Lawn and Order

A Review of the Literature on Effective Strategies for Reducing Outdoor Residential Pesticide Use

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for
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Acknowledgements:
This report owes its existence to a seed grant provided by the Centre for Urban Health Initiatives (CUHI) at the University of Toronto. Additional financial and in-kind support for this literature review was provided by Toronto Public Health.

Kara Griffin completed the electronic database searches. Loren Vanderlinden, Carol Mee, Rich Whate and Monica Bienefeld of Toronto Public Health contributed material on municipal survey data and provided editorial feedback. Donald Cole of the University of Toronto, Public Health Sciences Department, provided invaluable editorial comment and substantive corrections.

The title of the report comes from a documentary film of the same name directed by Adrienne Mitchell and Janis Lundman for Lawn and Order Films Inc. and the Canadian Broadcasting Corporation (1994).

About this report and the PURE project:
This report is one component of the Pesticide Use Reduction Evaluation (PURE) project, funded as a seed grant by the Centre for Urban Health initiatives (CUHI) in 2004. The ultimate objective was to develop the means to evaluate the impact of municipal by-laws in conjunction with outreach and education campaigns, in reducing pesticide use and exposures in the urban environment, in general, and for food production, in particular. The seed grant funds were used to develop a research framework, organizational support, and a research protocol to obtain funding for such evaluation research.

In particular, the activities completed using the seed grant were:

1) A review of potential indicators and data sources for evaluation of the impacts of pesticide by-laws in Ontario municipalities;
2) Key informant interviews, from which were identified 7 key domains for indicators of pesticide use reduction (Community behaviour and response; Education and outreach; Legal and enforcement; Economic; Environmental contamination; Human exposure; and Clinical episodes); and
3) This literature review, designed to assess the existing evidence regarding the success of by-laws in changing individual behaviours, and in particular, in reducing residential use of pesticides.

The PURE project group is currently identifying potential sources of funding for an inter-municipal evaluation project. The group is also in the process of identifying other individuals and groups with an interest in pursuing this evaluation project, with the aim of creating, at minimum, a common framework and set of core indicators that will be collected in multiple municipalities, allowing for further collaborative work to evaluate the overall results achieved with by-laws and education strategies.

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Table of Contents

EXECUTIVE SUMMARY

Chemical pesticides have become very much a part of contemporary urban and suburban life in rich world countries. Indeed, if one considers all products in which pesticides are found, and all uses for these products (e.g. indoors, outdoors, pet-related), it is estimated that most people use pesticides at some time during the course of a year. In terms of outdoor garden use, users tend to be middle class or higher, since they are owners of houses and land. People are motivated to maintain their lawns and gardens in order to display their wealth and status, to preserve or increase their property value, and because they feel a moral responsibility to their neighbours to keep standards high. This sense of community responsibility ties in with aggressive advertising that reinforces the public and moral nature of the blemish-free lawn and garden which, in turn, taps into the particular history of residential landscape aesthetics.

These lawn and garden ideals and practices have a specific history tying them to wider cultural, economic and technological trends and processes in the North American context. The contemporary aesthetic of an unbroken expanse of green turf grass accented by ornamental plantings originated in English interpretations of Italian Renaissance landscapes. This aesthetic migrated to North America in the nineteenth century, but was not widely adopted until urban zoning and industrial growth permitted the expansion of suburban residences and made both the economic and technological means of maintaining a lawn and garden widely available. In the last hundred years, this aesthetic has been promoted not only as a marker of middle class status but also as a public symbol of the morality and community spirit of homeowners. Following World War II, the introduction of widely available petroleum-based pesticides and fertilizers, made the 'perfect' lawn and garden an attainable ideal. Two industries – pesticide manufacturers and lawn-care providers – have promoted the ideal of the 'perfect' lawn, and have grown alongside the rising incomes of post-war homeowners. In the last decades of the twentieth century, a growing awareness of the environmental and health risks of chemical pesticide use around the home has created a small but growing interest in alternative land management methods. In the last fifteen years, this awareness has provoked a number of municipal regulations and educational campaigns to limit chemical pesticide use and promote a more 'natural' aesthetic.

There is a growing body of literature detailing the health and environmental consequences of non-point source pesticide pollution. However, information campaigns to bring these facts to public attention, by themselves, have not been very successful in reducing pesticide use. Behaviour modification literature indicates that this is due to inappropriate conflation of knowledge, attitudes and behaviour: information campaigns address only knowledge deficits and do not necessarily change attitudes or behaviour. Thus, in the example of pesticide use, telling people that pesticides are harmful to their health or to the environment would lead to behaviour modification only if lack of knowledge was the sole barrier to change. However, in the case of cosmetic pesticide use there are many more barriers and structures at work, including the power of the standard landscape aesthetic in advertising and in perceptions of real estate values; people's desire to appear moral and hardworking; their desire to conform; the perception that non-chemical alternatives require an increased commitment of time or money; and in some cases, regulatory requirements, such as maximum lawn heights or the banning of specific plants designated as weeds, that generally reinforce the standard aesthetic and can even be contradictory to pesticide reduction efforts.

Synthesizing our understanding of the factors that condition people to use pesticides with what is known about changing knowledge, attitudes and behaviours leads to the conclusion that to effect behaviour change (over the short- to medium-term) requires a legal prohibition on pesticide use. To be effective, this must be accompanied by information and education campaigns that communicate: the risks of pesticide use and the benefits of alternatives; the specifics of the (new) regulations, such as requirements for compliance and penalties for non-compliance; and guidance about acceptable actions. Ideally, campaigns should be tailored to specific ethno-cultural and socio-economic segments of the pesticide-using population, and should seek to undermine some of the assumptions used by marketers to make pesticides appealing. Shifting social norms is difficult, and campaigns of this type benefit by using role models and influential members of the community to spread the word. A variety of strategies, including participatory learning, will be more successful than a single mass approach. Popular media can be effective tools but need to be managed carefully for maximum impact. Budgetary limitations can be addressed by pairing similar issues (pesticides with water use or recycling for example) and by partnering with existing initiatives.

In the end, when addressing such a complex issue, neither command and control nor educating for voluntary compliance works in isolation. Both types of intervention are necessary to effect change that is both immediate (takes place over a few years rather than over generations) and sustainable (wherin people and organizations eventually self-regulate).

1. INTRODUCTION AND METHODOLOGY

Toronto Public Health is one of several Ontario health units that have been tasked with implementing strategies to reduce residential use of pesticides within their municipality. However, these organizations, and the municipalities, need to understand the relative effectiveness of different strategies in achieving reductions in pesticide use, and to evaluate the success of their initiatives. This literature review was prepared for the Department of Public Health Sciences, University of Toronto and Toronto Public Health (TPH), working together through the Centre for Urban Health Initiatives (CUHI) at the University of Toronto. The key question for the review was to examine whether education and outreach strategies alone (in other words, voluntary compliance measures) are effective in reducing residential use of chemical pesticides, and whether the use of by-laws increases the effectiveness of education and outreach activities. The review was undertaken to refine research questions and lay the foundation for funding applications to support further research to evaluate the effectiveness of different strategies for reducing urban pesticide use. The scope of the review was broadened to include studies of pesticide use behaviour and the history of gardening and lawn-care in North America, to paint a more complete picture of the motivations and structural limitations on individual choice in the context of private outdoor landscaping.

A variety of research strategies were used to find relevant peer-reviewed articles published between 1990 and the present. Initially, a number of scientific databases were searched using specific search terms and combinations. The databases were accessed online and included the following:

First Tier Searches	**Second Tier Searches**
CAB abstracts	Canadian *envir*OSH Legislation
Cambridge Scientific Abstracts	Canadian Research Index/Canadian Government Publications
Ecology abstracts	Environment abstracts
Medline	Health & safety abstracts
Ovid	Pollution abstracts
Proquest	PsycInfo
Wilson Business abstracts	Pubmed
	Sociological abstracts
	Scirus
	Web of Science

No single specific key word strategy was used across all databases. Searching was initially exploratory to determine which key words would produce relevant results. The search terms varied depending on the database being explored and reflected the target topics of interest for this literature review. Initial searching began with the terms: pesticide*; pesticide reduction/elimination/restriction; by-law or ordinance (effectiveness); legislation, enforcement, legislative or regulatory approach; adherence, legal compliance. A search of Medline also used the key word terms: health knowledge, attitudes, practice, public health practice.

In general, search results with the key word “pesticide*” had a focus on agriculture (organic or conventional), specific chemicals, clinical impacts, impact on the environment and the monitoring or study of exposure to pesticides. Studies of agricultural pesticide use were mostly eliminated, as the goal was to understand urban, rather than wide-scale rural, pesticide use behaviour. Searching with combinations of the key words “urban”, “residential”, “education”, “evaluation”, “garden/lawns” along with “pesticide*” yielded the most useful results.

Given the limited number of appropriate sources, studies from other countries and contexts were included where relevant. When database searches no longer turned up novel resources, bibliographies of collected materials were mined for further references and these were added to the collection. Searches using SCIRUS also yielded invaluable information from grey literature such as evaluation reports from other jurisdictions, conference presentations and edited volumes addressing relevant research. These searches produced much of the material used in Sections 2.2-2.4 on who uses pesticides, how they use them and how they understand their behaviours, and Section 3 on evaluations of intervention strategies.

The qualitative and historical materials for Section 2.1 on the history of residential landscaping in North America were compiled by starting with key sources and working through bibliographies as well as doing internet searches for general information. The internet was particularly useful for Canadian gardening history and for details on Toronto’s urban and suburban expansion.

The review begins with the history of gardening and landscaping in North America, with a focus on Canada and Toronto, then moves on to consider specific research findings on who uses pesticides and how they do so. From there, secondary and primary research on the effectiveness of interventions is considered along with a review of expert knowledge about behaviour modification at the population level. Some of the studies cited in the body of the review are summarized in Appendices 1 and 2 for ease of reference. Analysis of elements necessary for modifying population behaviour has been condensed into twelve steps for effective municipal strategies to reduce chemical pesticide use in the residential context (see Appendix 3).

2. OUTDOOR PESTICIDE USERS IN CONTEXT

In order to assess the effectiveness of different interventions (legislation, education, information) that attempt to change people's behaviour regarding pesticide use, it is essential to understand the context within which people make choices about use of these products. This section will address the wider historical and socio-cultural context in which residential outdoor (particularly lawn and garden) pesticide use occurs, and the questions of who uses pesticides, how they use them and what they think about these choices. Some attention will be given to the literature on risk-taking and perception of risk, in order to clarify some apparent discrepancies between attitudes, beliefs and behaviours regarding pesticide use.

2.1 A History of Residential Land and Pesticide Use in North America

To understand contemporary urban and suburban behaviours regarding the use of pesticides in the outdoor residential (non-farm) context, it is useful to establish a rough historical timeline of Canadian, and especially Torontonian, residence patterns, gardening and landscape practices.

2.1.1 The Nineteenth Century

The first gardening books were published in Canada in 1868 (on flower gardening) and 1872 (on fruit, vegetable and flower gardening) (Martin, 1998).[1] Martin suggests that landscaping around the home was the privilege of the rich in the early 1800s but became widely practiced enough by the end of the nineteenth century to support gardening guides and seed companies. Montreal was the first city to have a regular gardening newspaper feature at that time. The spread of the practice of designing and beautifying residential lots coincided with a movement known as the Social Gospel. This was a Protestant movement based on the idea that personal salvation was contingent on social salvation which in turn, was contingent on a beautified public environment. The Social Gospel translated into practical actions like the City Beautiful Movement to improve Canada's growing industrial centres (Martin, 1998).

The association of public space with social moral character, and the idea that to improve the latter required beautifying the former, was widespread in Anglo-European societies in the late nineteenth century. The original inspiration for this can be traced to Ruskin and Morris who founded the Arts and Crafts movement in England, and inspired the 'Garden Cities of England' campaign (Hoennighausen, 2003). Similarly, in the US, landscape gardening emerged as a profession with Andrew Jackson Downing's publication, *Treatise on the Theory and Practice of Landscape Gardening* (1859). Followers of Downing promoted well-tended, structured gardens for the middle classes with the argument that "working in one's garden was a socially valuable act, if not actually a public duty and moral obligation" (Slocum and Shern, 1997:148). The converse of this was a belief that weeds presented a threat to the social fabric, in as much as they were believed to carry disease, encourage garbage dumping and harbour 'lawless vagabonds' on unkempt private and public lands (Falck, 2002). The nineteenth century notion that maintaining the public/private space of residential property was a social duty and a reflection of moral worth continues to influence contemporary gardening practice in North America and Europe.

[1] Carol Martin, curator for Library and Archives Canada, created an exhibition and website on the history of Canadian gardening (1998).

The spread of home gardening through the nineteenth century corresponded with other significant social and technological changes. The growth of industry in Toronto resulted in an explosion in the urban population from only 600 in 1800, to about 200,000 in 1900. As well, Toronto's businesses and factories relied on a labour pool drawn from another 200,000 residents living in nearby villages connected to the city with mass transit (Alcock et al., 2004). The first route was established by Williams Omnibus Line to connect St. Lawrence Market (the heart of the city) to the village of Yorkville in 1849. By 1921, when all private transit was amalgamated under the public company, Toronto Transportation Commission, there were nine electric streetcar routes in operation and buses were introduced for the first time (Toronto Transit Commission, 2003).

The industrial revolution created a massive demand for labour, and also created a new middle class who aspired to upper class lifestyle ideals, including having land around the home that could be landscaped. The suburbs, closely associated with middle class lifestyles and larger properties, are often considered to be a product of the post-WWII economic boom and the growth of automobile ownership. However, Toronto, with its transit system, had suburbs like Parkdale and Brockton as early as the late 1800s (North Toronto Green Community, n.d.).

The combination of a growing population, growing middle class, expanding suburban development, mass transit connecting outlying areas with the business core and a cultural movement advocating beautifying public and public/private space (the front yard) combined to create a boom in domestic gardening and public landscaping in the early twentieth century.

2.1.2 The Lawn Ideal

The North American ideal for what the home garden or yard should look like also has a specific history. While we take the existence of lawns for granted, they are a relatively recent fashion that dates back only as far as the eighteenth century when English rural manor-owners used lawns to mimic the views produced in Italian landscape painting. This pastoral aesthetic was adopted by wealthy North Americans in the mid-nineteenth century, and most species of turfgrass were imported to North America in the last one hundred years (Robbins and Sharp, 2003a; Slocum and Shern, 1997).

Near the end of the nineteenth century, the growing North American middle class began to adopt the lawn as the main feature of the front yard in order to mimic the upper class. The lawn was seen primarily as a sign of economic status (because of the labour required) but slowly, its maintenance and upkeep came to be associated with industriousness, family and morality as part of the cultural gestalt exemplified by Social Gospel (Slocum and Shern, 1997; Feagan and Ripmeester, 1999).

Before WWII, lawns were fairly common but homeowners were advised to tolerate weeds and keep chickens to control insect pests (Robbins and Sharp, 2003a). Fruit, vegetable and flower gardeners were advised to use products such as (*inter alia*) arsenate of lead, copper sulphate, pyrethrum and nicotine, but these products and the tools for their application would have been financially out of reach for most Depression-era families (Biles, 1935). The first elements of the transformation to a high intensity lawn and garden management system, requiring equipment and chemical inputs, surfaced in home gardening literature in the 1930s, but expansion was forestalled by the Great Depression and then the war (Feagan and Ripmeester, 1999).

However, the post-war social and economic climate across urban North America facilitated the expansion of both lawn coverage and the emergence of a widely accepted ideal of lush, green, unbroken expanses of manicured grass. This expansion was tied to the growth of suburban areas ringing cities where part of the attraction was having land surrounding the house for lawn, garden and parking uses (Robbins and Sharp, 2003a; Feagan and Ripmeester, 1999; Slocum and Shern, 1997). The suburbs were marketed as a bridge between crowded, dirty cities and the wide open spaces of the countryside.

The post-war economic boom raised living standards and increased job security which, in turn, created a larger population of households that could buy their own homes in expanding suburban areas where land values were lower. While wages were going up, hours worked were being reduced with a shift to standard 40-hour work weeks, two-day weekends and mandatory annual holidays. As people were also living longer and healthier lives, they could take advantage of their leisure time (itself a new idea) to enjoy and improve their homes and gardens. Larger incomes meant household budgets could absorb the costs of lawn and garden technology (mowers, sprinklers, sod, seeds, plants etc.) (Yergin, 1992).

Also following the war, new chemical weapons were added to the home gardener's arsenal: organochlorine and organophosphate pesticides developed in the 1940s; phenoxy herbicides, like 2,4-D, also developed in the 1940s; carbamate insecticides used in the 1950s; and pyrethroid insecticides developed in the 1970s (Standing Committee on Environment and Sustainable Development, 2000). In a sense, the modern ideal of a lawn as an unbroken expanse of emerald green, mono-cultured grass surrounded by flawless shrubbery and flowers is necessarily a post-war phenomenon, given the need to control for insect and plant 'pests' in order to achieve it. Shern and Slocum (1996) argue that homeowners adopted this ideal only after the spread of colour television in the 1950s brought images of this ideal into their homes during televised golf tournaments. Since then, the ethic of absolute control over pests has become the guiding principle in domestic and commercial gardening. To quote insect ecologist, Mark Winston, "we approach pests as organisms to control rather than manage; we exterminate instead of reduce; we dominate rather than learn to accommodate. Pest management has become a modern war against nature…" (1997:x).

Post-war lawn managers, usually men, worked to mow, trim and maintain mostly exotic turf species across the climates of suburban North America. By 1962, Rachel Carson observed that suburbanites were advised by garden centers to use toxic chemicals to combat crabgrass without knowing what they were introducing to their home environments (Robbins and Sharp, 2003a). An article in *Life* magazine in 1969, although tongue-in-cheek, nonetheless summed up the prevailing lawn order of the time:

> Let a man drink or default, cheat on his taxes or cheat on his wife, and the community will find forgiveness in its heart. But let him fail to keep his front lawn mowed, and to be seen doing it, and those hearts will turn to stone. (Zinsser, quoted in Feagan & Ripmeester, 1999:620)

The 1960s reinforced the 'perfect' lawn as a status symbol because maintaining it required access to costly mechanical and chemical technology.

2.1.3 Lawns as Big Business

To make up for the economic contraction that accompanied the beginning of outsourced manufacturing (away from North America's more expensive labour market) and then the Oil Crisis of 1973, women entered the workforce in greater numbers in the late 1960s and 1970s. As this happened, household incomes often increased, but labour time to maintain the residence and outdoor spaces decreased. Lawn care companies emerged in the late 1960s, as a response to this new situation. From the beginning, these companies relied on the fact that most post-war households had telephones so that people could be marketed to directly (Slocum and Shern, 1997). Feagan and Ripmeester (1997) report that contracting a lawn care service quickly became associated with high economic status in the 1960s and that today, the plastic signs that indicate a professional application on one's lawn continue to signal the 'cachet' of disposable income. Interestingly, while men have traditionally taken responsibility for the lawn, women have often had significant influence in the decision to contract a lawn care company, a situation still true today (Slocum and Shern, 1997; Robbins and Sharp, 2003a).

Until the mid 1980s, the main pressures to use chemical pesticides came from the primary retailers of pesticides: nurseries and hardware stores. In other words, while the ideal of perfect lawns was becoming more widespread as more people became home owners and moved to areas with greater lawn coverage, people relied primarily on retailers and word-of-mouth for specific information about appropriate treatments for pests. Manufacturers of domestic lawn and garden pesticides used a 'push' strategy of marketing in which they offered incentives to nurseries, garden centres and hardware stores to carry their products. This meant that among those managing their own lawns, only motivated lawn managers would make the effort to seek out pesticide products (Robbins and Sharp, 2003b).

However, in the mid-1980s, the formulators of pesticides faced a number of pressures. Agricultural use of pesticides was being reduced following consumer concerns over pesticides in food and legislation banning particular products. A major shift was occurring in retailing, away from small, local retailers and toward large centralized discount stores.[2] The 'big box' stores sacrificed customer service for aggressive price slashing, which increased pressure on formulators to reduce prices. At the same time, research and development costs were skyrocketing for new products, due to reforms in government requirements. This could translate into eleven years of research and development for a new product, costing between US$50 and $70 million (Uri, 1997). Meanwhile, patents were expiring on older formulations. Finally, the price of chemical ingredients was also on the rise, as were legal costs for defense against government and civil suits against poor practices. All of these factors forced manufacturers to implement a new strategy to create demand for home pesticides (Robbins and Sharp, 2003b): 'Push' (marketing to retailers) became supplanted by 'pull' (marketing directly to consumers) strategies in the mid-1980s, with Scotts Company taking the lead (Robbins and Sharp, 2003a).

To create demand for their products, Scotts began an aggressive advertising campaign directed at homeowners. In order to make people want to buy pesticides and fertilizers, Scotts' advertising emphasized the association of perfect lawns with idyllic nuclear family activities (parents playing

[2] Templeton et al. (1998) note that in 1995, supply of outdoor residential use pesticides was primarily through large home centres (43%) and discount or grocery stores (37%) while traditional venues like nurseries and hardware stores accounted for only (20%) in the US.

with their children), commitment to community values and neighbourliness, and, most surprisingly, with a connection to nature (Robbins & Sharp, 2003b). Formulators also began to promote the use of lawn care service companies who, in turn, advocated the high intensity use of inputs like fertilizers and pesticides (Robbins & Sharp, 2003b). This union of advertising and interests caused a virtual explosion in the lawn care industry in the 1980s (Munson Scullin, 2005).

In addition, the relationship between a property's external appearance and its value may have contributed further to the appeal of the 'perfect' lawn. Although there are no details on the specific history of the notion of 'curb-appeal,' it is certainly prevalent today and promoted by a number of television programs. That people value the external appearance of their homes is demonstrated by the fact that *Money* magazine estimated that a homeowner would recover a minimum of 100% of the cost of landscaping in the sale of their home, versus minimums of 75% for a new kitchen and 20% for a new bathroom (quoted in Hall, 1999).

The sale of lawn and garden pesticides increased dramatically and rapidly to become a multi-billion dollar industry. The US EPA says 78 million households used lawn inputs (Henry, 2005) worth US$8.9 billion in 1999 (Robbins and Birkenholtz, 2003). An article in *Saturday Night* reported that seven in ten Canadian homeowners used pesticides on their lawns or gardens, and that sales of non-agricultural pesticides were worth $100 million in 2000 (Evenson, 2001), although this amount was down from $121 million in 1997 (Standing Committee on Environment and Sustainable Development, 2000).

It should be noted that not everyone joined the chemical bandwagon over this period. Inspired by Carson's *Silent Spring* (1962) and the growth of Green parties and politics in Europe, some North Americans embraced a 'back-to-the-land' movement in the late 1960s (Hoennighausen, 2003). In Canada, James Lawrence founded *Harrowsmith Magazine* in 1976 as a response to demand for information on organic and environmentally sound land uses. *Harrowsmith* promoted using garden space to grow organic food and soon branched out into the garden book business to give advice to a specifically Canadian audience (Martin, 1998). Since then, organic farming has grown to the point that it can now be considered mainstream, and no longer tied specifically to left political ideologies.

2.1.4 Contemporary Canadian Gardening

Gardening enthusiasm in Canada has grown substantially in the last decades. Martin (1998) notes that there were only 26 Canadian gardening books in print in 1973 but by 1997, this had grown to 190 titles. As well, Canadians are now served by a number of national and regional magazines[3] that have all started business in the last 20 years. Gardening gurus like Mark Cullen, the late Lois Hole, Marjorie Harris and Benoit Prieur grace the airwaves and library shelves. The Government of Canada reports that 80% of Canadians garden as a hobby (Martin, 1998).

While it is impossible to characterize the practice of gardening across the country, most contemporary books and advice columns emphasize non-chemical approaches to dealing with

[3] The most popular titles in print (with year of launch) are: Gardens West (1987), Canadian Gardening (1990), The Gardener for the Prairies (1995), Manitoba Gardener (1998), Gardening Life (c.2000), Ontario Gardener (2000) and Alberta Gardener (2002)

pests, even while magazines and spokespersons advertise chemical fertilizers and pesticides. This somewhat inconsistent relationship can be attributed to the economics of producing magazines and websites in the context of growing public unease about exposure and the political manifestation of this unease in the increasing number of municipal by-laws restricting cosmetic uses of pesticides.

A subjective assessment of garden styles and landscape trends suggests some movement away from lawn monoculture to 'garden rooms' with diverse plantings. Diversity also informs movements like the Backyard Wildlife Habitat Program which encourages people to create wildlife-friendly spaces on their properties by providing food and water sources, and trees and shrubs for cover and nesting sites (www.backyardwildlifehabitat.info/planningthehabitat.htm). There are also gardening interest groups that focus on butterfly gardens, hummingbird gardens, toad gardens and gardens that reproduce native ecosystems like wetlands, meadows and forests. All of these trends represent a shift away from high-intensity lawn and formal garden landscapes.

2.1.5 Gardens are Social Spaces

Most research about pesticide use focuses on the individual as the locus of choice, as do the majority of interventions designed to curb this behaviour. However, the point of this brief history is to provide an understanding of the wider historical and economic context that created first, the prevalent lawn aesthetic of domestic landscapes and its association with upper class status, and second, the desire for perfect lawns and gardens as a sign of hard work, healthy family, strong community and connection with nature. The contradictions inherent in the constellation of meanings and actions with regard to the largest residential land use, the lawn, are summarized by Robbins and Sharp (2003b:442):

> Herbicides that flow off lawns and represent a risk to the good of the community are seen as fundamental to proper community behavior. Lawn chemicals that are potentially harmful to children and collect in carpet dust are viewed as important for the family. Lawn chemicals with potentially detrimental impacts on the ambient environment are understood as taking care of the environment. Chemical users are more likely to be concerned about their neighbors' values and feelings. … They are more likely to be concerned about the quality of water.

This is supported by Shern and Slocum (1996) and Slocum et al. (1997) who found that people did not always see their personal decisions regarding lawn care as impacting the wider community or global environment. And to quote Feagan and Ripmeester (1999:631), who investigated both the formal structures of lawn culture (municipal by-laws, landscape trends) and people's attitudes toward conventional and natural yard aesthetics in Niagara Region, Ontario:

> Letting the lawn go or attempting an ecological naturalization project is contrary to deeply hallowed signifiers of neighborliness and industriousness. It not only contravenes these associations but comes with decidedly stigmatized symbols of welfare indolence and uncaring. It seems fair to speculate from our work here that the lawn, in its strictly grass monoculture incarnation, has in many ways become seemingly more natural than what might occur naturally.

Individuals make choices within these larger economic and cultural contexts. While there is movement away from the dominant aesthetic, a short drive down a residential street in southern Ontario will likely show that alternatives to lawns and manicured flowerbeds are still in the minority. Any successful attempt to modify individual behaviours will have to be at least as powerful as the messages conveyed by industry, real estate markets, family and neighbourhood norms.

2.2 *Who* uses pesticides?[4]

When domestic pesticides are defined broadly to include those used to fight indoor insect or rodent infestations, fleas and ticks on pets and people, and head lice, the short answer to the question 'who uses pesticides?' is: almost everyone. In the United Kingdom in 2001, Grey et al. (2004) conducted interviews in 147 households in Bristol, pre-selected to have children aged from 9 to 11 years. Fully 93% of these respondents reported using pesticides in the previous year. Similar proportions of users were found in US surveys: In 1997, Adgate et al. (2000) interviewed 147 Minnesota families with children ranging in age from 3 to 13 years, and found that 97% had pesticides in the home, while 88% reported using pesticides in the past year. In 1989-90, Davis et al. (1992) conducted telephone interviews with 238 Missouri households with children, and found that 97.8% used pesticides at least once per year, and 67% used them five or more times a year. None of these studies reported any correlation between pesticide use and demographic characteristics like income, age, rural/urban residence or ethnicity. In sum, nearly everyone interviewed reported using some type of chemical insecticide, repellent, herbicide, rodenticide or fungicide at least occasionally – and if this is true of parents of young children, it seems likely to be equally true of non-parents.

When the focus is limited to outdoor (i.e. lawn and garden) pesticides there are fewer users, although several sources indicate that between one-half and three-quarters of US households use chemical pesticides on their outdoor spaces. Robbins et al. (2001) cite a national survey in the US in which 74% of households reported using pesticides and/or fertilizers outdoors, while Robbins' survey of residents of Columbus, Ohio, found that 50% of households used chemical inputs (fertilizers and/or pesticides). Reporting EPA figures, Henry (2005) claims that over 50% of US households apply pesticides to their lawns themselves, while another 12% pay professional applicators. On the other hand, Sachs (1987) found that the proportion of households reporting use of pesticides on home food gardens in Pennsylvania halved between 1965 and 1984, dropping from 73% to 35%, even while the percentage of people growing some of their own food increased from 42% to 59%.

However, it would be unwise to assume that Canadians in general, or urban Canadians and Torontonians specifically, will absolutely mirror their US counterparts in terms of overall usage statistics. Certainly, differences in climate and types of pests are likely to engender differences in patterns of use. Furthermore, while most US municipalities cannot legislate on the use of pesticides without State approval (Henry, 2005), Canadian municipalities have begun to enact legislation to restrict the use of pesticides within their boundaries.[5] Their jurisdiction has, so far, been upheld by the courts, despite appeals by pesticide producers and lawn care companies.

As a result of these municipal actions, Canadian cities and towns are increasingly interested in quantifying the use of, and public attitudes towards, pesticides in their communities. However, information about sales and use of pesticides is not made publicly available by either pesticide manufacturers or retailers in Canada. Therefore, municipalities must conduct surveys to obtain such information. The results from several such surveys are presented below. A detailed table of several recent surveys conducted in Ontario, Nova Scotia and Alberta is included as Appendix 2.

[4] A summary table of the quantitative studies referenced in this and the following section is available as Appendix 1.
[5] The legislative context in the US differs from that in Canada. Many States have moved to inhibit municipal powers in this regard. In Canada, the situation depends upon Provincial legislation relevant to municipal powers.

Overall, the surveys *suggest* some commonalities amongst municipalities in Canada. Approximately one quarter of all respondents (whether or not they maintain a lawn) report using pesticides, while approximately half of homeowners maintaining lawns and gardens report using pesticides, either exclusively or in addition to alternative approaches. The proportion of households hiring lawn care companies ranges from 20% to 50%, and the majority of lawn care companies apply chemical pesticides (compared to natural methods/organic techniques) to their clients' properties for the control of weeds and insects. At the same time, the vast majority of respondents say they would welcome information on alternative products and techniques to help them switch from chemical pesticides, but those that have tried alternatives generally reported these to have been less effective in controlling weeds or insects. Health and environmental concerns are most frequently cited as reasons for switching to non-chemical methods of lawn and garden care. Generally then, use rates in Canada do appear to be comparable to those in the US (to the extent that survey methods and questions are comparable). This is not surprising given that lifestyle ideals as featured in pesticide and lawn care advertising are quite similar across North America. The Canadian interest in alternatives to chemical pesticides and concern for health and environmental impacts of pesticide use could be the result of media attention to by-laws, to legal challenges mounted by the pesticide industry and to lobbying by advocacy groups.

For the City of Toronto, some information about proportions of people using pesticides on their lawn was obtained from several surveys conducted by Toronto Public Health (TPH). In a 2000 survey of homeowners (those who made lawn care decisions), 45% reported pesticide use outdoors in the previous two years (TPH, 2002a). In a 2002 survey conducted among adults in Toronto, 64% reported that they had a lawn (not restricted to homeowners), and 38% of these people reported pesticide use outdoors in the previous two year period (TPH, 2002b). And, in a separate 2002 survey, the practices and awareness of over 450 Toronto parents with children aged 0 to 12 years were explored. Over one-quarter (28%) of the parents living in houses (i.e. detached, semi-detached, row or townhouse, or apartment in a house) reported that pesticides had been used outdoors on their lawns and gardens (TPH, 2005). In contrast, 39% of parents living in apartments reported that pesticides had been used outdoors on their residence's property. The results from the survey of Toronto parents suggest that households with young children are less likely to use pesticides than the general adult population, particularly if they live in a house rather than an apartment and therefore have potentially more say in decisions about pesticide use.

A number of demographic characteristics are seen to be correlated with outdoor pesticide use among those with lawns to take care of. Generally, pesticide users are economically better off than non-users, having higher incomes and properties of greater value; they are older (especially those over 50 years); and they tend to have more education (Robbins and Sharp, 2003a; Robbins et al., 2001). Of course, these factors are also all correlated with each other, independently of lawn pesticide usage; some may also be correlated with availability of free time (e.g. age). There is some evidence that men are more likely than women to use pesticides on lawns – and Aceti Associates (2002) report studies showing that men tend to be responsible for lawn care. Among experienced gardeners (as a subclass of home gardeners), Grieshop et al. (1992) found that men in Sacramento, California, had been involved in garden and lawn maintenance for a longer period of time, had used pesticides for longer, and tended to use more of them than women. Significantly, both genders used non-chemical alternatives such as insecticidal soaps and *Bacillus thuringiensis* more often than pesticides but women opted for synthetic chemicals less often than men (Grieshop et al., 1992). This corresponds with the finding by Slocum et al. (1997) that

women were more likely than men to view chemical pesticides as threatening to their personal health and to the environment. Coppin et al. (2002) found that rural residents were more likely to use pesticides than urban residents in Utah. However Robbins and Sharp (2003a) found the reverse to be true when examining data from a nation-wide US survey, and data reported by the US Geological survey in 1999 revealed that "insecticides were detected more often and at higher concentration in urban watersheds than any other watershed land use, including agriculture." (Robbins and Birkenholtz, 2003:182).

Some, though not all, of these relationships are borne out for the population of Toronto as well. Based on the 2002 survey of Toronto residents, specific subgroups of the survey sample were more likely to report use of pesticides than others. Individuals with higher income, and who were in older age groups, reported more often having used pesticides outdoors in the past two years. TPH also found that households with a higher square footage of lawn coverage were more likely to use pesticides, that is, the more valuable the property, the more likely that the household used synthetic pesticides and fertilizers. However, in the Toronto survey those with less education (had completed less than grade 9) were more likely to report recent pesticide use (TPH, 2002a). No information was found that details ethno-cultural variability in outdoor pesticide use in the Canadian context. However, given the variability seen in pesticide use and users, it seems probable that ethno-cultural differences exist in attitudes, knowledge and behaviours with regards to lawn care and pesticide use.

Further complexity of the pesticide use issue is demonstrated by Berger (1997). Comparing census and environmental questionnaire data in Canada, she found that access to recycling programs, and thus participation in them, was positively correlated with socioeconomic indicators like higher levels of education, ownership of single family dwellings and household income. There was also a correlation between active recycling and other environmentally-minded behaviours like energy and water conservation, composting and using cloth shopping bags. However, all of these behaviours correlated positively with environmentally *detrimental* lawn care practices and negatively with responsible transportation decisions (Berger, 1997). Berger's work indicates that even a constellation of factors such as sufficient income and education, knowledge of environmental issues, access to alternatives, and motivation to behave in an environmentally sound manner may not be sufficient to induce a move away from current notions of proper lawn care, including cosmetic use of pesticides.

The geographer, Paul Robbins, and his colleagues have done the most to paint a fuller picture of lawn input users using the political ecology paradigm, and many of their conclusions are supported by others. Users were more likely to know their neighbours by name and more likely to have learned about lawncare from a family member or neighbours (Robbins and Sharp, 2003b; Grey et al., 2004). They reported a sense of pride in their neighbourhood and a sense of responsibility and obligation toward others to maintain the appearance of their lawns. They believed that tended lawns kept property values high and that it was a moral duty to take care of everyone's investment in this way (Robbins and Sharp, 2003a; Aceti Associates, 2002). Some respondents saw the lawn as a public symbol of their personal morality, so that an unkempt lawn would bespeak a person with moral failings (Feagan and Ripmeester, 1999). Robbins et al. (2001) argue further that use of the lawn among the middle and upper classes is a form of conspicuous consumption. This term was coined by Thorstein Veblen (1899) to refer to types of public consumption of goods and leisure that signal high class position to others. As intensive lawn

management costs, on average, US$222 per year and one third of US households spend more than US$500 per year, lawns certainly are a public sign of disposable wealth (Robbins and Birkenholtz, 2003). Surprisingly, of respondents in Robbins' 2000 survey who were aware of the impact of lawn inputs on the environment, a full 74% still used them (Robbins et al., 2001).

In summary then, people who use outdoor pesticides for the purposes of maintaining the aesthetic quality of their properties are those who are more connected with their communities and who feel an obligation to keep up class appearances and investment. They are generally older, have higher levels of income, and have larger properties of greater market value. In general, however, knowledge of environmental consequences is often not associated with decreased chemical use.

2.3 *How* do people use pesticides?

Studies show that people do not always make a connection between all types of pesticides and risks to their own or their children's health. For example, Davis et al. (1992) found that 80% of their sample of parents had used pesticides during a pregnancy, while 70% had used them during the first six months of the child's life. Many in this sample reported limiting exposure to many pesticides for pregnant women and infants, but they largely did not perceive flea collars and no-pest strips to represent a pervasive exposure risk and so did not control exposure to these for pregnant women and infants. Pesticides were most commonly used indoors (80%) followed by herbicide treatments outdoors (57%), insecticide treatments on pets (50%) and use in gardens and orchards (33%) (Davis et al., 1992). Bass et al. (2001) found that 70% of pesticides were stored indoors, usually in the kitchen, with fully 50% stored less than four feet from the ground within easy reach of children. Grey et al. (2004) confirmed the finding that the kitchen is the most common place to store pesticides indoors. The parents in Grey's study were most likely to treat indoor insect problems and least likely to treat weeds with chemical pesticides. Respondents chose pesticides based on perceived safety first and effectiveness second, while cost was not a factor. However, they depended on friends and family to recommend products and only paid close attention to labels of unfamiliar pesticides. Those who did read labels (45%) did not always understand them and 43% reported that labels were inadequate because they did not contain sufficient information. Despite their preference for safe products, only 28% reported willingness to wear gloves when applying pesticides and only one respondent had been trained to use pesticides properly (Grey et al., 2004). Since the 'safety' of pesticide products, as determined by risk assessment, is dependent on the use of the product according to the instructions on the label, if the instructions are not followed, the 'safe' designation of the product is no longer valid (TPH, 2005).

Adgate et al. (2000) conducted in-home interviews using cue cards and prompts to inventory pesticides in the home. They found 850 different registered pesticides in 308 households. Banned products – including one that had been banned for seven years – were found in 9% of households. The most commonly used product was DEET and related compounds found in repellents, while the most common active ingredients found came from the pyrethrin class. In general then, pesticides are common fixtures in most homes and are not always treated like dangerous poisons.

Outdoor pesticide use shows similar patterns of disregard of the risks associated with pesticide use. For example, one study found that outdoor pesticides stored in garages and sheds were locked only 12% of the time (Grieshop and Stiles, 1989). As another example, a Toronto Public Health survey of Toronto residents found that over 10% of respondents who hired professional

lawn care companies did not know whether or not chemical pesticides had been applied to their lawn, and about 40% had not been given information on appropriate precautions after their lawns had been treated (TPH, 2002a). In addition, less than half (46%) of this group said that items such as "toys, garden tools, lawn decorations and easy to move garden furniture [were] removed from the lawn before the pesticides were used" by the lawn care company (TPH 2002a:21). By comparison, almost three quarters (74%) of Toronto respondents who had applied chemical pesticides to their own lawns reported taking the precautionary measure of moving things off the lawn before the application of chemicals (TPH, 2002c). However, in other surveys about people's practices when applying pesticides themselves almost half report that they do not always read the labels and understand them, or follow the directions for pesticide and fertilizer use (Butterfield, 2004; Grieshop and Stiles, 1989), 21% report using higher-than-recommended dosages (Grieshop and Stiles, 1989), less than half (47%) wear protective clothing (Grieshop and Stiles, 1989), and only 32% report researching appropriate control methods before treating insects or weeds (Butterfield, 2004). It should be noted that most of these findings are not surprising in light of the fact that in one of the surveys a full 38% of the sample did not think pesticides were toxic, and that furthermore, there was a correlation between perceived pesticide safety and a low threshold for treating pests with synthetic chemical controls (Grieshop and Stiles, 1989).

Once again, however, the relationships between attitudes towards pesticides and actual behaviour are not always predictable, and reflect the paradox of incompatible knowledge and attitudes about pesticides. In one study of gardeners from the Sacramento area, Grieshop et al. (1992:135) found that "no one felt safe without protection while using pesticides" and yet none of the protective behaviours examined were used by all the respondents. Reading labels and washing after using pesticides were reported by approximately 90% of the respondents, whereas wearing protective clothing such as long pants, long sleeves and gloves, was reported by only 50-75% of respondents, eye protection was worn by less than half (40%) and only 25% of respondents reported wearing a mask while applying pesticides. In addition, those who had gardened for longer had a significantly stronger "denial of risk associated with pesticides" and were more likely to use them in the future and to do so less safely (Grieshop et al., 1992:135). It should also be noted that responses to surveys may not accurately reflect users' actual behaviour (TPH, 2002c), and that one study found that even when verbal instructions about application procedures were provided, some individuals failed to follow all mandatory protective steps, such as wearing gloves throughout the application procedure (Harris et al., 1992, cited in TPH, 2002c). Thus, even though a reasonably high number of people claim to take precautions, the reality may be rather different. While these studies are far from conclusive about the behaviour of contemporary Toronto pesticide users, they do suggest that chemical pesticide use tends to beget more of the same and that people do not always perceive these products to be dangerous.

As well, people may judge different pest control strategies as valuable for different reasons. Chemical pesticides were valued by the Sacramento gardeners for their efficacy and time-savings since they did not need to be applied as frequently as alternative products. They were acknowledged to be more expensive but cost was accounted for by the outlay of both time and money. Alternative methods were valued for their safety but recognized to reduce the immediacy of effect and to cost more in time (Grieshop et al., 1992). Jetter and Paine (2003) explored choice criteria for chemical versus biological pest controls using the case of a hypothetical infestation of public eucalyptus trees in southern California. Participants were sent information about chemical pesticides (carbaryl), the biological pesticide Btt (*Bacillus thurigensis tenebrionis*) and the use of

natural predators and were asked to rank their preferences given a number of cost scenarios. In the absence of a price difference, people preferred natural over chemical methods (especially since the latter required repeated applications), but cost was the prime determinant of consumer preference. Respondents were not concerned about waiting for results with natural methods though they preferred one application versus multiple applications. While this study investigated a hypothetical situation on public land, it is interesting that when people know about alternatives, they preferred them at least up to the point that they were not wildly more expensive than chemical alternatives (Jetter and Paine, 2003).

To extrapolate from these studies, it appears that people choose pest control interventions based on the type of pest, its location (indoor/outdoor), time and money costs, and safety. These choice parameters lead them to choose chemical pesticides at least some of the time. The more exposure one has to a product (flea collar or herbicide), the more likely one is to perceive it to be safe and the less likely one is to take precautions using or storing it. Strong warning labels will not guarantee compliance with safety measures if people ignore or cannot understand them. Given sufficient information, people prefer natural over chemical methods but they are sensitive to costs as a primary determinant of choice.

2.4 Knowledge and Attitudes About Pesticides – the Lens of Risk

It might be assumed that informing people of the toxicity of chemical pesticides would be sufficient to change their choices of pest treatments, but a cursory review of the literature on how risk is constructed, communicated and perceived suggests that it is not that simple. In this section, the focus is on subjective perception of risk, following Weegels and Kanis (2000), rather than on the objective calculation of risk by risk assessors.

Much of the literature on public knowledge and attitudes toward events, agents or products perceived to be dangerous takes the perspective of trying to allay public concerns rather than create them. In this vein, a number of studies have tried to elucidate what people perceive as risky, why they do so and how to communicate objective risks more effectively in the face of subjective perceptions that outweigh 'real' risk. Part of the problem is that trust in the source of information is critical in public risk construction, but trust in government and industry sources has declined in the USA since the late 1960s (Slovic, 1987, 1993; Leiss, 2004; Sachs et al., 1987; Williams and Hammitt, 2001; Dunlap and Beus, 1992). Sjöberg (2001) counters Slovic's claim about the importance of trust by showing that trust in experts accounted for only 10% of the risk perception in his survey data, while a belief that scientific knowledge is limited and imperfect accounted for 40-50% of perceived risk. The fact that the latter study was done in Sweden may prove the point that trust in government and industry varies by specific socio-political context. Since the early 1980s, with the election of Ronald Reagan and the broad shift to Conservative policies in the USA, there has been a growing attack on government regulation, with the consequence that people's trust in government regulatory agencies has declined (Christoffel, 1985). Pair this with a legal system in which the courts, rather than government, are used to resolve questions about knowledge and communication of risks, and the marshalling of battalions of experts who contradict one another (Slovic, 1993), it becomes clearer that the US public will perceive more instances of government and industry failure to protect public interests than citizens of other countries.

While we cannot conclude that Canadians will or will not trust government sources on questions of public health and safety, it is still possible to glean significant factors affecting how the public views risk. The following is a list of findings from the risk literature:

- people accept known over unknown risks (car accidents over radiation for example) (Leiss, 2004)
- people fear risks to children more (Leiss, 2004)
- people fear slow, degenerative diseases over others (Leiss, 2004)
- people accept lower levels of risk from involuntary exposures (Slovic, 1987)
- non-occupational risks create more distress (Lebovits and Levin, 1991-92)
- single accidents or examples of technological failure will have a disproportionate effect on people's perception of risk (Freudenberg, 1997 and Slovic, 1987) because negative events are more visible and emotional than positive, get more media attention and sources of bad news are considered more credible than those communicating good news or non-news (i.e., 'there were no accidents today') (Slovic, 1993).

Where researchers have correlated demographic data with risk perception, a few correlations show up consistently. Women, young adults and those without post-secondary education were usually more likely to perceive greater risk (Williams and Hammitt, 2001, Howe, 1990 and Grieshop and Stiles, 1989). Flynn et al. (1994) argue that this data must be interpreted very cautiously as there is a tendency to assume women are risk averse because they bear children and that less educated people are irrational in their understanding of risks. They show that white women and all non-white respondents of both genders in the US tend to perceive greater degrees of environmental health risks than white men but that, by the same token, environmental inequities in siting potential sources of contaminants does actually increase the risk for poorer people who tend also to be non-white. They conclude that a better explanation of risk perception is that those who feel powerless in the creation of potential exposures and who benefit less, will likely perceive greater risk (Flynn et al. 1994).

In terms of influencing public risk perception and behaviour, there are a number of factors that make it difficult to get people to take precautions regarding products and actions that could have negative health and environmental consequences. Studies indicate that:

- strong initial views are very hard to change (Slovic, 1987)
- people become accustomed to warnings (on labels, for example) and ignore them (Leonard and Wogalter, 2000)
- repeated exposure or use without negative consequences increases the perception of safety (Leonard and Wogalter, 2000 and Grieshop and Stiles, 1989)
- even those who perceive products (outdoor pesticides for example) to be dangerous do not take full precautions in their use (Grieshop and Stiles, 1989)
- even when people perceive a 'dread risk' (threat is not well understood, effects are delayed, long-term and possibly fatal) like pesticides on their food, they do not change their behaviour unless alternatives are to hand (Dunlap and Beus, 1992)
- people do not always understand the precise sequence of physical events that will lead to an accident around the home and thus do not take precautions (for example, standing on something not designed for the purpose) (Leonard and Wogalter, 2000)
- if a product (child's toy for example) appears benign, people assume it is safe (Weegels and Kanis, 2000).

By and large, the studies cited above have focused on household products and behaviours that do not, or have not, received the same sort of media coverage as large-scale, public events such as chemical spills or nuclear disasters. In the domestic realm, people tend to take greater risks and perceive less danger than an objective risk assessment would warrant.

In terms of communicating risk to the public, Leiss (2004) and Smith and Johnson (1988) suggest that information must be clear. In other words, while people are becoming more comfortable with the idea of probabilities (weather prediction for example), they still prefer yes/no risk assessment information (Leiss, 2004). As well, risk information should include actions people can take to reduce risk (Smith and Johnson, 1988). Both Leiss (2004) and Flynn et al. (1994) suggest that risk communication must avoid 'scientific jargon' and respond directly to public concerns (subjective risk perception rather than objective assessment). Failing to address public concerns and establish a shared understanding, as difficult as this is, will likely fail to change public perception.

To summarize and bring this discussion back to the specifics of residential pesticide use, it is clear that patterns of behaviour and the knowledge and attitudes that support them are likely to be difficult to change by simply warning people about risks, especially if they feel there are no alternatives, or if they have long since become accustomed to warnings. At the same time, people are less willing to accept domestic, involuntary exposures that have long-term, unknown or degenerative consequences or those that affect children, so communicating this evidence, where it exists, could have a greater impact on public perception of the dangers associated with pesticide use around the home.

3. EVALUATING EFFECTIVE INTERVENTIONS

In the areas of environmental and health promotion, both of which are relevant to individual outdoor pesticide use, many interventions to control or modify behaviour have been tried with greater or lesser success. The literature surveyed here has been selected on the basis that it contributes to an overall understanding of what factors influence human behaviour, and more specifically, of what types of interventions are likely to be successful in modifying behaviour in different circumstances.

3.1 Evaluating Evaluations

Given the ethical and practical complexity of the topic – people's use of outdoor pesticides in their home gardens – it is understandable that there have been no randomized control trials of the effectiveness of by-laws versus education and voluntary compliance programs. This type of study would be impossible given that laws apply to whole jurisdictions making it difficult to ensure that different 'samples' are comparable across geographic and ecological space, or in terms of economic class and cultural background. As well, no by-law affecting citizen behaviour would be passed without information and education campaigns to inform people of its intent so that the by-law intervention can never be assessed in isolation.

Despite the absence of what Pawson (2003) calls the 'Gold Standard' of evidence on effectiveness of intervention (randomized control trials), it is nonetheless possible to use a combination of quantitative and qualitative evidence to determine what has been most successful in changing environmental and health behaviour of individuals. With regard to health promotion, both Pawson (2003) and Nutbeam (1998) recommend the use of triangulation (comparing findings across types of studies, methods and researchers) to uncover agreement and synthesis in results. In his critique of the idea of 'research standards,' Pawson argues that:

> The acid test of research quality is whether a study provides a good explanation and this involves examination of how it jockeys for position amongst competing explanations. Inquiries are judged to be competent only when they secure a place in a developing network of explanations. *Research quality is confirmed only when synthesis is achieved*. (2003:2, italics added)

Nutbeam explores the difficulties of evaluating health promotion strategies that are long-term, non-specific ('healthy living' as compared to 'stopping smoking' for example), and incorporate community participation in their design implementation. These features of intervention strategies, as will be shown below, are also recommended for modifying environmental behaviours (pesticide and water use, waste reduction etc.). Nutbeam argues that measuring the success of health promotion programs must expand to include changes that are not measurable using "the tightly defined criteria of experimental design" (1998:38). He suggests that indicators such as individual literacy, competence, attitudes and intentions, community competence, empowerment, connectedness and ownership of programs, and institutional policies, procedures, practices and resource allocation are all significant in evaluating the effectiveness of health promotion interventions (1998). Brown (2003) argues that qualitative methods are essential for understanding how people react to and deal with environmental health concerns. Taken together, Pawson, Nutbeam and Brown support the use of multiple sources and types of information in order to evaluate the effectiveness of interventions on people's behaviour.

Using the criterion of synthesis to assess the quality of results, a wide range of evidence has been included. Both quantitative and qualitative studies are reported as well as evidence from both health and environmental promotion interventions since reducing home pesticide use clearly exists in the large overlap between these abstract categories of knowledge and behaviour. Much of the useful literature comes in the form of secondary summaries of the effectiveness of interventions. Finally, where their prescriptions agree with evaluation data, information from experts in the field of social marketing and public behaviour modification has been incorporated to formulate a synopsis of best practices available in Appendix 3 of this report.

3.2 Evaluation Literature

3.2.1 Secondary Source Evaluations

These are presented first because they tend to include higher level comparison and analysis of what works best across a variety of situations. Due to the paucity of literature, comparisons of interventions beyond the sphere of residential pesticide use are reviewed including those relevant to agricultural pesticide reduction, and to more general health and safety.

Residential Pesticide Use

The most useful summary was prepared by The Canadian Centre for Pollution Prevention and Cullbridge Marketing in 2004 (referred to here as the C2P2 report). This report summarizes interventions in residential outdoor pesticide use around the world and focuses on the activities of nine selected communities in Canada[6], the USA[7], Denmark[8] and Germany[9]. At the time of writing, only three of these jurisdictions (Quebec, Halifax and Baden-Wuerttemberg) had passed laws limiting or prohibiting residential cosmetic pesticide use while the others had conducted educational and outreach campaigns. The maturity of programs assessed varied from eight months to twelve years. Reduction in pesticide use was ranked as being high (51-90%), medium (25-50%), low (10-24%) or marginal (<10%). In Canada, the communities with by-laws had achieved high reduction while those without had only achieved marginal to low reductions (these were also the newest programs). In the USA, Chesapeake Bay achieved medium reduction based on retailer estimates of sales within a short period of time (16 months) using only information/education campaigns but this reduction decreased to low in a follow-up survey one year later. Washington and Texas communities reported only marginal to low reductions despite having longer running programs (ten and three years respectively). The authors of the C2P2 report conclude that the best way to reduce residential use of pesticides is to combine legal enforcement with education. Education alone produces only marginal to medium reduction. They suggest that using a system of permitting allows municipal officials the opportunity to communicate directly with users of pesticides and add that other institutional and/or political support [for example, a ban on the sale of pesticides (as in Quebec and Germany) or raising taxes on pesticides (as in Denmark)] is helpful. Denmark was able to achieve a high reduction without a law because community pride was invoked in national campaigns. C2P2 recommends tying residential pesticide use to other issues like water use in order to make alternative behaviours

[6] Hudson/St. Lazare/Notre Dame, Quebec; Halifax, Nova Scotia; Hamilton, Ontario; and City and District of North Vancouver and District of West Vancouver, British Columbia.
[7] Chesapeake Bay, Pennsylvania; Seattle and King County, Washington; and North Central Texas.
[8] Frejlev.
[9] Baden-Wuerttemberg

(using non-chemical methods for example) part of a global shift in residential lawn and garden practices. Finally, the C2P2 report acknowledges the limitations in its evaluation data as they were all drawn from surveys which could have biased results due to inaccurate reporting of pesticide use and other activities.

Agricultural Pesticide Use

Watts and Macfarlane did a similar review of pesticide reduction initiatives in agriculture around the world (1997), in which they surveyed initiatives from Europe[10], North America[11], Latin America[12] and Asia[13]. Globally, Sweden was most successful in reducing agricultural pesticide use without regulation but, the authors argue, this was related to unique factors such as a culture of environmental protection and the custom of 'Everyman's Right' whereby commons are freely accessible to all Swedes. In combination with financial incentives to switch to organic farming and a relatively small farming sector, Sweden's education and voluntary compliance system worked very well. Overall, the case studies demonstrate that the most successful interventions combine at least some regulation, measurable targets and widely available extension programs to teach farmers alternative agricultural methods (IPM, organic). More generally, Wilbanks and Stern (2002) warn that self-regulation does not work well within profit-making industries unless there is very strong public concern and specific industry leaders can be targeted and pressured. Indeed, part of the success of the Swedish case resulted from the fact that farmers enjoyed greater returns when they accepted small crop losses but used fewer inputs (Watts and Macfarlane, 1997). Regulations force farmers to think about alternatives and extension makes information easily accessible.

Watts and Macfarlane also recommend that interventions be backed with bans on pesticides or tax disincentives. They acknowledge that any government move to reduce pesticide use must combat pervasive and persuasive advertising by chemical pesticide formulators. In addition, the pesticide industry may try to protect their own interests through promoting 'Safe Use' campaigns as an alternative to initiatives designed to reduce reliance on pesticides (Sherwood et al., 2005). Indeed, this is the situation in Ecuador that Sherwood et al. have described, even though they have also documented an extreme situation of very high rates of pesticide poisoning (171 per 100,000 population) and mortality (21 per 100,000) in the country. It would appear from this data that perhaps toxic chemicals cannot be used 'safely' on a consistent basis under challenging social and environmental conditions. Instead, like Watts and Macfarlane, the authors conclude that the reduction of risk needs to come, at least in part, from hazard removal (Sherwood et al., 2005). While the challenges of reducing agricultural pesticide use are different from those found in the residential context, this summary analysis suggests that voluntary compliance does not work as well as a combination of regulation and education about alternatives. This conclusion resonates with the findings of the C2P2 report.

General Health and Safety

Adler and Pittle (1983-84) evaluated three information/education campaigns conducted in the USA: a national campaign to promote seatbelt use, a burn prevention campaign in Massachusetts,

[10] Sweden, Denmark, Netherlands, Finland, Germany, Italy, Norway, Switzerland and the UK.
[11] Canada and the USA.
[12] Cuba.
[13] Bangladesh, Bhutan, Cambodia, China, India, Indonesia, Korea, Lao PDR, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam.

and a heart disease preventive campaign run by Stanford University in California. All three campaigns employed 'state of the art' communication tools in mass media information campaigns. The first two were considered to have failed in that after two years seatbelt use had increased less than 3% nationally and after an eight month intensive media blitz, burn injuries did not decline in the Massachusetts area. The third campaign was modestly successful as it combined information, education and intensive medical and lifestyle consultations with a select group of participants. These participants did show impressive gains in their knowledge of the causes of heart disease and some behaviour modification but, Adler and Pittle argue, this intervention would be financially impossible to reproduce on a wider scale. The authors conclude that the popularity of information/education campaigns 'rests more on philosophical and ideological grounds than on solid empirical evidence supporting their ability to alter consumer behaviour' (Adler and Pittle, 1983-84: 161). They suggest that governments prefer information/education campaigns because they are generally cheap and do not threaten vested political interests the way that regulation often does. In fact, Adler and Pittle propose that, given their low rate of success, these campaigns are, in the end, less cost effective than regulation in many cases. The problem, they argue, is that mass media education is assumed to work as well as product advertising which, in turn, is assumed to be a powerful way to change behaviour. In fact, advertising works by influencing predisposed consumers to choose particular brands rather than by trying to get people to do something they are not predisposed to do. Further, while advertising can remove knowledge barriers to action, it cannot shift attitudes and behaviours, both of which are dependent on wider social norms and pressures. When a government tries to shift habitual behaviours without a clear benefit to the consumer and without any means of influencing social norms, campaigns are bound to fail. In addition, there is a tendency to abandon campaigns too soon in the "campaign of the month" subculture of government agencies. Adler and Pittle conclude that media information/education campaigns should be restricted to one-time behaviour shifts (buying an energy efficient appliance for example) or be carefully weighed against regulation in terms of costs.

3.2.2 Primary Source Evaluations

This section combines evaluations of specific programs and interventions from both the municipal and academic literature and again, not every evaluation reported was specifically of a residential pesticide use reduction program. Municipal reports tend to include prices while academic assessments do not. Conversely, academic assessments tend to be more precise regarding the target population and statistical significance of observed results.

Landscape Maintenance Practices and Outdoor Pesticide Use

In Canada, where initiatives by some municipalities have created a variety of legal contexts for residential pesticide use, the federal government's Pest Management Regulatory Agency has begun a web-based survey of pesticide use practices across the country. Their 2004 survey was completed by 300 Canadians, with responses received from residents located across the country in multiple jurisdictions. Participants volunteered to take the survey by following links from the Healthy Lawns Website. Therefore, this is not a random sample since potential participants were self-selected by their interest in lawn care practices and their choice of the internet as their tool for researching the issue. There are several significant methodological limitations to this study, and unfortunately the written report does little to provide a good understanding of the research methods and results. However, there is one finding of potential relevance here: of the 20% of respondents who reported using a lawn-care company, the majority ("over half") of those who

reported living in municipalities with pesticide by-laws also reported that they chose their lawn-care company's non-chemical or reduced-chemical pesticide alternatives to maintain their lawns, whereas among those who reported living in areas with no restrictions, the largest group ("over one third") chose the standard package, including chemical pesticide use, from their lawn-care company (Pest Management Regulatory Agency, 2004). This lends some support to the idea that by-laws can affect residential pesticide use behaviours.

As opposed to a regulatory approach, several US-based initiatives have focused on influencing pesticide use behaviours directly through education. Sadof et al. (2004) conducted workshops about biological controls of insect pests for Master Gardeners in Indiana and Illinois between 1998 and 2002. A total of 534 gardeners participated in the information workshops, and 161 of these gardeners also conducted guided research experiments in their own gardens to test the effectiveness of biological controls. The study population had an average age of 54 years (range: 35 to 77 years), and was mostly female (78%), college educated (76%) and urban (65%). Sixty-three percent had been Master Gardeners for more than one year. A baseline (pre-workshop) survey determined that 80% of the participants used chemical pesticides at least once per growing season and less than 50% used biological controls. One year after the workshop, questionnaires were sent to all participants to ask about the use of pesticides and biological controls since the workshops, and 227 (42%) of the participants responded. Two years after the workshop, a second questionnaire was sent to those who had responded to the first questionnaire, and 62 of these were returned (27% of the 227 initial respondents). Among these respondents, the number of participants using pesticides was significantly reduced both one and two years following the training, with approximately 15 to 20% fewer gardeners using pesticides. Those who adopted biological controls or increased their use of them (20%) were those who had participated in at least one of the guided experiments and were not using pesticides. Sadof et al. conclude that knowledge gained from hands-on experiments was a significant factor in people's subsequent commitment to biological over chemical pest controls.

In another initiative based on face-to-face interactions and learning, Thurston County, Washington, implemented a project in 2002, to create a pesticide-free model neighbourhood (Johnson, 2003). The 2-year project involved 14 households in a single neighbourhood and combined monthly workshops, information, personalized landscape consultation, free tools and products and mass media coverage. Participating households had to commit to 80% attendance at meetings, to passing on information about non-chemical pesticide gardening to at least five friends or non-participating neighbours and to abstain from using chemical pesticides for one year. At the conclusion of the project, all participants agreed to continue pesticide-free gardening. Johnson (2003) reports that the project was very successful, but a quick calculation shows that it cost over US$11,000 per household (total cost was US$156,000). No assessment of knock-on effects in the wider neighbourhood or county was reported.

In comparison, the "Bert the Salmon" mass media campaign that ran between 1997 and 2000 in King County, Washington, targeted middle-aged, middle class male homeowners through radio and television advertisements during baseball games (Reilly et al., 2001). The total cost for this media campaign was a much higher $1.4 million, although this was estimated to break down to a

cost of only $1.28 per 'homeowner'.[14] Over the four years, there were changes in behaviours according to polls of area households. An additional 13.3% left grass clippings on the lawn 'most of the time' (bringing the population total for this behaviour to 41%), 13.2% more households stopped using weed and feed on their lawns (population total of 60%), and 15.6% more households stopped watering their lawns (population total of 34%). However, Reilly et al. (2001) include no analysis (if one was done) of the causes of these behaviour changes over this time period.

A third approach, as evaluated by Kristoffersen et al. (2004), is to focus specifically on municipal use of pesticides. In this study, questionnaires were used to determine differences among 163 Danish municipalities in their use of pesticides, use reduction, and use reduction strategies at three points in time, 1995, 2000 and 2002. The context for the study was a 1998 agreement among levels of government to phase out municipal pesticide use by 2003. The study tested for correlations among the factors of baseline use (1995), pesticide reduction, size of municipality and whether or not the municipality had an action plan for phase-out. The only significant correlation (30%) was that between baseline use and total reduction such that municipalities with lower use rates in 1995 achieved higher overall reduction. The remaining 70% of the variance was accounted for by characteristics that were not measured such as local tradition and a highly effective national plan to research and disseminate alternatives to chemical pesticide use on public lands. Overall, there was a 78% reduction across the country between 1995 and 2002.

Indoor Pesticide Use

The Roach Coach Project conducted workshops and distributed information pamphlets to 80 households in Toronto in 1997 to encourage people to try Integrated Pest Management (IPM) methods in managing cockroach infestations (Campbell et al., 1999). Questionnaires were administered over the phone before the workshop and six weeks after the educational intervention to determine the effect of the intervention on knowledge (about cockroaches, pesticides and IPM), attitudes, and behaviour (choice of cockroach control method). There were statistically significant shifts in all areas with 90% using gel and paste treatments (versus 38% before the workshop), only 11% using pesticide sprays (versus 62% before), and 0 participants buying cockroach sprays (versus 60% before). Knowledge and attitudes showed small but significant shifts, although only 50% of participants actually read the pamphlet that was distributed at the workshop. However, while behaviour changed substantially during the eight months the program was active, the cost of $525 per household would make it unreasonable to replicate on a large scale.

Other Household Hazardous Products

Werner (2003) developed and assessed a program ("No More Chemically Dependent Homes") to promote a reduction in the use of toxic products in the home (such as pesticides, auto products, drain cleaners etc.) and to promote sharing rather than disposal of leftover products in Salt Lake County, Utah. Pre-existing social groups like church groups were contacted in 1998 to participate in an outreach program involving a short informational video, group discussion with a facilitator, information brochures and follow-up questionnaires and interviews. Seventy-three groups

[14] It is not clear from the report whether the '1.1 million homeowners' refers to households or registered title holders of a property or individuals living in a privately owned dwelling. Reports of behaviour change in households given by percent and number do not add to 1.1 million suggesting that homeowner does not refer to household.

participated. To assess the effectiveness of the program, group leaders plus one non-attendee to the session were asked to complete a questionnaire. Forty-seven leaders (64%) and 33 non-attendees (44%) completed the surveys. As well, 22 leaders participated in a telephone interview about the program. There were significant differences between attendees and non-attendees in their behaviours with attendees more likely to reduce their use of toxics, dispose of them correctly and recycle them by sharing with others. Werner concludes that seeing friends discuss new behaviours is significant for changing individual attitudes and behaviours.

McDonald (2001) assessed the Homebuyer Education Program in King County, Washington. The program has been running since 1997 and is part of the Local Hazardous Waste Management Program which works with businesses and households to reduce use of household hazardous waste (HHW), recycle these products and improve disposal practices. In the first two years, new homeowners were sent a brochure about HHW. In 1999, a tear-off postcard was added that allowed homeowners to request a Green Home Kit by mail. The kit included information about lawn and garden products, natural lawn care, HHW, locations for recycling motor oil, a green business directory, a magnet with information for disposing of leftover paint and a bookmark with the HHW website on it. The kit was pretested and this resulted in the addition of the 'widgets' (i.e. magnet, bookmark). Questionnaires were mailed to 511 households that had requested a kit. The mailing included coloured paper, real signatures, real stamps, was co-sponsored with a university and was sent in winter. People were contacted four times. All of this was designed to improve the response rate which was quite high at 75%. Overall, 84% of respondents reported that they had read the material in the kit, especially the information on lawn and garden care. Sixty-two percent had actually used the kit in some way (used a recycling centre, called for information, used the website etc.) and 70% said they would in future. Men and women had equal rates of use of the kit while less educated people were more likely to have used it (73%) than those with higher education levels (61%). Overall, respondents were mostly women (67%), middle aged (50% were aged 30-39; 84% were aged 18-49), college educated (74%) and childless (70%). The Green Home Kit Program operated on the principle of encouraging incremental commitments to behaviour change. Homeowners took a small step in mailing in the request for more information and this paved the way for greater commitments in terms of HHW behaviours. McDonald (2001:14) concluded that information provided by government was "unlikely to be the root cause of behaviour change so much as a tool used by those ready and likely to act".

Communication Methods

Sklansky et al. (2003) tested whether an information pamphlet accompanied by a brief oral explanation would improve knowledge about residential pesticide risks among mothers in Janesville and Beloit, Wisconsin, USA. Women attending Women, Infants and Children Clinics were approached to complete a baseline survey of their knowledge of home pesticide risks. The women were by definition poorer than the average since this was part of their qualification to attend the clinics. A total of 103 women completed the baseline survey. They were then assigned randomly to control or experimental groups. The experimental group was given an information pamphlet on pesticides and residential IPM along with a brief explanation of its contents. Seventy-three were contacted two weeks later and given the same questionnaire to assess whether the pamphlet had made a difference to their knowledge of home pesticides. The intervention group scored significantly higher on the follow-up test (19% improvement). While the authors conclude that information pamphlets did have an effect on knowledge, behaviour change was not

measured. In addition, it should be noted that the time lag was only two weeks, there were only 16 questions (all true/false), the average intervention score was only 11/16, and the pamphlet was accompanied by a verbal explanation. In short, this study demonstrates the limited impact of written information.

Chipman et al. (1996) compared responses to four media formats that explained the use of agricultural pesticides on food. Participants (n=86) were all women from the USA who completed a background survey to test their level of concern about food pesticides. There were two videos (news release and public service announcement) and two print messages (news release and newsprint column). Overall, the news releases (video and print) were preferred by all respondents while those who were most concerned about food pesticides responded more favourably to the printed versions than others. The authors conclude that this study demonstrates how difficult it is to design an information campaign that both maintains the interest of non-concerned citizens and is considered objective and useful by concerned citizens.

Both Patel (2000) and Murphy and Smith (1993) evaluated the perception of implementers as to the effectiveness of interventions. Murphy and Smith surveyed health professionals' attitudes to the use of health education leaflets to inform the public and change behaviour. While most professionals saw a need for the leaflets, they did not think leaflets were effective in increasing knowledge or changing behaviour (1993). Patel reviewed ten public education campaigns in Alameda County, San Francisco. Four were government projects while six were non-governmental. Government interviewees preferred mass media education formats while NGOs used community-based outreach (workshops, field training). Patel (2000) did not evaluate the success of the programs but did note that NGOs reported greater satisfaction with local outreach in changing behaviour than with impersonal information/education campaigns.

3.2.3 Evaluation Literature Summary

Overall, sources concur that changing behaviour is a complex business involving setting targets, providing necessary information and education, changing people's attitudes to the behaviour by shifting social norms, ensuring individuals make efforts to adopt the new behaviour and then measuring whether or not the behaviour has been adopted. This is complex when people obviously stand to gain by adopting a new behaviour (quit smoking, eat healthy etc.) and becomes even more difficult when clear individual benefits are not obvious (disposing of hazardous wastes correctly) or when people perceive the new behaviour to counter their interests (weeds in the lawn affecting property values). Most sources concur that information can affect people's knowledge of an issue, but that education alone is not particularly effective in changing attitudes and behaviour – it neither results in widespread behaviour modification nor is it necessarily cost effective when compared with regulation.

3.3 Review of Expert Knowledge About Public Behaviour Modification

It seems counter-intuitive that informing people about the negative consequences of their behavioural choices (for themselves or their environment) is not sufficient to induce them to modify those choices. Kreuter et al. (2004) suggest that in the fields of health and environmental protection and promotion, there is a class of problems known as 'wicked' problems. These are complex problems that are difficult to define or for which the definition is disputed, there are multiple stakeholders, there is no clear stopping point for the intervention and each community

experiences the problem differently. Residential pesticide use qualifies as 'wicked' by three of the four criteria. First, there is no consensus about the definition of the problem, with interested parties arguing over the issues of safety, exposure and necessity (TPH, 2002). There are multiple stakeholders including individuals (parents, homeowners), businesses (lawncare companies, pesticide manufacturers, golf courses) and institutions (municipalities, schools, NGOs, professional associations). And, residential pesticide use is not likely to be uniform in terms of practice or motivation for use given different types of gardening (food, flower, lawn), different cultural sub-groups and different social milieus and pressures (upscale suburban versus urban streetscapes and neighbourhoods). Kreuter et al. argue that "traditional expert-oriented and mechanistic methods of problem solving alone are inadequate and inappropriate" for "wicked problems" which require stakeholder consultation, flexibility and alternative approaches (2004:450). As many, if not most, non-point source environmental problems and health promotion problems are to some degree 'wicked,' there is a growing field of expert knowledge on how to promote behaviour change in these areas (through social marketing) and how to understand the precise relationship among knowledge, attitudes and behaviour. These ideas are summarized below.

3.3.1 Mass Media Information Campaigns to Increase Knowledge

Schultz (2002) argues that most information campaigns are based on the faulty assumption that lack of knowledge is the primary barrier to changing behaviour. Using the example of recycling, he argues that telling people how to recycle, if there are other barriers to the behaviour (convenience for example), will have only a marginal and short-term effect on behaviour. Valente and Schuster (2002) argue that mass information campaigns are useful to the extent that they reduce the time lag between having the necessary knowledge to alter behaviour and developing positive attitudes to the behaviour. They note that while most mass media information campaigns can only expect to change behaviour by about 1-5%, they are most influential on pioneers and early adopters who are less influenced by their social context. Wilbanks and Stern argue that information campaigns are necessary to provide information that would not otherwise be available (especially if it runs counter to corporate interests) but an undue emphasis on information alone distracts from other more effective and timely interventions and must compete for consumer attention within a context of information "soup" or overload (2002:341). Stern sums up the problem nicely by suggesting that information/education interventions can influence some target individuals and their social context "but cannot make inconvenient behaviors convenient, make expensive behaviors inexpensive, or remove institutional or legal barriers to behavior change. They often cannot even get people to put environmental actions high enough on their personal to-do lists to get them done, even if they are convinced to act" (2002:202). Valente and Schuster (2002) add that mass media campaigns, if they work, will only do so over the long term and so cannot be short-term projects or subject to evaluation too soon after implementation. Thus, information dissemination can only be effective on its own when lack of knowledge about an alternative behaviour is the *only* barrier to adopting it and this is most certainly not the case with residential use of pesticides.

Mass media can be used constructively, however, to get the word out about outreach programs and events. Hubbell and Dearing (2003) found that prepared news releases about community events were generally accepted by local newspapers but that what interested reporters was not so much the goals of the program (health extension in this case) but the activities of key community personalities in making the programs work. Where media coverage was largely positive, there

was greater participation in and funding for the programs. Negative coverage increased participants' determination to make the project work but impacted negatively on funding and enrolment. In the end, all media coverage increases the salience of an issue which gets it into public discourse. Hubbell and Dearing (2003) recommend having a clear media strategy, cultivating good personal relations with key reporters and having a regular stream of new information to maintain media interest.

3.3.2 Changing Attitudes

The next step in changing most behaviours, after providing the necessary knowledge, is to change people's attitudes toward the behaviour. Creating positive attitudes, like providing information, is a necessary but insufficient step to getting people to change their behaviour. It is also quite difficult to accomplish given that attitudes are formed in social contexts so that the goal is to change not individuals, but whole communities of people. Social marketing expert, Doug McKenzie-Mohr (n.d.), argues that the first step in this process has to be identifying social and attitudinal barriers to change. He suggests that shifting social norms is easiest with visible behaviours (placing recycling boxes at the curb for example) and hardest when people cannot know what others are doing. This can be overcome by publicizing private decisions (lawn signs, releasing survey results to the press etc.) (McKenzie-Mohr, n.d., Stern 2002, Hubbell and Dearing, 2003, and Schultz, 2002).

Schultz (2002) suggests that another way to influence attitudes is to involve community leaders in the new behaviour so that they become role-models and trend setters for others. This works best when a community is cohesive and relatively uniform so that people see themselves as similar to adopters of the behaviour. Stern (2002) suggests that existing community groups should be involved as intermediaries. Accessing communities is key to this phase of behaviour change and involves moving beyond the impersonal information campaign toward interpersonal and interactive programs (workshops, extension services, street fairs, home visits etc.). However, as Stern acknowledges "no matter how well designed a community-based communication program may be, it will only be effective in certain kinds of communities" (2002:207). In the case of residential pesticide use in a large urban environment, the first requirement would be to determine whether there were identifiable communities and whether they were cohesive enough to coordinate and benefit from outreach programs (Schultz, 2002).

3.3.3 Removing All Other Barriers

Many authors acknowledge that even with a normative shift in attitudes and sufficient knowledge, behaviour can be resistant to change if there are other barriers. For example, Berger (1997) found that where people have access to recycling in Canada, there are very high participation rates (94% in Ontario) but access was greater for people with higher socioeconomic status. Berger (1997) concluded that making recycling (and all environmentally friendly behaviours) accessible was the first significant barrier to overcome to expand this behaviour. Similarly, access to information and products relating to alternative home pesticide use must not be limited by class, region or culture.

Templeton et al. (1998) argue that non-toxic IPM strategies are time- and labour- intensive in terms of monitoring pests, learning about IPM and implementing non-chemical controls. Since residential pesticide users also tend to be higher earners who may value their time very dearly, and can afford to pay for time-saving products and formulations, they may not easily be

convinced to sacrifice their time for IPM-based gardening practices. Aceti Associates (2002) identified a number of other barriers that impede alternative lawn care practices that cannot easily be addressed with information/education or public outreach. These include the effect of less than perfect lawns on property values, the expense of alternative products, the greater labour required to implement alternatives, a lack of time to learn about alternatives and the counter-weight of lawncare industry advertising that leads people to believe pesticides are both necessary and safe[15] (Aceti Associates, 2002). In some areas, there may also be institutional impediments such as condominium or gated community rules mandating particular landscape choices or municipal lawn height and weed restrictions.

Some solutions to these problems, apart from mandating the behaviour by law, can include providing economic incentives and disincentives (rebates and taxes), labeling products, providing information about low maintenance and/or low-cost alternatives and overturning any legal impediment. Any campaign that fails to first identify and then address these barriers will likely achieve a lower rate of behaviour change.

3.3.4 Correlations Between Environmental Behaviours

The problem of identifying the meaningful barriers to behaviour change does not appear to be made significantly easier by an understanding of other environmental behaviours and the barriers to their change. Berger's work (1997) showed some correlations among environmentally-minded behaviours, and between these behaviours and socio-economic variables. However, lawn care practices (and transportation decisions) did not appear to follow the same pattern as might be expected, based on other behaviours. Indeed, McKenzie-Mohr and colleagues (1995) concluded that each behaviour must be individually assessed to determine the specific factors that encourage or prevent people from adopting it. This conclusion was based on an investigation of general correlates of environmentally positive behaviour in the Canadian context. Assessing correlations between these environmental behaviours and demographic, psychological, economic, and knowledge factors showed that there were no constant predictors of who would engage in a given behaviour (e.g. using energy saving light bulbs, recycling, composting) (McKenzie-Mohr et al., 1995).

Wakefield et al. (2005) explored these ideas further, using a framework that describes interactions between influences and behaviours at three different levels: individual, neighbourhood, and social networks. Results of a case study investigating the utility of the framework suggested that certain individual characteristics, local exposures, social network variables and predisposition (e.g. concern for the environment) were all important predictors of environmental action. However, although there were some commonalities, the authors noted that the factors predicting action were observed to vary by the type of action. As well, like McKenzie-Mohr et al. (1995), they concluded that the differences between predictors of environmental actions need more attention, and that the different types of action should not automatically be conflated. They also emphasize the importance of non-individual factors as determinants of participation in environmental actions, in particular the central role played by contextual factors (e.g. the visibility, duration and

[15] The United States General Accounting Office (1990) found that lawncare companies made illegal claims about the products they employed using terms like 'safe,' 'nontoxic' and 'completely safe for humans.' Similarly, in Canada the Pest Control Products Act prohibits the description of pesticide products with such terms, and yet a 2002 report by the Toronto Environmental Alliance indicates that such claims are made with some frequency by lawn care and pesticide companies.

intensity of local environmental pollution) and collective resources (e.g. social network ties and formal participation within community structures and organizations) (Wakefield et al., 2005).

3.3.5 Maintaining New Behaviours

If people know how to change their behaviour, believe that there is moral or normative pressure to do so and face no other barriers, they will likely alter their behaviour. The next challenge is to maintain the new behaviours over time. McKenzie-Mohr (n.d.) suggests the use of prompts to remind people of the desired behaviour ('turn lights off' stickers near switches for example) and providing incentives as closely tied to the behaviour in time as possible. Valente and Schuster (2002) also advocate using positive reinforcement and concur with McKenzie-Mohr that economic incentives are the least useful. They advocate using non-monetary rewards like social approval. Most experts agree that maintaining new behaviours over time requires a long term commitment to information/education and outreach campaigns.

3.3.6 Mandating Behaviour Change

Regulating behaviour by law would seem, in contrast, to be the easiest way to make people change their behaviour but if there is no system of enforcement, no one knows about the law and the behaviour is mostly invisible, then regulation alone will also be ineffective. The C2P2 report stresses that by-laws have been effective when they were widely advertised and when municipal employees could reinforce the message about alternatives during the face-to-face permit application process. Where permits to use chemicals were issued to professional applicators on behalf of residents (Halifax) this opportunity was lost. Thus, even with legal restrictions, there still needs to be information/education and outreach components to ensure compliance, encourage alternative behaviours and discourage law-breaking.

3.4 Synthesis

Bearing in mind the proviso that expectations for information/education campaigns are often unrealistic, the literature reviewed above confirms that merely telling people that they should or should not do something has very little overall or long-lasting effect. Indeed, it is difficult to create materials that are memorable and can compete with the myriad streams of information people are subjected to every day. This is especially so if individuals are influenced by strong social norms and cannot perceive automatic benefits from the alternative behaviour. In the case of residential pesticide use, there are both moral and corporate pressures on lawn and garden managers to keep their yards pest free as a symbol of their social, economic and personal status and commitment to community and family values. As well, people generally learn lawn and garden care practices from those around them, not from government or NGOs, making it difficult for a public information campaign to supersede these trusted sources.

Overall, changing convenient and socially approved behaviours cannot rely solely on information/education campaigns. Where voluntary interventions have been successful, there has been a cultural predisposition to change (for example, environmental respect in Sweden, community pride in Denmark). Otherwise, the greatest success is reserved for programs that combine regulation with information/education and outreach to make alternatives widely known.

4. CONCLUSION

The answer to the original question regarding the effectiveness of legislative versus information/educational strategies in changing the cosmetic use of chemical pesticides in the residential context is, simply, that neither approach works well in isolation. People cannot comply with laws that are not widely announced while relying solely on public education does not produce significant or long-lasting behavioural changes except under circumstances of intensive participatory outreach focused on a limited number of targets (individuals, households or community groups). While voluntary compliance campaigns appear to be cost effective and politically less contentious than regulation, if they do not achieve the desired changes, legislation can, in the end, be the more effective strategy both in terms of cost and results.

As a "wicked problem," however, residential pesticide use is unlikely to change dramatically without further legislative support (banning the sale of pesticides to consumers for example) or a multi-pronged education campaign that will address the specific and general barriers to change experienced across a given municipality. In the Toronto context, the first key challenge is to identify the ethno-cultural and socioeconomic barriers specific to different pesticide using segments of the population. Second, these barriers need to be addressed in linguistically and culturally specific formats and media to be effective. Third, while the 'community' can be a cost effective target, the existence of communities, their structures and patterns of leadership need to be identified before these types of approaches can be implemented. To the extent that the City already connects with known community groups, organizations and leaders, these contacts could serve as a network of key informants to determine how different groups use residential outdoor spaces. These same informants could become consultants or testers for municipal education and outreach strategies.

In the end, the goal is to shift social norms such that using pesticides for cosmetic purposes becomes as morally suspect in this century as letting 'weeds' run rampant was in the last. This is the ultimate cost-effective means of behaviour control and it is achievable; one need only remember the smoke-filled restaurants, malls and hospital waiting rooms of the recent past for hope and inspiration.

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APPENDICES

Appendix 1: Summary of Quantitative Data Referenced in Sections 2.2 and 2.3

Author(s)	Date of Study	Type of Study, n	Sampling Frame	Selection Criteria	Research Question(s)	Summary of Findings
Adgate et al., 2000	1997	In-Home Interviews, n=308	Commercial phone list for Minneapolis, St. Paul, Goodhue and Rice Counties, Minnesota	Households selected to contain children aged 3-13. Sample controlled to represent wider population as per the Minnesota Children's Pesticide Exposure Study	To investigate what pesticide products are stored and used in households with young children.	97% of households contained pesticides and 88% had used them in the previous year. 850 unique pesticides were found across the sample and 9% of households had banned products. Over half of these products were insecticides, then repellents then herbicides. DEET had been most often used in the last year. There were no rural/urban or socio-economic correlations to use and storage patterns.
Bass et al., 2001	1999	Survey, n=107	Arizona, USA	Households with a child under 10 years and having used pesticides 6 mos prior to the survey	To investigate what pesticides are used in the home; how are they used and stored; how are they disposed of.	148 products found with 70% stored in the home and half stored less than 4 feet/1.22m from the ground. The kitchen was the most common storage and use area: 69% reported using pesticides there.
Berger, 1997	1990-91	Statistics Canada Surveys: 1990 Income; 1991 Environmental Questionnaire to same sample, n=43,000	N/A	N/A	To investigate and understand the role of socio-economic & demographic indicators as they correlate with environmentally responsible behaviours, especially recycling, in Canada.	Access to recycling facilities varies with socio-economic factors like income, home ownership and education. Large percentages of those with access (80% national, 94% Ontario) do recycle so access rather than environmental philosophy accounts for correlations with higher class.
Butterfield, National Gardening Association, USA, 2005	2004	Survey, n=2000+	US households	N/A	To investigate how environmentally responsible lawn and garden consumers are.	67% maintain yards to add beauty to home & neighbourhood; 53% read pesticide/fertilizer labels carefully; 32% research organic alternatives before using insect or weed pesticides

Author(s)	Date of Study	Type of Study, n	Sampling Frame	Selection Criteria	Research Question(s)	Summary of Findings
Coppin et al., 2002	1996	Questionnaires completed at home, n=247 (119 rural, 128 urban)	Random selection of rural (from phone company) & urban (from water utility) residents in Cache County, Utah	Both urban and rural: adult with most recent birthday selected	To investigate factors affecting public acceptance of pesticide use including trust in pesticide information from various sources, perceptions of safety, concerns about exposure, personal experience with pesticides and residence (urban/rural).	Sampled adults viewed pesticides as moderately acceptable with few having strong reservations. Trust in information (govt & industry) and concern about exposure did not correlate with acceptability. Rural respondents had more experience with pest. use and more confidence in the safety of pesticides. This was a stronger predictor of acceptability than residence alone.
Davis et al., 1992	1989-90	Telephone Interviews, n=238	Missouri Families	N/A	To investigate the use of pesticides in the home, garden, orchard & yard.	97.8% used pesticides at least 1/yr and 67% used them 5+/yr. 80% had used them during pregnancy and 70% with children of less than 6 mos. old. 80% used pesticides in the home followed by 57% using herbicides in the yard, 50% using flea/tick control with pets and 33% in the orchard. Flea collars, carbaryl, sevin, no pest-strips and lice shampoo were most used.
Feagan & Ripmeester, 1999	1997	In-home interviews, n=49	Private residences where a non-lawn yard was present in the neighbourhood in Port Colborne, St. Catherines & Niagara-on-the-Lake, Niagara Region, Ontario.	N/A	To investigate the extent to which the lawn is so 'naturalized' or taken for granted by homeowners that they don't see it as a place of environmental concern.	45% connected their lawn care practices with a deeper environmental concern, 55% did not. Both groups had similar mowers and cutting regimes and both thought lawns were important to neighbourhoods. The first group used fewer chemical inputs but both groups accepted or rejected alternative, non-lawn yards according to their perception that owners worked hard on their yards.

Author(s)	Date of Study	Type of Study, n	Sampling Frame	Selection Criteria	Research Question(s)	Summary of Findings
Grey et al., 2004	2001	In-home interviews, n=147	Households participating in Avon Longitudinal Study of Parents and Children (ALSPAC), Avon & Bristol, UK	ALSPAC participants had children born between April 1991 & December 1992. A screening questionnaire was adminstered at ALSPAC Focus Clinics and 147 were selected randomly from 713 possibles.	To investigate non-occupational use and disposal of pesticides in the UK.	93% had used pesticides in the last year. Information about what to use came from friends, family and neighbours while labels were the main source of safey information. However, few (28%) used precautions like wearing gloves to treat indoor pest problems. Kitchen, garden shed and garage are the most common storage areas. 84% preferred non-chemical interventions for head lice which was linked to school campaigns to discourage chemical shampoo use.
Grieshop & Stiles, 1989	1986	Mailed Questionnaire, n=415	Respondents requested information on pesticide safety from the University of California by mailing in a postcard found near pesticide displays in retail stores, Sacramento Metropolitan Area, CA, USA	Self-selected by returning the questionnaire	To investigate home pesticide use, sources of information on pesticides, precautions taken and perception of risk and safety.	Respondents used pesticides most on the lawn (91%), in the home (88%), on flowers (87%) and vegetables (79%). Most used the retailer as a source of information (70%) followed by the label (65%) though 38% said they didn't always understand the label. 53% took no precautions during use and only 12% locked unused chemicals. Women viewed pesticides as riskier and used fewer than men but overall, perception of risk did not guarantee safe behaviours.
Grieshop et al., 1992	1988-89	Mailed Questionnaire, n=71	Respondents from Grieshop & Stiles 1989	Respondents from the original 415 who still lived in the Sacramento area and agreed to participate.	To investigate the decision-making tools used by home gardeners in selecting chemical versus non-chemical alternatives.	Generally people choose alternatives for their safety and chemical products for their effectiveness. Women use fewer chemical products. Men have more gardening experience and more direct experience with chemicals; they also view them as safer.

Author(s)	Date of Study	Type of Study, n	Sampling Frame	Selection Criteria	Research Question(s)	Summary of Findings
Jetter & Paine, 2003	N/A	2 phone surveys with mailed information booklet in between calls, n=522	Random selection of households by survey research firm in Los Angeles, Ventura & Riverside Counties, CA, USA	N/A	To investigate public preferences for chemical (carbaryl), biorational (Bacillus thurigensis) or biological (release of natural predator) control methods for G.scutellatus beetle infestations of public eucalyptus trees.	People preferred the biological over chemical options but cost was the most important variable. Waiting longer for results was not a deterrant but multiple applications (carbaryl, Btt) was. Cost tolerance could be related to perceived value of affected plants or trees.
Robbins et al., 2001	2000	Phone survey, n=417	Random digit dialing	Households with grass lawns in Ohio state, USA	To investigate the class structure of use of lawn care chemicals.	About 50% of households used nitrates or pesticides. Users of inputs had higher incomes (US$75,000+), more expensive homes (US$250,000+), were older (60+) and 73.8% of those who know their lawn care activities had a negative environmental effect were users of inputs nonetheless.
Robbins & Sharp, 2003	2001	Phone survey with follow-up phone and face-to-face interviews, n=594	Random digit dialing	Respondents responsible for lawn care across the USA for the first survey. Ohio residents chosen for follow-up interviews.	To investigate correlates with use of lawn care chemicals (via contracted company or self-application).	Chemical lawn care company users were most likely to have high income, high value homes and be well educated. They were also most likely to believe that their practices had a negative impact on local water sources. Those who practiced intensive lawn management were also more likely to report attachment to their community, family and to nature.
Sachs et al., 1987	1965 & 1984	In-home interview (1965) (n=728) & Phone survey (1984) (n=605)	Random sample of houses (1965); Random selection of telephone numbers (1984) in Pennsylvania, USA	Both samples selected for adult respondents doing grocery shopping for household	To investigate changes in consumer attitudes over time toward pesticide use in agriculture and domestically by repeating an earlier study (Bealer & Willits, 1968).	Socio-economic characteristics explained little variation in response. Overall, respondents in 1984 expressed more concern about the effects of pesticides on wildlife, farmers and consumers of pesticide sprayed food. More people grew their own vegetables in 84 (59% vs. 42%) and fewer used chemical sprays in home food gardens in 84 (35% vs. 73%).

Author(s)	Date of Study	Type of Study, n	Sampling Frame	Selection Criteria	Research Question(s)	Summary of Findings
Slocum et al., 1997	N/A	In-home interviews, n=20 couples / 40 people	Home-owning couples living in matched suburban areas in Michigan State, USA	Half of the couples were selected as users of a lawn care service and all were well-educated middle to upper middle class	To investigate attitudes toward lawn care chemicals and whether these were influenced by demographic variables, use of a professional service, environmental orientation or health beliefs.	Younger respondents tended to be more environmentally sensitive and to perceive a health threat from pesticides. Women were more likely to perceive lawn chemicals as a threat to health. Users and non-users of a service were the same. The majority did not connect their use of lawn chemicals with changing the global or local environment.

Appendix 2: Summary of Surveys of Pesticide Use Patterns in Canada

Table Compiled by Rich Whate, Environmental Protection Office, Toronto Public Health

Jurisdiction	Notable Findings	Comments
City of Waterloo Public opinion poll February 2000	The majority of respondents identified insects, rather than weeds, as the target for pesticides. 41% of respondents feel pesticides are somewhat necessary on lawns, 23% feel not at all important, 20% say very important 41% of respondents are described as having "mixed feelings" about pesticides – they are not very concerned, and feel pesticides may be somewhat necessary. Only 16% are not concerned at all.	Survey conducted prior to high-profile coverage of Supreme Court decision in Hudson, PQ.
Town of Caledon, ON Public opinion poll November 2000	44% of residents use pesticides (51% urban, 35% rural) 53% of those use a spray companies 53% of those who do not use pesticides report having used them in the past - 27% cite health concerns, 21% found alternatives, 10% cite environmental concerns as reasons for stopping the use of pesticides. 73% said they would stop using pesticides if they were shown an alternative. 83% agreed that pesticides posed environmental hazards. 59% support a total ban on pesticides; 75% support a restriction to certain days of week. 80% more likely to support ban after reading about health concerns	Survey conducted prior to high-profile coverage of Supreme Court decision in Hudson, PQ.
Halifax Regional Municipality Omnibus poll Fall 2001 & Omnibus poll Fall 2002	90% aware/had some general knowledge of by-law 82% using safer alternatives (61% using no pesticides, 23% using alternatives and some permitted pesticides) 85% interested in learning more about alternatives 7% still using pesticides as their main means of pest control 89% using safer alternatives (76% using no pesticides, 13% using alternatives and some permitted pesticides)	By-law passed in 2000, came into force in 2003. Public education began in 2000. HRH suggests that these comparison surveys provide evidence of the success of public education programs and a pending by-law Survey question introduced by-law at the beginning - respondents may have been influenced by desire to appear law-abiding. Awkward wording may also confuse reporting.

Jurisdiction	Notable Findings	Comments
City of Ottawa Public opinion poll April 2002	80% of residents have a lawn or garden; 48% of this group uses pesticides (1/2 of this group first reported not using pesticides, then acknowledged some use of chemicals). 20% report hiring a company for all or part of the work. Pesticide use generally increases with those that do not consider them to be a hazard, place high value on appearance/a weed-free lawn, and/or hire a lawn care company. Use of alternatives (eg. weeding) is strongly linked to those who do not use pesticides or place high value on a weed-free lawn. 7% of those familiar with non-chemical methods rate them as or more effective than chemical methods.	Poor understanding of term "pesticides" may underestimate actual use…as people become more familiar with term over time, numbers may actually increase, inflating reductions Pesticide use strongly related to the value people place on the appearance of the property; alternative methods not recognized to be as effective, even among those who use alternatives.
Middlesex-London Health Unit Door-to-door survey April 2002 & RRFSS May - Dec 2002 & RRFSS June 2003 - Jan 2004	77% support a pesticide ban on private property* 57.8% support a pesticide ban on private property Of those properties with a lawn or garden (82.6%), 46.2% report using pesticides 19.7% of all households report hiring a pesticide company: 63.4% of companies used pesticides and 79.7% of companies provided info on how to reduce exposure to pesticides. 36.5% of companies offered pesticide-free programs. 35.4% of those with lawns reported using pesticides whether they hired a company or not; of these, 76.3% spot sprayed rather than treated the entire lawn. 57.2% of those with laws reported using alternatives - not having information was given as the most common reason for not using alternatives. 43% said that pesticides have a negative effect even when used properly.	*Only City of London residents polled in door-to-door survey. Residents of London and Middlesex County polled for others City of London and Middlesex County polled. City of London began PHC/IPM public education program in 2003. 9.2% reported an awareness of this campaign.
York Region RRFSS Jan - Oct 2002 & RRFSS Jan - Dec 2003	61% support for by-law on private lands. 72% supported by-laws for municipal and 65% for commercial lands 56% support for by-law on private lands. 64 % supported by-laws for municipal and 61% for commercial lands	Decline in support for private and commercial by-laws between 2002 & 2003 not statistically significant
Peel Region RRFSS Jan 2002-Jan 2003	68.1% strongly or somewhat support a municipal ban, 61.9% for commercial properties and 59% strongly or somewhat support a ban on private property (for both, support declines from Caledon to Mississauga to Brampton)	Peel advises caution in interpreting results.

Jurisdiction	Notable Findings	Comments
City of Peterborough Public opinion poll Sept 2004	28.5% of homeowners use pesticides. 64.3% of them stated that they would stop using them if given a way to have "a weed free lawn without cosmetic pesticides." 47% of those who do not use pesticides reported that they had used them in the past. 83.8% support a phase-out of pesticides on private property 63.6% supported a by-law to phase-out pesticides	
City of Edmonton Public opinion poll Sept 2004	26% of homeowners use pesticides. 54.0% of them stated that they would stop using them if given a way to have "a weed free lawn without cosmetic pesticides." 40.3% of those who do not use pesticides reported that they had used them in the past. 75.4% support a phase-out of pesticides on private property 50.6% supported a by-law to phase-out pesticides	
City of Toronto Public opinion poll Fall 2002 & RRFSS Oct 2003 - Apr 2004 & RRFSS Oct 2004 - Apr 2005	76% of respondents had a lawn or garden. Of this proportion: 33% reported using pesticides and 27% hired a company 40% of those applying pesticides themselves also hired a company 62% of those that hired a company reported the company using pesticides, 46% used alternatives and 30% of those that used alternatives also hired a company. 17% of those who used alternatives also used pesticides. 72% support a by-law on private property (no difference whether they own a lawn or not). 54.8% of respondents had a lawn or garden. 36.6% used pesticides, 24% hired a company 47.5% of respondents had a lawn or garden. 30.1% used pesticides, 24% hired a company	Public opinion poll conducted following highly-publicized consultation process and Council debates, which may affect reporting RRFSS data is not statistically significant (due to small sample size and apparent misunderstanding of the term "pesticides" and "pesticide-free methods"), but suggests an estimated 10% decrease in the use of pesticides and a 10% increase in the use of pesticide-free methods, by both individuals and lawn care companies. Data also suggests that more than half of lawn care companies used pesticides and less than half offered to use alternatives.

Note: These surveys illustrate some challenges in collecting data on pesticide use, which need to be addressed by municipalities:

- Respondents frequently misunderstood the terms "pesticide" and "pesticide-free" but still responded to the question. For example, people may report using no pesticides while using a weed and feed product (which is a fertilizer-pesticide combination), or under-report their use of techniques such as proper mowing or aerating because they do not consider these to be a pesticide-free approach or are thinking primarily of products they can buy in a store.
- Municipalities must use caution not to lead with questions relating to a pesticide by-law, as respondents' desire to appear law-abiding may result in an under-reporting of pesticide use.
- Repeat surveys are required to explore changes in pesticide use from year to year and the factors that may have influenced any change.

Appendix 3: Strategies for Effective Behaviour Modification

Effective behaviour modification in the public sphere necessitates a variety of strategies including providing knowledge, shifting social norms, removing economic, legal and structural (time) barriers, regulating and enforcing behaviour and maintaining momentum over a long enough period for this to have a permanent effect. To relate all of this to the specific problem of reducing residential cosmetic use of chemical pesticides in Toronto or other Canadian communities, this review will conclude with a list of best practices derived from all sources consulted.

1. **Advertise by-laws widely** and establish clear enforcement policies and penalties.
2. **Determine the general and specific barriers to reducing pesticide use:** General barriers such as cost, time limitations and property values may not be subject to municipal intervention but they can be addressed in campaigns if they are significant for pesticide users. In other words, if non-chemical pesticides are more expensive *and this is identified as a barrier by users*, a campaign could stress, for example, that one's health and the environment are worth it or that there are actually savings over the long term because of the need for fewer applications. Specific barriers will differ among different sub-groups (cultures, classes, types of gardeners) and need to be assessed. This will likely require more than a public questionnaire strategy as these are limited by language, by willingness to self-report behaviours and by people's ability to articulate diverse influences on their behaviour. As an example, while lawn managers are generally able to identify neighbourhood pressures to conform, they may not recognize the effect of mass advertising on their lawn maintenance decisions (Robbins and Sharp, 2003a; Feagan and Ripmeester, 1999). Some **qualitative research** will be necessary to elucidate the barriers affecting different sub-groups of pesticide users.
3. **Target information campaigns to sub-sections of the population** according to the barriers (individual and social) that affect their behaviours. Use appropriate language and metaphors to communicate the message. Create messages that are at least as compelling as those used by advertisers. When pesticide-using sub-groups are identified, have information about alternatives available immediately in their preferred language on the website or in targeted sendouts. People are very unlikely to make the effort to request information in their language if they are not already committed to changing their behaviour. Gardening terminology and species names tend not to be learned in a second language as these are largely domestic activities so this barrier must be addressed.
4. **Always pair the negative message** ('don't use pesticides') **with a positive one** ('use this solution for that problem' or 'avoid that pest problem altogether by …').
5. **Involve influential role-models** (gardening experts, model homes in neighbourhoods, community leaders) to shift social acceptance of alternative garden design and maintenance. Gardening experts and magazines will likely be most useful in influencing relatively affluent, English-speaking households whereas community leaders will most likely be the easiest access to non-English speakers and lower income communities. Remember that most people get their gardening expertise from friends and family so that changing a few key people can ramify through a group. Consider involving children who are powerful conduits of environmental and health information for their parents. In addition, signs on all public or institutional properties using IPM or organic pest

management would give people local models for alternative practices. A municipal website linked to specific parks or buildings could provide details about pest and drought resistant plants used in public landscaping.

6. **Make changing social norms a priority** since this will greatly enhance compliance with the by-law, and over the longer term, may remove some barriers like the property value incentive to having a picture-perfect lawn and garden. For example, if property values dropped due to latent pesticide residues in the garden or home, this would provide a significant economic incentive to stop using pesticides. A guide to home buyers advising them to look for toxics and ask sellers and agents about lawncare practices would soon have the effect of communicating an anti-pesticide message. Part of this message must include a realistic portrait of the non-chemical landscape and promote reasonable expectations so that people do not become frustrated if alternative products work more slowly or only in combination with a holistic lawn and garden care regime.
7. **Try a variety of outreach campaigns** and evaluate them over different periods of time to assess immediate and long-term accomplishments. Keep expectations for results reasonable and maintain a consistent strategy over time to reinforce the core message. All experts advise pre-testing all campaigns for clarity and effectiveness.
8. **Reward positive behaviours**. Organic garden or home produce competitions within or between neighbourhoods is one idea that would attract local media attention as well as highlight alternative practices.
9. **Communicate the personal and public risks of chemical pesticide use** in terms people can understand (no jargon or probabilities) and in terms that emphasize consequences for children (and possibly pets). Take advantage of the uncertainty of pesticide exposure consequences over the long term to exploit its 'dread risk' character. Giving people concrete actions to avoid exposure could be tied to enforcing the by-law in the sense that neighbours do not have to suffer involuntary exposure (which creates more fear) if they have a way to report pesticide use near them.
10. **Group pesticide use with other relevant issues** to improve cost effectiveness of campaigns and to make pesticide reduction part of a wider commitment to environmentally friendly property management. For example, advocating a move away from lawns for pesticide *and* water concerns gives homeowners two reasons in place of one for thinking about alternative ground covers. Pairing outdoor pesticide use with the presence of lead paint, asbestos, or other dangerous substances inside the home and CCA-treated wood outdoors in a home buyers guide would give them a list of questions to pose to sellers and agents. Offering xeriscaping alternatives along with IPM or organic pest management presents a holistic alternative to lawns.
11. **Link into other programs** like the Backyard Wildlife Habitat program to disseminate information about chemical pesticide alternatives.
12. **Use popular media at every opportunity**. Press releases about all activities regarding pesticide reduction as well as having a spokesperson available to answer reporter's questions would drum up attention on the issue. Creating a steady stream of new material primes media interest. Mutually beneficial cross links with gardening magazines or newsletters (eg., between an online article on IPM in X magazine and the municipal website) would increase traffic for both parties.