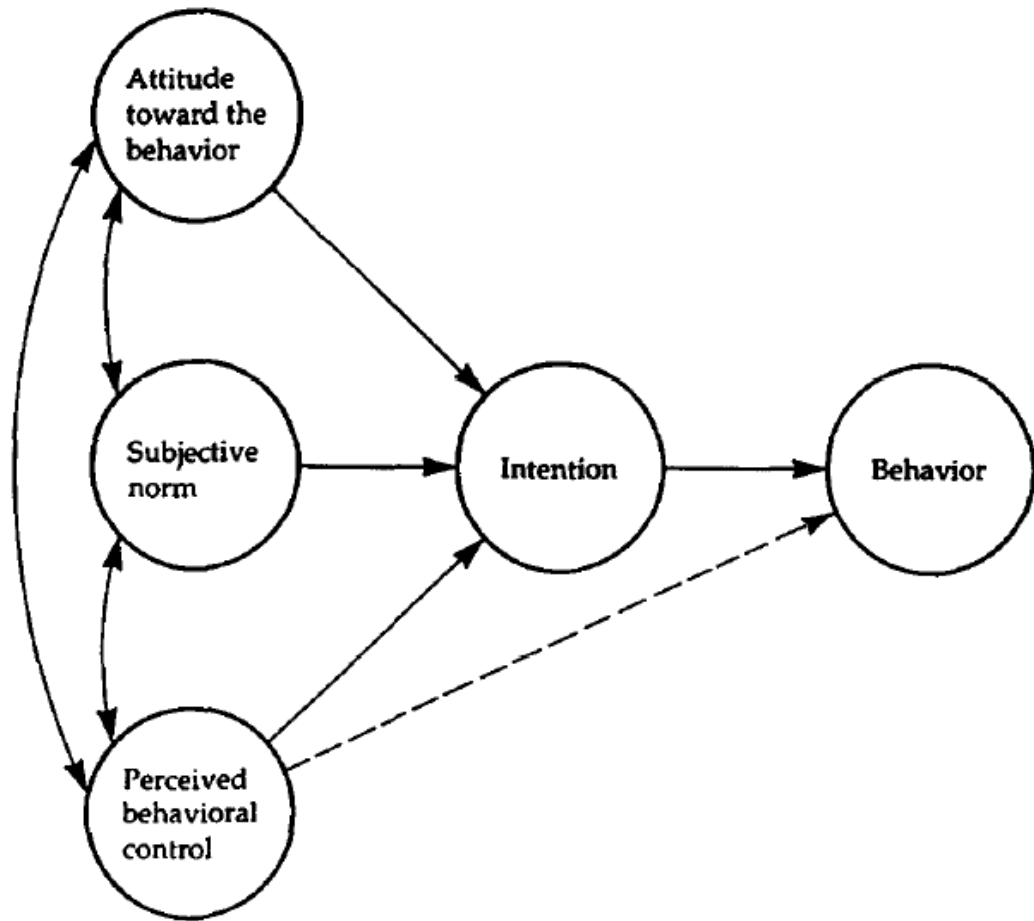


Figure 6: Visual representation of the Theory of Planned Behaviour (TPB) from Ajzen, 1991.

This thesis did provide some insights into overall attitudes towards participation, the perceptions of social norms surrounding voluntary initiatives and the amount of perceived control felt by industry professional. Generally, there seems to be a range of attitudes related to participating in voluntary initiatives. Some industry professionals responded to discussion about preventing invasive species introductions with clear concern and enthusiasm. Others seemed less interested and generally less worried about horticultural invasive species introductions. The results also show some discrepancies in the perceived social norms regarding reducing the sale and distribution of horticultural invasive species. Some industry professionals believed that

selling invasive plants is totally socially acceptable because they are only selling standard horticultural species. Others disagreed and felt that it was not socially acceptable to sell invasive plants. I did not gain much insight into the level of control felt by industry professionals relating to participation in voluntary initiatives. Possible factors that could be outside the control of the plant retailer include customer demand and pricing of non-invasive plant stock. In order to better understand the behaviour of industry professionals, a future study could frame analysis using the TPB.

4.2.3 The Behavioural Perspective Model

The above theories aid in understanding why individuals engage in environmental prosocial behaviour. Theories from social marketing can assist in understanding how to encourage changes in these types of behaviour. In the case of this thesis, one can directly apply social marketing theories to efforts such as encouraging gardeners to choose non-invasive species. The Behavioural Perspective Model (BPM) is useful in analysis of consumer behaviour and can have applications for understanding environmental behaviour (Foxall et al. 2006). The BPM describes purchasing behaviour as a function of consequences; it proposes that consumer behaviour is a result of the behavioural setting and the learning history of the consumer. The behavioural setting refers to factors that communicate potentially different consequences for different purchasing decisions to the consumer. (Foxall et al. 2006). In the case of purchasing invasive species, this could refer to labelling campaigns which indicate cultivar names, if a species is invasive or not, etc. Understanding how the behavioural setting of a garden center or nursery could influence the purchasing decisions of gardeners could aid in the development of successful alternative species promotion campaigns. Evidence of labelling and signage impacting purchasing decisions of gardeners could be used to encourage garden centers and nurseries to

engage in these kinds of activities. The BMP describes the outcomes of consumer behaviour as either informational or utilitarian and identifies that both can be either reinforcing or punishing. Informational consequences are generally socially-driven and can refer to social status or prestige gained or lost by purchasing a specific product. Utilitarian consequences refer to the functionality of the product and the value gained or lost from having purchased it (Foxall et al. 2006). In terms of plant purchases, informational consequences that reinforce purchases could be compliments on a beautiful garden species from neighbours or friends. Informational consequences that could punish a purchasing decision could be scorn from neighbours or friends that notice an invasive species has been purchased. Utilitarian reinforcing consequences could refer to purchasing a garden species that successfully fills the needs of the gardener and provides them with enjoyment; punishing consequences could refer to the amount of work required to prevent an invasive species from taking over a garden. I recommend that future studies build upon the result of this thesis and frame questions through the BPM to further understand gardener purchasing decisions.

Overall, using environmental and social psychology theories as well as theories from social marketing will aid in the promotion of environmental behaviour in regards to preventing invasive species introductions. This thesis identified some areas which need further investigation and using theoretical frameworks would be an excellent strategy to gain insights into effective strategies for the future. The theories discussed here would be excellent starting places to frame future research. Due to the highly integrated relationship between the behaviour of gardeners and plant retailers relating to the reduction of horticultural invasive species introductions, success with one group would likely lead to success with the other. Any insights that could be gained from using theoretical knowledge could be highly valuable for developing future efforts to

reduce horticultural invasive species introductions.

4.3 Benefits of Horticulture

Using the results of this thesis to determine how to reduce the potentially adverse impacts of horticulture is important, as horticulture is both ecologically and culturally significant. For example, as the impacts from climate change become more widespread, ecosystems conditions and therefore plant habitats will begin to shift, possibly becoming uninhabitable for many plant species (Williams et al. 2007). Horticultural activities can help prevent biodiversity loss; by planting species across a wide range, gardeners are aiding in the migration of native plants that may not be able to adapt to changing conditions (Van der Veken et al. 2008). In terms of cultural significance, having horticulture within a community increases community pride, improves economic and social conditions, and provides a comfortable environment in which to live and work (Relf 1992). Clearly the horticultural industry can provide benefits for society; it is for these reasons that understanding the current and future success of voluntary initiatives to reduce invasive species introductions is important.

Overall, this study provided insight into the attitudes, perceptions, behaviours and preferences of the retail side of horticulture. The results identified current barriers to the effectiveness of voluntary initiatives as well as found some reasons for optimism. The relationship between the gardener and the garden centre/nursery can be used to develop successful voluntary initiatives. As customer behaviour changes, external pressures on the industry, such as customer demand and the desire to create green business image, will increase and could lead to increased levels of participation. As plant retailers participate in more initiatives and promote that participation to the customers, customers will learn more about the

importance of avoiding invasive species and come to expect participation from plant retailers. As a result, gardeners and plant retailers would cyclically put pressure on each other to act in more environmentally friendly ways. While voluntary actions to reduce invasive species introductions are not widely successful at the present time, with efforts applied to overcome some of the barriers identified in this study, there is hope that they will become effective in the future.

REFERENCES

- Alberini, A. and K. Segerson. 2002. Assessing voluntary programs to improve environmental quality. *Environmental and Resource Economics* **22**:157-184.
- Alberta Invasive Plants Council. Invasive ornamentals. Alberta Invasive Plants Council, Okotoks, AB. Available from <http://www.invasiveplants.ab.ca/InvasiveOrnamentals.htm> (accessed Sept 2011).
- Ajzen, I. 1991. The theory of planned behavior. *Organizational Behavior and Human Decision Processes* **50**:179-211.
- Bansal, P. and K. Roth. 2000. Why companies go green: a model of ecological responsiveness. *The Academy of Management Journal* **43**:717-736.
- Behe, B., R. Nelson, S. Barton, C. Hall, C. D. Safley, and S. Turner. 1999. Consumer preferences for geranium flower color, leaf variegation, and price. *HortScience* **34**:740-742.
- Burt, J. W., A. A. Muir, J. Piovia-Scott, K. E. Veblen, A. L. Chang, J. D. Grossman, and H. W. Weiskel. 2007. Preventing horticultural introductions of invasive plants: Potential efficacy of voluntary initiatives. *Biological Invasions* **9**:909-923.
- Caley, P., R. H. Groves, and R. Barker. 2008. Estimating the invasion success of introduced plants. *Diversity and Distributions* **14**:196-203.
- Campbell, B. L., R. G. Nelson, W. A. Ebel, J. L. Adrian, and B. R. Hockema. 2004. Fruit quality characteristics that affect consumer preferences for Satsuma mandarins. *HortScience* **39**:1664-1669.
- Center for Plant Conservation. 2012. Current list of endorsements of the voluntary codes of conduct. Missouri Botanic Garden. St. Louis, Missouri. available at: <http://www.centreforplantconservation.org> (accessed January 2012)

- CFIA (Canadian Food Inspection Agency). 2009. Invasive Alien Species Program Evaluation. CFIA Evaluation Committee.
- Colautti, R.I., S.A. Bailey, C. D. A. van Overdijk, K. Amundsen, and H. J. MacIsaac. 2006a. Characterized and projected costs of nonindigenous species in Canada. *Biological Invasions* **8**:45-59.
- Colautti, R. I., I. A. Grigorovich, and H. J. MacIsaac. 2006b. Propagule pressure: a null model for biological invasions. *Biological Invasions* **8**:1023-1037.
- Credit Valley Conservation. 2010. Alternative plants for invasive species (Rev. 2.) [Brochure].
- Darnall, N., I. Henriques, and P. Sadorsky. 2010. Adopting proactive environmental strategy: the influence of stakeholders and firm size. *Journal of Management Studies* **46**:1072-1094.
- Dawson, W., A. S. Mndolwa, D. F. R. P. Burslem, and P. E. Hulme. 2008. Assessing the risks of plant invasions arising from collections in tropical botanical gardens. *Biodiversity and Conservation* **17**:1979-1995.
- De Groot, J. I. M., and L. Steg. 2009. Morality and prosocial behaviour: the role of awareness, responsibility and norms in the Norm Activation Model. *The Journal of Social Psychology* **149**:425-449.
- DeBossu, A. 1988. What do people want to buy? *American Nurseryman* **167**(9):91-96.
- Dehnen-Schmutz, K., J. Touza, C. Perrings, and M. Williamson. 2007. A century of the ornamental plant trade and its impact on invasion success. *Diversity and Distribution* **13**:527-534.
- Drew, J. N. Anderson, and D. Andow. 2010. Conundrums of a complex vector for invasive species control: A detailed examination of the horticultural industry. *Biological Invasions* **12**:2837-2851.

- Dukes, J.S. and H. A. Mooney. 1999. Does global change increase the success of biological invaders? *Trends in Ecology & Evolution* **14**:135-139.
- Ellstrand N.C., and K. A. Schierenbeck. 2000. Hybridization as a stimulus for the evolution of invasiveness in plants? *Proceedings of the National Academy of Sciences*, **97**:7043-7050.
- Fey K. C. (Ed). 2001. Linking ecology and horticulture to prevent plant invasions. *Proceedings of the workshop at the Missouri Botanical Garden, St. Louis, MO, Dec. 1–4, 2001.*
- Fey. K. C. (Ed). 2002. Linking ecology and horticulture to prevent plant invasions. *Proceedings of the meeting at the Chicago Botanic Garden, Chicago, IL, Oct. 31, 2002.*
- Fishbein, M. and I. Ajzen. 1975. *Belief, attitude, intention and behavior: An introduction to theory and research.* Reading, MA: Addison-Wesley.
- Foxall, G. R., J. M. Oliveira-Castro, V. K. James, M. M. Yani-de-Soriano, and V. Sigurdsson. 2006. Consumer behaviour analysis and social marketing: the case of environmental conservation. *Behaviour and Social Issues* **15**:101-124.
- Foxcroft, L. C., D. M. Richardson, and J. R. U. Wilson. 2008. Ornamental plants as invasive aliens: problems and solutions in Kruger National Park, South Africa. *Environmental Management* **41**:32-51.
- Gagliardi, J. A. and M. H. Brand. 2007. Connecticut nursery and landscape industry preferences for solutions to the sale and use of invasive species. *HortTechnology* **17**:39-45.
- Geller, E. S. 2002. The challenge of increasing proenvironmental behavior. Pages 525–540 in R. B. Bechtel, and A. Churchman, editors. *Handbook of Environmental Psychology.* New York: Wiley.
- Gineo, W. M. 1990. A conjoint/logit analysis of nursery stock preferences. *Northeast Journal of Agriculture and Resource Economics* **19**:49-58.

- Government of Canada. 2004. An invasive alien species strategy for Canada. Environment Canada.
- Government of Ontario. 2011. Ontario invasive species strategic plan. Government of Ontario.
- Green, P. E. and V. Srinivasan. 1978. Conjoint analysis in consumer research: issues and outlook. *Journal of Consumer Research* **5**:103-123.
- Green, P. E. and Y. Wind. 1975. New ways to measure consumers' judgements. *Harvard Business Review* July-August 1975: 107-117.
- Haber, E. 2002. Spread and impact of alien plants across Canadian landscapes. Pages 43-57 in R. Claudi, P. Nantel, and E. Muckle-Jeffs (Eds.), *Alien Invaders in Canada's Waters, Wetlands, and Forests*. Ottawa: Canadian Forest Service, Natural Resources Canada
- Hair, J. F., R. E. Anderson, R. L. Tatham, and W. C. Black. 1998. *Multivariate data analysis*. Fifth edition. Prentice Hall, Upper Saddle River, NJ.
- Hair, J. F., W. C. Black, B. J. Babin, R. E. Anderson, and R. L. Tatham. 2006. *Multivariate data analysis*. Sixth edition. Prentice Hall, Upper Saddle River, NJ.
- Hanspach, J., I. Kuehn, P. Pyšek, E. Boos, and S. Klotz. 2008. Correlates of naturalization and occupancy of introduced ornamentals in Germany. *Perspectives in Plant Ecology Evolution and Systematics* **10**:241-250.
- Harrington, R.A., R. Kujawski, and H. D. P. Ryan. 2003. Invasive plants and the green industry. *Journal of Aboriculture* **29**:42-48.
- Head, L., and P. Muir. 2004. Nativeness, invasiveness, and nation in Australian plants. *Geographical Review* **94**:199-217.
- Hejda, M., P. Pyšek, and V. Jarosik. 2009. Impact of invasive plants on the species richness, diversity and composition of invaded communities. *Journal of Ecology*. **97**:393-403.

- Henriques, I. and P. Sadosky. 1996. The determinants of an environmentally responsive firm: an empirical approach. *Journal of Environmental Economics and Management*. **30**:381-395.
- Holdgate, M. W. 1986. Summary and conclusions: characteristics and consequences of biological invasions. *Philosophical Transactions of the Royal Society of London* **314**(1167):733-742.
- Hulme, P. E. 2009. Trade, transport and trouble: Managing invasive species pathways in an era of globalization. *Journal of Applied Ecology* **46**:10-18.
- Invasive Plant Council of British Columbia. 2007. Minimizing the impacts of invasive plants in horticulture. (Report #4) Williams Lake, BC. Invasive Plant Council of British Columbia.
- Invasive Plant Council of British Columbia. 2009. Grow me instead. Beautiful non-invasive plants for your garden [Brochure]
- Invasive Species Council of Manitoba. 2011. Brochures, ISCM's "What not to plant" list for Manitoba gardeners. Invasive Species Council of Manitoba. Winnipeg, MB. Available from <http://www.invasivespeciesmanitoba.com/site/index.php?page=brochures> (accessed Sept 2011).
- Kaiser, F. G., and T. A. Shimoda. 1999. Responsibility as a predictor of ecological behaviour. *Journal of Environmental Psychology* **19**:243-253.
- Kaiser, F. G., S. Wölfling, and U. Fuhrer. 1999. Environmental attitude and ecological behaviour. *Journal of Environmental Psychology* **19**:1-19.
- Kate, T. K. and S. A. Laird. 2000. Biodiversity and business: coming to terms with the 'grand bargain'. *International Affairs* **76**:241-264.
- Koehler, D. A. 2007. The effectiveness of voluntary environmental programs – a policy at a crossroads? *The Policy Studies Journal* **35**:689-722.

- Leung, B., D. M. Lodge, D. Finnoff, J. F. Shogren, M. A. Lewis and G. Lamberti. 2002. An ounce of prevention or a pound of cure: bioeconomic risk analysis of invasive species. *Proceedings of the Royal Society of London Series B-Biological Sciences* **269**:2407-2413.
- Lodge, D. M., et al. 2006. Biological invasions: recommendations for U.S. policy and management. *Ecological Applications* **16**:2035-2054.
- Lonsdale, W. M. 1999. Global patterns of plant invasions and the concept of invisibility. *Ecology* **80**:1522-1536.
- Mack, R. N. 2003. Plant naturalizations and invasions in the eastern United States: 1634-1860. *Annals of the Missouri Botanic Garden* **90**:77-90.
- Mack, R.N. 2005. Predicting the identity of plant invaders: future contributions from horticulture. *HortScience* **40**:1168-1174.
- Mack, R. N. and W. M. Lonsdale, W.M. 2001. Humans as global plant dispersers: getting more than we bargained for. *BioScience* **51**:95-102.
- Mack, R.N. et al. 2002. Predicting invasions of nonindigenous plants and pests. National Academy Press, Washington D.C.
- Mack, R.N., D. Simberloff, M. Lonsdale, H. Evans, M. Clout, and F. A. Bazzaz, F.A. 2000. Biotic invasions: causes, epidemiology, global consequences and control. *Ecological Applications*. **10**:689-710.
- Marco, A., S. Lavergne, T. Dutoit, and V. Bertaudiere-Montes. 2010. From the backyard to the backcountry: How ecological and biological traits explain the escape of garden plants into Mediterranean old fields. *Biological Invasions* **12**:761-779.

- McGeoch, M. A., S. H. M. Butchart, D. Spear, E. Marais, E. J. Kleynhans, A. Symes, J. Chanson, and M. Hoffman. 2010. Global indicators of biological invasion: Species numbers, biodiversity impact and policy responses. *Diversity and Distributions* **16**:95-108.
- NGIA (Nursery & Garden Industry Australia). 2009. Grow me instead. Nursery & Garden Industry Australia. Epping, NSW. Available from <http://www.growmeinstead.com.au/> (accessed Sept 2011)
- Niemiera, A. X. and B. Von Holle. 2009. Invasive plant species and the horticultural industry. Pages 167-187 in Interjit, editor, *Management of Invasive Weeds*. Springer Science + Business Media B.V.
- Ontario Invasive Plant Council. 2011. Grow me instead. Beautiful non-invasive plants for your garden. [Brochure]
- Orme, B. 2010. Getting started with conjoint analysis: strategies for product design and pricing research. Second edition. Research Publishers LLC, Madison, WI.
- Peters, W. L., M. H. Meyer, and N. O. Anderson. 2006. Minnesota horticultural industry survey on invasive plants. *Euphytica* **148**:75-86.
- Pimental, D., R Zuniga, and D. Morrison. 2005. Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* **52**:273-288.
- Pyšek, P., D. M. Richardson, M. Rejmánek, G. L. Webster, M. Williamson, and J. Kirschner. 2004. Alien plants in checklists and floras: towards better communication between taxonomists and ecologists. *Taxon*. **53**:131-143.
- Randall J. M. and J. Marinelli, editors. 1996. *Weeds of the global garden*. Brooklyn Botanic Garden, Brooklyn, USA.

- Reichard, S. H. 2004. Conflicting values and common goals: codes of conduct to reduce the threat of invasive species. *Weed Technology* **18**:1503-1507.
- Reichard, S. H. and P. White. 2001. Horticultural introductions of invasive plant species: a North American perspective. Pages 161-170 in J. A. McNeely, editor. *The Great Reshuffling Human Dimensions of Alien Invasive Species*. IUCN, Gland, Switzerland and Cambridge, UK.
- Reichard, S.H., and C. W. Hamilton, C.W. 1997. Predicting invasions of woody plants introduced into North America. *Conservation Biology* **11**:193-203.
- Relf, D. 1992. Human issues in horticulture. *HortTechnology* **2**:159-171.
- Ricciardi, A. and J. Cohen. 2007. The invasiveness of an introduced species does not predict its impact. *Biological Invasions* **9**:309-315.
- Richardson, D. M., P. Pyšek, M. Rejmánek, M. G. Barbour, F. D. Panetta, and C. J. West. 2000. Naturalization and invasion of alien plants: concepts and definitions. *Diversity and Distributions* **6**:93-107.
- Satterthwaite, L.N., J. J. Haydu, and A. W. Hodges. 2006. Consumer purchasing habits of environmental horticulture products in Florida. *Journal of Environmental Horticulture*, **24**: 68-73.
- Schwartz, S. 1970. Moral decision making and behavior. In J. Macauley and L. Berkowitz editors. *Altruism and helping behavior*. New York: Academic Press.
- Simberloff, D. 2009. The role of propagule pressure in biological invasions. *Annual Review of Ecology, Evolution and Systematics* **40**:81-102.

- Statistics Canada. 2011. Average income after tax by economic family types. Statistics Canada. Ottawa, ON. Available from <http://www40.statcan.ca/101/cst01/famil21a-eng.htm> (accessed July, 2011)
- Steg, L. and C. Vlek. 2009. Encouraging pro-environmental behaviour: an integrative review and research agenda. *Journal of Environmental Psychology*. **29**:309-317.
- Stürmer, S and M. Snyder (eds). 2010. *The psychology of prosocial behaviour*. Blackwell Publishing Ltd. West Sussex, UK.
- Theoharides, K. A., and J. S. Dukes. 2007. Plant invasion across space and time: Factors affecting nonindigenous species success during four stages of invasion. *New Phytologist* **176**: 256-273.
- Townsley-Brascamp, W. and N. E. Marr. 1995. Evaluation and analysis of consumer preferences for outdoor ornamental plants. *Acta Horticulturae* **319**: 199-206.
- Van der Veken, S., M. Hermy, M. Vellend, A. Knapen, and K. Verheyen. 2008. Garden plants get a head start on climate change. *Frontiers in Ecology and the Environment* **6**: 212-216.
- Van Liere, K. D. and R. E. Dunlap. 1978. Moral norms and environmental behaviour: an application of Schwartz's Norm-Activation Model to yard burning. *Journal of Applied Social Psychology*. **8**:174-188.
- Venter, O. N. N. Brodeur, L. Nemiroff, B. Belland, I. J. Dolinsek, and J. W. A. Grant. 2006. Threats to endangered species in Canada. *Bioscience* **56**: 903-910.
- Vining, J., and A. Ebreo, 1992. Predicting recycling behavior from global and specific environmental attitudes and changes in recycling opportunities. *Journal of Applied Social Psychology* **22**:1580-1607.

- Westphal, M.I., M. Browne, K. MacKinnon, and I. Noble. 2008. The link between international trade and global distribution of invasive alien species. *Biological Invasions* **10**:391-398.
- Williams, J.W., S. T. Jackson, and J. E. Kutzback, J.E. 2007. Projected distributions of novel and disappearing climates by 2100 AD. *Proceedings of the National Academy of Science* **104**:5738-5742.
- Williamson, M. and A. Fitter. 1996. The varying success of invaders. *Ecology*. **77**:1661-1666.
- Williamson, M.H. and K. C. Brown. 1986. The analysis and modelling of British invasions. *Philosophical Transactions of the Royal Society of London*. **314**:505-522.
- Wirth, F.F., J.L. Stanton, and J.B. Wiley. 2011. The relative importance of search versus credence product attributes: organic and locally grown. *Agricultural and Resource Economics Review* **40**:48-62.
- Wittenberg, R. and M. J. W. Cock, (Eds.). 2001. *Invasive alien species: a toolkit of best prevention and management practices*. CAB International, Wallingford, Oxon, UK, xii-228.
- Yue, C., T. Hurley, and N. Andersen. 2009. Do native and invasive labels affect customer willingness to pay for plants? Evidence from experimental auctions. Selected Paper prepared for presentation at the Agricultural & Applied Economics Association's 2009 AAEA & ACCI Joint Annual Meeting, Milwaukee, WI, July 26-28, 2009.
- Zadegan, Y. R., B. K. Behe, and R. Gough. 2008. Consumer preferences for native plants in Montana residential landscapes and perceptions for naturalistic designs. *Journal of Environmental Horticulture* **26**:109-114.

APPENDIX 1 – SURVEY INSTRUMENTS FOR CHAPTER 2

Background questions

Sex (circle one): Male Female

Age (circle one): <20 20-34 35-49 50-64 65+

Household Income (circle one):

<\$ 19 999	\$20 000 – \$39 999	\$40 000 – \$59 999
\$60 000 – \$79 999	\$80 000 – \$99 999	\$100 000+

Preference for groundcover characteristics

Step 1: In the space provided in column A, please list all the characteristics that are important to you when purchasing a **ground cover** species.

<u>Column A</u>	<u>Column B</u>
_____	1 – Most important

_____	2

_____	3

_____	4

_____	5

_____	6 – Least important

Step 2: From all of your characteristics listed above, please rank only your top 6 in order of importance. Please do this by drawing a line from the number in Column B to the corresponding characteristic.

To ensure confidentiality, please place the completed survey in the box provided.

Thank you for your participation!!

Consumer Survey

Part A

Age: <20 20-34 35-49 50-64 65+
Sex: Male Female

Are you employed/studying in an environment related field? Yes No

How long have you been gardening (circle one)?

Just started this season 1 – 4 years 5 – 9 years
10 – 14 years 15 – 19 years 20 + years

During the growing season, how many hours per week do you spend in your garden?

<1 hour 1 – 2 hours 3 – 5 hours
6 – 10 hours 10+ or every chance I get

Part B – BLUE SET

The cards provided each represent a hypothetical ground cover. Please indicate for each your desire to purchase on a scale of 0 (**absolutely would not purchase**) to 10 (**definitely would purchase**).

- | | | |
|----------|-----------|-----------|
| 1. _____ | 10. _____ | 19. _____ |
| 2. _____ | 11. _____ | 20. _____ |
| 3. _____ | 12. _____ | 21. _____ |
| 4. _____ | 13. _____ | 22. _____ |
| 5. _____ | 14. _____ | 23. _____ |
| 6. _____ | 15. _____ | 24. _____ |
| 7. _____ | 16. _____ | 25. _____ |
| 8. _____ | 17. _____ | 26. _____ |
| 9. _____ | 18. _____ | 27. _____ |

Part C

Prior to this study, were you familiar with the term “invasive species” Yes No

If yes, where did you find out about invasive species?

School Garden centre/nursery Conservation organization

Media Other (please specify)_____

What is your definition of an invasive species?

Prior to this study, were you aware that some horticultural species can become invasive?

Yes No

To what extent do you agree with the following statements regarding the gardener’s role in invasive species introductions?

Gardeners should educate themselves on the subject of invasive ornamental species	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
Gardeners should plant only native species.	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
Gardeners should plant only species they know are not potentially invasive (not necessarily native).	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
Gardeners should be able to plant any species they chose.	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree
Gardeners should discourage others from planting potentially invasive species.	Strongly disagree	Somewhat disagree	Neutral	Somewhat agree	Strongly agree

THANK YOU FOR YOUR PARTICIPATION!!

APPENDIX 2 – SURVEY INSTRUMENTS FOR CHAPTER 3

Retailer Telephone Interview Script

Personal (foundation/motivation/personal investment)

1. What is your formal and informal education history?
2. What is your job title?
3. Is this a full-time or part-time position?
4. How long have you been in this position?
5. What are your primary duties?

Business (model/structure/priorities/network and influence)

6. Is your business a: Chain / Franchise / Independent / Other
7. Is your business primarily: Retail / Wholesale
8. Does your business purchase any plant materials from suppliers outside of Canada?
 - a. If yes, what percentage of your stock comes from outside Canada?
9. Does your business grow any of its own plants?
 - a. If yes, what percentage of your stock is grown in-house?
10. Does your business engage in plant breeding? Yes / No
11. Thinking about other nurseries in your area, do you consider your business to be:
Small / Large
12. Is there a plan to change the size of your business in the future? Yes / No
 - a. If yes, how would you change the business size? Smaller / Larger
13. Is your business associated with any industry associations?
 - a. If yes, which ones?

Knowledge Foundations (foundation/ values/ science / independence)

14. Have you heard the term “invasive species”? Yes / No

15. To what extent to which you agree with each of the following statements:

Invasive plants have a negative impact on native plants and animals	Strongly disagree	Disagree	Neither	Agree	Strongly Agree
Invasive plants are an important environmental concern	Strongly disagree	Disagree	Neither	Agree	Strongly Agree
The horticulture trade plays a role in the introduction of invasive plants	Strongly disagree	Disagree	Neither	Agree	Strongly Agree
The nursery trade should determine which plants will become invasive	Strongly disagree	Disagree	Neither	Agree	Strongly Agree
Scientists/experts should determine which plants will become invasive	Strongly disagree	Disagree	Neither	Agree	Strongly Agree
It is okay to sell plants known to be invasive	Strongly disagree	Disagree	Neither	Agree	Strongly Agree

16. What is your definition of “invasive species”?

Previous and Current Participation (initiative/receptivity/innovation/risk)

17. Are you familiar with any voluntary initiatives designed to reduce horticultural invasive species introductions?

a. If yes, please describe the initiative(s) you are familiar with.

18. Has your business considered or implemented any of initiatives (or others) to reduce invasive species introductions?

a. If considered, what motivated to do so?

b. If implemented, what motivated you to do so?

19. Thinking specifically about initiatives designed to prevent invasive species introductions: at this time, please indicate on a scale of 1 to 5 the amount of influence to participate.

	No influence				Significant influence
	1	2	3	4	5
Potential government regulations	1	2	3	4	5
Customer demand	1	2	3	4	5
Competing with other garden centres/nurseries	1	2	3	4	5
Creating a “green” business image	1	2	3	4	5
Pressure from other industry professionals	1	2	3	4	5
Pressure from employees	1	2	3	4	5
Sense of personal responsibility	1	2	3	4	5
Pressure from community groups	1	2	3	4	5

Future Participation (motivation vs. barriers)

20. The following are some commonly discussed initiatives designed to reduce invasive species introductions; for each initiative, please indicate the likelihood that you would participate in the future.

Evaluate horticultural plants for whether or not they are likely to become invasive	No and would not	No, but would	Have participated	Not applicable
Monitor plants to assess if they may be invasive	No and would not	No, but would	Have participated	Not applicable
Interact with experts to determine which plants are or might become invasive	No and would not	No, but would	Have participated	Not applicable
Interact with experts to determine alternatives to plants that might be invasive	No and would not	No, but would	Have participated	Not applicable
Try to breed alternatives to invasive plants	No and would not	No, but would	Have participated	Not applicable
Phase out plants that nursery associations, scientists, and other experts determine to be invasive	No and would not	No, but would	Have participated	Not applicable
Encourage customers to use non-invasive plants	No and would not	No, but would	Have participated	Not applicable

20. I'm going to read you a list of possible motivating factors. Please indicate which factor would most likely motivate you to participate in some or all of these initiatives in the future. I can repeat them as many times as you'd like.

Motivating Factor	Low	Moderate	High
Anticipation of future legislation			
Consumer pressure			
Competing nurseries are participating			
Creating a green business image			
Pressure from other industry professionals			
Pressure from employees			
Sense of personal responsibility			
Pressure from community groups			
Other (please explain)			

21. If there are other factors that are influencing your decision to participate in initiatives to reduce invasive species introductions that have not been addressed in this survey, please describe them.

22. Do you have any additional comments on initiatives designed to reduce invasive species introductions?