Informing Water Use Planning with Consumer Preferences: A Case Study in Kelowna, B.C.

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Abstract

Increased residential water use and climate change threaten fresh water supplies, especially for communities located in dryer regions such as Kelowna, B.C, Canada. Outdoor water use is an excellent target for water conservation, as it accounts for a major portion of residential water use. This study employed a choice experiment to examine detached homeowners' preferences and intended behaviour for domestic lawns in Kelowna. To account for context specific choices, current lawn features (i.e. the status quo) were individualized in the survey and resulting model. Findings illustrate that the proportion of turf around the home is the strongest factor driving residents' lawn choices. Also, residents with higher proportions of turf are more interested in water conserving landscaping retrofits and, therefore, make priority targets for water conservation strategies. These residents are also most receptive to a reduction of lawn cover, constituting significant water savings. This knowledge can help planners make more informed decisions about water use planning.

Keywords: Choice experiment; water resource management; water use planning; landscaping preferences; lawn; turf

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1. Introduction

Water is one of the most important resources on Earth. For example, the human body is composed of up to 60% water and other organisms can be comprised of up to 90% water (USGS 2012). Throughout the planet, plants and animals rely on water to function and survive and approximately 70% of the earth is covered in water (Environment Canada 2009). However, freshwater sources only hold 2.5% of Earth's water and, out of this, 68.9% of freshwater is in the form of glaciers and permanent snow cover (Environment Canada 2009). The scarcity of fresh water supplies globally demonstrates how vulnerable freshwater resources are to stressors such as climate change. As temperature increases, glaciers and permanent snow cover melt at increasing rates leading to freshwater loss to oceans and saltwater bodies (Kundzewicz et al. 2008). Furthermore, studies predict that river flows and groundwater recharge in currently water stressed semi-arid and arid regions will decline (Döll and Flörke 2005). Drought prone ecosystems and their inhabitants, therefore, will be adversely affected if preventative measures aren't taken to reduce drought risk and water stress.

Currently, many different factors increase potable water demand worldwide. Population and economic growth, urbanization, climate change effects (i.e. unpredictable weather patterns and escalating drought extent and frequency), land use changes, and pollution will adversely impact earth's future water supply (Bates et al. 2008; Willis et al. 2011; Harlan et al. 2009; Postel et al. 1996). Additionally, high consumption of water in affluent nations is increasing (Harlan et al. 2009) and attempts to reduce consumption through levelling growth or technological innovations will most likely be offset by increasing prosperity in developing nations (Myers & Kent 2003). Therefore, as urbanization increases throughout the world, reducing urban household water consumption constitutes an important impetus to conserve water for the future (Harlan et al. 2009; Mainieri et al. 1997; Berk et al. 1980). However, currently, no universal solution exists for the management of urban water. More likely, many different approaches should be applied in countries, regions, and watersheds. For the scope of my research, I will discuss one solution: water use planning.

Water use planning is one approach to managing residential urban water resources (Willis et al. 2011). For my research, water use planning focuses "on supplying tools, mechanisms and knowledge to enable residents to continually reduce their potable water consumption" (Willis et al. 2011 p. 1996). Compared to supply side options for addressing water supply security, water use planning programs seek to curb water use rather than increase water supplies (White et al. 2007; Willis et al. 2011). In countries such as Canada, regional water management authorities and local water utilities can use water use planning to augment their current water supply programs or alleviate deficiencies in water supply infrastructure investments.

Canada is often perceived as a water rich country storing one-fifth of the world's supply of freshwater; however, national water supply figures do not often reflect the realities of local conditions (Sprague 2007; Pentland 2009; Boyd 2003). While Canada holds 20 percent of the world's freshwater in lakes, the county only holds 6.5 percent of global renewable freshwater supplies (Sprague 2007; Bakker 2009), which is defined as the total quantity of fresh water available as the net result of precipitation minus evapotranspiration plus annual inflow by rivers and underground flow (UNESA 2003). According to Pentland (2009), "Canada has about seven percent of the world's renewable water supply and that supply meets the ecological needs of about the same proportion of the world's landmass" (p.61). Further, while Canadians are relatively water wealthy on a per capita basis, most Canadians live along the southern border of Canada where only 40 percent of the nation's freshwater (i.e. 2.6 percent of global freshwater) is available (Brandes, Maas, and Reynolds 2006; Sprague 2007). Also, Canada's fresh water supplies vary regionally; while some regions are relatively water rich, others are water poor. For example, the Fraser Valley is a relatively wet region located in the southwest corner of British Columbia. About 400km away, the Okanagan valley – located in the south central interior – is the driest region in the country (OWSC 2008). Therefore, planners and water managers need to consider local context when managing water supply and demand.

In Canada, federal and provincial governments share jurisdiction over different facets of water resources. For example, the federal government has jurisdiction over the conservation and protection of oceans and water resources on federal lands (e.g. National Parks), federal facilities, and First Nations reserves (Environment Canada 2010). Conversely, provincial governments have primary jurisdiction over management of most water resources on provincial lands (Environment Canada 2010). In BC, the *Water Act* (RSBC 1996, c 483), originally enacted in 1909, is the primary statute for defining water governance. *The Water Act* assigns water licensing authority to the province but delegates significant water management authority to municipalities (i.e. riparian protection, land use decisions, drinking water treatment, and wastewater treatment in urban areas) (Brandes and Curran 2009; Environment Canada 2010).

Climate change and urbanization present challenges to water management in Canada and BC. To combat these challenges, the provincial Minister of the Environment created the Water Stewardship Division and released *Living Water Smart: British Columbia's Water Plan* (LWS) in 2008 (Brandes and Curran 2009; BCME 2008). LWS is the provincial government's plan to govern and manage water sustainably through policy tools such as planning, regulatory change, education, and economic instruments (BCME 2008). For example, the provincial government stated "fifty percent of new municipal water needs will be acquired through conservation by 2020" (BCME 2008, p. 75). Lofty goals for conservation are especially important for managing water sustainably for drought susceptible regions and municipalities such as BC's Okanagan Valley, the area of study in this research.

1.1. Study Area and Background

My research project is part of a larger study on water use in the Okanagan led by Steve Conrad (PhD Candidate) at Simon Fraser University (from here on I will refer to this study as the "Okanagan Water Study"). While the larger project explores the integration of residential and agricultural water user preferences in a coupled demand and supply model of water use for the Okanagan Basin (see Conrad, 2010), my research examined residential water use only. Specifically, this paper focuses on detached homeowners' preferences and choices for lawns in the City of Kelowna BC.

The results of my analysis will be complementary to results of the Okanagan Water Study currently under study.

Our study focused on the Okanagan Basin in south central BC; specifically, the City of Kelowna. Almost 200 km long and 8,000 km^2 in area (OBWB 2012a), the Okanagan Basin is a semi-arid valley and – along with its social and political issues – its unique climate poses interesting challenges for water management. For instance, the Okanagan Basin is the driest region in Canada (OWSC 2008) and has the lowest per capita availability of freshwater in the country (Hrasko et al. 2008). Due to the rain-shadow created by the Coast and Cascade mountain ranges, the basin only receives an average of 300-400 mm of annual precipitation with 80% lost to evaporation and evapotranspiration (Cohen et al. 2004).

The Okanagan Basin is a sub-watershed of the larger Columbia River Basin which covers a total area of approximately 416,015 km^2 shared between Canada and the U.S. (approximately 15% lies within Canada) (USGS 2002). Kelowna is the largest city in the basin and, with a population of 176,435 in 2011 (Statistics Canada 2013), it is the 22nd largest metropolitan area in Canada. During the summer, temperatures can reach 39^{o}C and in 2003, Kelowna experienced the driest June to August period since 1899 (Hrasko et al. 2008). Further, climate change scenarios predict less precipitation stored in snowpacks, which, coupled with an earlier onset of the freshet and higher summer temperatures, will result in reduced streamflows in the region (Merritt et al. 2006; Neilsen et al. 2010; Harma, Johnson, and Cohen 2011).

As a mountainous region, the Okanagan Basin watershed relies on accumulation and recession of the snowpack to regulate timing and amount of water available in the basin (Merritt et al. 2006). Less snowpack in combination with longer growing seasons will stress water supplies in Kelowna and the Okanagan. Furthermore, because the Okanagan Lake and its river systems behave as a single well-mixed hydrologic unit, impacts affecting one source of water, such as snowpack, could result in repercussions throughout the watershed (Wassenaar, Athanasopoulos, and Hendry 2011).

Climate is not the only factor contributing to water stress in the Okanagan. Population growth and urbanization further elevate water demand and water stress (Hrasko et al. 2008; Cohen and Kulkarni 2001; Van der Gulik and Neilsen 2008). Currently, agriculture constitutes a key economic sector for Kelowna and the Okanagan region, accounting for 55% of water consumption in the basin (OBWB 2012b). However, Kelowna's landscape is transitioning from lands predominantly dedicated to agriculture to lands developed for real estate and recreation. To ensure that this trend toward urbanization does not negatively impact future water supplies, planners and resource managers should carefully consider residential water use planning opportunities. Urbanization also elevates the importance of good land management decisions such as the location of new developments, property sizes, and outdoor landscaping.

In the Okanagan Basin, residential uses account for 31% of water consumption (OBWB 2012b). Based on a year-round average, indoor residential uses (i.e. showers, appliances) average 7% of total water use (150 litres per person per day) while outdoor residential uses (i.e. landscaping, irrigation, etc.) average 24% of total water use (525 litres per person per day) and over 50% of residential water use (OBWB 2012b).

Five water purveyors manage the Kelowna's water supplies: the City of Kelowna Water Utility, Black Mountain Irrigation District, Glenmore-Ellison Improvement District, Rutland Waterworks District, and South East Kelowna Irrigation District (City of Kelowna 2009b; Belzille 2011). This study focused on the service area supplied by the City of Kelowna Water Utility which serves over 50,000 residential customers (City of Kelowna 2009e). According to the City of Kelowna Water Utility, the average Kelowna home uses 55 percent of total annual water for outdoor landscape irrigation (City of Kelowna 2009a), translating into about 72 million litres of water used on lawns and in gardens on an average summer day (City of Kelowna 2009a). Therefore, residential outdoor water use is a viable target for water conservation and management in Kelowna.

The City of Kelowna makes land management decisions and defines landscaping guidelines and bylaws. The results from this study will inform their process. For example, in Kelowna, land-use decisions have resulted in the promotion and development of low density neighbourhoods (Maurer 2010). Urban sprawl in Kelowna has resulted in the development of residential properties with larger properties and lawns that require more water to maintain. This model of land management increases outdoor water consumption. Understanding water users' preferences for lawns can help inform how Kelowna moves forward in their land management practices. This study attempts to undertake an examination of these preferences and make recommendations to inform water use planning.

1.2. Research Purpose

As mentioned previously, this research was undertaken as part of the larger Okanagan Water Study. That study is investigating how water user preferences in the Okanagan Basin, British Columbia can inform and be coupled with an existing traditional water management model simply based on current supply and demand information (Conrad, 2011).

Central to the study is water governance and a decision-making process that takes into account the preferences of water users within a watershed. Researchers have attempted to develop a comprehensive definition of governance and definitions vary within the literature (Lynn, Heinrich, and Hill 2001; Stoker 2004; Ansell and Gash 2008). For the purpose of my work, I will interpret governance as collective decision-making encompassing processes used to establish laws and rules for managing public goods (Ansell and Gash 2008). In essence, water governance accounts for how decisions are made and how accountability is assigned to decision makers when managing water supply and demand. Traditionally, governance systems in BC are institutionally centralized. Many researchers criticize centralized systems because policy outcomes are inflexible, processes can be disconnected from broader stakeholders, and approaches are too dependent on reductionist science (Ostrom 1999, Brunner et al. 2005, Brandes and Curran 2009). Therefore, experts suggest that collaborative processes are more effective at realizing communities' needs, as these processes engage multiple stakeholders in the planning process. This may result in more resilient policies and plans that can be adapted to current and future challenges (Brandes and Curran 2009).

Adaptive governance is a flexible decision-making approach that encourages collaboration is adaptive governance. Accounting for behavioural complexity, adaptive governance incorporates local context into decision-making processes allowing communities to properly express their views on management of common resources such as water (Ostrom 1999, Dietz, Ostrom, and Stern 2003, Brunner et al. 2005). The power in adaptive governance stems from using local participants' knowledge to inform resource management. Dietz, Ostrom, and Stern (2003) suggest that water management policymaking should incorporate adaptive management principles by encouraging collaboration and engagement between government and communities. Taking this approach to water management allows local knowledge to be integrated with traditional scientific and analytical models to inform policy and planning.

Incorporating water users' attitudes preferences into water policy and planning processes in Canada would be especially powerful when designing programs that are most effective for a specific community or user group. For example, past research suggests education programs may be effective measures to promote conservation given the existence of a fundamental societal paradox: "Canadians value water, but are largely unaware of the costs associated with water management and are consequently unwilling to invest in the resource" (Belzille 2011, p. 82). Furthermore, a majority of Canadians consider fresh water to be Canada's most important natural resource to ensure the country's future (Nanos 2009; RBC 2013). However, Canadians do not consider water pollution and supply issues as top priorities compared to economic and health care concerns (RBC 2013). In 2011, the *Royal Bank of Canada Canadian Water Attitudes Survey* found while 61% of Canadians "… admit they do not know how much their household currently pays for water... [70%] believe that the unknown price is high enough to ensure water is treated as a valuable resource" (RBC 2011, p.2). Survey results emphasize that Canadians exhibit a lack of awareness of current water issues and that there is "widespread ignorance among Canadians of the cost of water service provision and basic water management best practices, such as source water protection and matching water quality to water use" (Belzille 2011, p. 82).

The conclusions above are not surprising given Canada's subsidized water services, lack of universal water metering, and water prices that are not sufficient to meet operative and capital costs of water suppliers or offset ecological impacts (Renzetti

2007). Belzille (2011) argues that Canada's current pricing structure separates users from their water supplies. Proactive countries such as Australia use full cost pricing and universal metering to sustainably manage water resources. Incorporating innovative water management strategies into Canadian water governance could help to increase Canadian's perception of the value of fresh water. Adopting an adaptive governance approach to policymaking could help increase public acceptability of new policies such as residential outdoor irrigation management schemes.

Coupled with water governance issues, traditional urban planning paradigms have encouraged rapid growth within Canadian cities developed around a suburban sprawl model (Roseland 2012, Blais 2010). Reduced accessibility of suburban areas, in conjunction with larger property sizes, increases resource use and negatively impacts the environment. Retrofitting neighbourhoods to reduce outdoor water use at the household level is one strategy to increase water conservation. Such water reducing retrofits would include decreasing the amount of regular grass (turfgrass) in residential yards, restricting outdoor water use, switching from traditional turfgrass varieties to water conserving types, and mandating lawn watering restrictions during summer (Addink 2005; Hurd and Smith 2005; Vickers 2007; Maurer 2010).

To promote and achieve residential water savings, water resource managers can work collaboratively with local governments to create management strategies for efficient landscaping and irrigation practices. However, to ensure that users accept and understand potential new management practices, governments and policymakers should engage and collaborate with citizens. Traditional top-down water governance approaches involve reliance on experts for scientific hydrological data to influence decision-making and tend to ignore user preferences and behaviour. Conversely, Brunner et al. (2005) argues bottom-up approaches to decision-making promote adaptive governance and can accommodate behavioural complexities not recognized by top-down analytical models. Therefore, when attempting to reduce outdoor residential water consumption, bottom-up approaches incorporating local preferences, be it based on qualitative data or formal surveys of residents (described in sections below) allow planners and policymakers to make informed decisions based on input from real people.

Through my research, I seek to develop a tool to aid decision makers based on data collected from a survey of detached homeowners' in Kelowna, B.C. This decision support tool (DST) will inform planners and water managers about detached homeowners' preferences for managing their landscaping essentially incorporating grass-roots information from the community into traditional top-down water use planning processes. Land-use decisions in Kelowna have promoted the development of low density neighbourhoods with large yards that require more water to maintain compared to higher density developments (Maurer 2010). With the information gathered from the DST, decision-makers will be informed about which retrofits on their properties are most feasible for detached homeowners and what tools and incentives they can use to promote water conserving landscaping alterations. My research will inform planners about detached homeowners' preferences for private lawns and reveal appropriate land management practices in Kelowna (i.e. the proportion of turf and outdoor water use restrictions and turfgrass variety alterations).

In the Okanagan, communities must develop water management practices that satisfy a variety of water users with varying needs. My research seeks to examine public support for water reduction strategies within residential yards in suburban Kelowna. Analysis and results from this study will inform the larger Okanagan Water Study.

1.2.1. Research Objectives and Questions

The purpose and objectives of my project in Kelowna are reflected in the research questions below:

1. What are detached homeowners' preferences for lawn characteristics in the City of Kelowna?

2. Do detached homeowners' socio-demographic and current house and property conditions affect their water conservation attitudes and lawn preference?

1.3. Report Organization

Including the introduction, this report is organized into six different chapters. Chapter two contains a literature review of academic literature related to urban water use planning, sprawl and water demand, scenario based planning, public engagement, and applying choice experiments to urban water management. Chapter three details the research methods I used to collect, assemble, and analyze data. Chapter four summarizes the results from the survey and choice experiment. Chapter five discusses the key findings of my analysis in relation to the research questions including management scenarios generated from a decision support tool. Finally, chapter six concludes the main points of the paper.

2. Literature Review

2.1. Urban Water Use Planning

Two main factors influence water resource management: water supply and water demand. Managing water supply focuses on controlling sources of fresh water by managing water stock (e.g. man-made reservoirs) and availability (e.g. public infrastructure that carries water to and within communities). Conversely, managing water demand relies on promoting water efficient behaviour to reduce water consumption, thereby decreasing demand for water and, ultimately, reducing water supply and infrastructure requirements (Tate 1993, Deverill 2001, Brooks 2006). Relevant strategies encourage sustainable use of water resources by promoting and incentivising efficient water use behaviour (Savenije & van der Zaag 2002; Brooks 2006; Willis et al. 2011). For example, governing bodies can subsidize residential landscaping alterations that increase a property's water efficiency. Focusing on reducing end use consumption – the final destination for the resource to be used or applied (e.g. outdoor irrigation) – water demand management avoids or reduces the need for additional water supply measures (i.e. new reservoirs and infrastructure) that can have negative environmental, social, and economic impacts (Willis et al. 2011). By focusing on end use consumption, WATER DEMAND MANAGEMENT strategies offset "the need for additional water supply and wastewater treatment measures which are costly and can be environmentally and socially detrimental" (Willis et al. 2011, p. 1996).

Reducing negative environmental, social, and economic impacts of water demand is especially essential in arid climates such as Australia, the southern United States, and Canada's Okanagan Valley. These areas are susceptible to droughts during summer months leading to water scarcity for both urban residents and the environment. Along with other factors, climate change, population growth, and urbanization combine to increase water stress in arid regions (Hrasko et al. 2008; Cohen & Kulkarni 2001; Van der Gulik & Neilsen 2008). Countries like Australia and the United States are less water rich than Canada and have utilized proactive approaches to managing water resources. Canada can learn from proactive countries to adapt policy and planning methods and tools to manage water resources more sustainably.

Australia has over two decades of water reform experience and has become a global leader in water management and restructuring (Belzille 2011; Crase 2008). The country's federal government has invested billions of dollars into the water sector (Belzille 2011; ADSEWPC 2011). One reason for the large investment in the Australian water sector is the relatively high water literacy – the knowledge about water resources, their sources and uses – of Australian citizens when compared to other countries such as Canada. Toward that goal, the Australian government created and utilized information feedback loops. In the context of water management, "feedback loops are any means through which consumers of the resource receive information about their past consumption or resource status, which can then influence their future consumption choices" (Belzille 2011, p. 85). Examples of feedback loops include daily weather reports incorporating local reservoir levels in broadcasts, roadside signs displaying current drought risk, water bills, and smart meters. These tools provide people with knowledge about current water issues and give individuals reference points in times of water abundance or scarcity. Along with education and public awareness, Australia uses economic tools like full-cost pricing to represent the true value of the resource and promote water conservation by individuals. Similar water conservation methods are employed by other countries, including the United States.

Dealing with water scarcity and promoting water conservation constitutes challenges for many communities throughout the western United States (Hurd 2006). Such communities seek to develop "water conservation plans and strategies that will permit economic development in the face of limited and, in some cases, dwindling water resources" (Hurd 2006, p. 173). For example, the New Mexico State Water Plan recommends that comprehensive water conservation plans be required in any application for State financial assistance for water development infrastructure (New Mexico Office of the State Engineer, Interstate Stream Commission 2003). Similar laws exist in Colorado (Colorado Water Conservation Board 2005). Within the last decade, water researchers have explored innovative methods to manage water resources and inform policy decisions by exploring water users' behaviour and preferences for water management and conservation strategies (Hurd 2006; Yue, Hugie and Watkins 2012). Assessing the effectiveness of potential management measures before they are implemented allows decision makers (i.e. local governments and utility managers) to design policies that will most likely be accepted by the public. Using water sustainably has been an important policy issue in dryer regions in the United States and Australia and currently, water conservation strategies are becoming more common in Canada.

More recently, BC has started shifting toward sustainable water management through its Living Water Smart plan (BCME 2008). In BC, the provincial government uses a number of methods to manage water demand including legislation to protect ecosystems and provide incentives for water efficient behaviours (e.g. water efficient appliance retrofits) and building construction (e.g. green building codes requiring water conservation plumbing fixtures such as low flush toilets), increasing education and awareness of water issues in schools, and developing partnerships with industry to promote water conservation (e.g. developing a water efficiency labelling system for water consuming products) (BCME 2008). Proactive water conservation strategies are also applied at the regional level.

In the Okanagan Basin, the Okanagan Sustainable Water Strategy is a comprehensive plan to guide the development and management of water resources (OWSC 2008). Policies to conserve water include developing higher density neighbourhoods, creating drought management plans for utilities and the region, implementing universal metering, developing a community engagement strategy to increase conservation awareness, and encouraging research to fill in knowledge gaps (OWSC 2008). Prepared by the Okanagan Water Stewardship Council in 2008 – an ad hoc technical committee to the Okanagan Basin Water Board – this plan seeks to create "a Basin-wide culture of water conservation and efficiency" (OWSC 2008, p. 15), but it is not the only policy document that directs water conservation in the Okanagan. Cities within the Basin – such as Kelowna – utilize their own policies and plans to govern development and management of water resources.

At the municipal level, the City of Kelowna implemented a Water Sustainability Action Plan in 2007 that includes policies to reduce per-capita water use by 15% by 2012. While per-capita water use decreased by 12% in 2010 (City of Kelowna 2012), water use statistics were not available for 2012 at the time of my research. Therefore, I am uncertain if the city achieved its 15% per-capita water use reduction goal. Policies include partnering with water purveyors to ensure a consistent water management approach is used throughout the community, developing social marketing programs to educate water users, requiring new developments and retrofits of existing buildings to use the best available water conservation technologies; implementing full cost pricing with volume based pricing structures to promote water conservation while providing equitable access through water rates; conducting leak detection surveys; and developing water reuse opportunities (e.g. grey water reuse) (City of Kelowna 2009c).

As mentioned above, Kelowna faces water management challenges from climate change, population growth, and urbanization. Previous and current land-use decisions in Kelowna have promoted the development of low density neighbourhoods creating urban sprawl and increasing water stress (Maurer 2010). Therefore, to manage water resources efficiently, implementing policies under the Water Sustainability Action Plan in Kelowna and other sprawling Canadian cities is important.

2.1.1. Urban Sprawl and Water Demand

Land-use decisions are involved in every aspect of planning for community sustainability (Roseland 2012). These strategic decisions consider how people organize the use of land and the form that use takes (e.g. streets, parks and civic infrastructure) (Roseland 2012). Different social and cultural motivations have influenced planning paradigms throughout history which, in turn, direct land-use decisions. These can have long-lasting positive and negative impacts on the landscape, environment, and society. Examples of problematic land use planning are urban and rural sprawl.

Most commonly, urban sprawl is defined as low-density urban and suburban development of previously undeveloped land (Sierra Club 1998; WRA 2004). Low-density, sprawling neighbourhoods consume significantly more water compared to denser residential developments (RERC 1974). In the Okanagan, population growth will increase rapidly over the next 30 years. Depending on lot size, outdoor residential water demand varies from 30% to 60% of annual domestic water demand (Maurer 2010). Accounting for climate change impacts, if urban growth continues as usual, water requirements for outdoor residential water demand will increase by 55% by 2026 (Maurer 2010).

To combat problems associated with urban sprawl, planners can design innovative planning approaches such as Smart Growth, which seeks to address six goals: neighborhood livability; better access to daily destinations and less traffic; infill development to support thriving cities, suburbs, and towns; shared benefits of regional prosperity with all residents; lowered costs for infrastructure and lower taxes; and conserving open space for communities (Roseland 2012). Planning strategies include densification, mixed use zoning and developments, land trusts, and proximity planning (i.e. locating housing close to jobs) (Roseland 2012). Benefits of Smart Growth planning include increased sustainability of urban communities through financial savings for public and private infrastructure and reduced resource use such as outdoor residential water (Downs 2005, Maurer 2010). For example, creating denser neighbourhoods with smaller yard sizes and lawn proportions will help reduce residential water consumption in new developments. Similarly, introducing lawn reduction strategies can help increase water efficiency in current neighbourhoods.

Planners and policymakers in Canadian cities such as Kelowna can combine planning approaches like Smart Growth with water conservation strategies to reduce residential water use. For example, aggressive conservation practices such as reducing turfgrass areas, xeriscaping, and mandatory water restrictions can significantly increase water savings in outdoor residential yards (Maurer 2010). Furthermore, Maurer (2010) projects that by 2026, water conservation practices coupled with densification planning can reduce outdoor residential water demand by over 50% from current conditions in the Okanagan Basin. One component of successful water use planning relies on consumers understanding how they as individuals can reduce water consumption and apply this knowledge in their daily lives (Willis et al. 2011). Therefore, through public engagement, teaching communities about water conserving tools, mechanisms, and information is imperative for planners to manage water sustainably.

2.1.2. *Improving Water Use Planning Programs by Understanding Preferences and Behaviour*

Public involvement in environmental decision-making is not a novel idea and is widely recognized as a basic requirement of sustainable development (National Task Force 1987; Government of Canada 1990; Smith 1993; Renn, Webler, and Wiedemann 1995). In Canada, public involvement was incorporated as a formal component of environmental assessment processes through the adoption of the Canadian Environmental Assessment Review Process in 1973 (Roberts 1995). However, while public involvement refers to consultation and participation, public participation and greater involvement is often overlooked in decision-making processes, including water management (Haider and Rasid 2002).

Public hearings, roundtables, and workshops are often conducted by planners to facilitate public participation in planning processes. However, researchers argue that meetings and attendees are not necessarily representative of the general public (Gundry and Heberlein 1984) and stakeholder representation is not necessarily equitable (Sewell and O'Riordan 1976; Prystupa et al. 1997). For example, powerful vocal minorities may use their influence to sway proceedings in their favour. Haider and Rasid (2002) emphasize that the majority of the literature on limitations of public participation highlights "representativeness as a fundamental prerequisite for effective and equitable public participation" (p.338) but experts lack consensus on the methodology to achieve this. Researchers and professionals often use conventional survey instruments to evaluate public acceptance of policy options. However, conventional methods overlook the behavioural complexity of individuals' preferences that drives their decisions.

Considering a community's behavioural complexity is important to ensure that new policies and plans fit a community's needs and are accepted by the general public. To support water conservation programs, local governments and utility managers need to allocate public resources to new and existing programs. Therefore, decision makers are concerned about program effectiveness and seek methods and tools to measure program outcomes and performance (Hurd 2006). Hurd states that "assessments of public attitudes and behavioural changes can provide both quantitative and qualitative measure of the impacts of water conservation programs and their effectiveness" (Hurd

2006, p. 174). Therefore, designing a method or tool to measure behavioural changes and motivations, or the willingness to change, is essential for both developing new conservation programs and monitoring existing programs. For an individual, water conservation consists of one's awareness of water sources and services combined with "an understanding of how behavioural changes can enhance the value of these services" (Hurd 2006, p.174). Consequently, examining how individuals and households respond to various types of water conservation options and incentives is crucial when designing effective water conservation programs and long-term plans for urban water resources (Hurd 2006). Building from Hurd (2006) and accounting for heterogeneity within residents, my research will quantify how households with varying qualities will respond to changing characteristics of lawn management programs.

Engaging with residents to understand their preferences and behaviours provides planners and policymakers with more insights about the appropriateness and acceptability of water use planning strategies. For example, past studies have concluded that household water consumption is dependent on a number of factors specific to the residence and the individuals living in it (Nieswaidomy and Molina 1989; Renwick and Archibald 1998; Mayer and DeOreo 1999; Renwick and Green 2000; Inman and Jeffrey 2006). These factors include:

> the number of people in the house, the age of residents, education levels of residents, lot size of properties, residents' income, efficiency of water consuming devices (i.e. clothes washers, shower heads, tap fittings, dishwashers and toilets) and the attitudes, beliefs and behaviours of consumers" (Willis et al. 2011, p. 1996-1997;

Recent research, however, has regarded residential water demand as largely price inelastic due to the relatively low cost of water compared to other basic life essentials (Worthington and Hoffman 2008; Barrett 2004). Compared to indoor use, outdoor residential demand is more elastic with summer demand trends being more elastic than winter (Mitchell and Chesnutt 2009). Therefore, understanding what factors influence demand is essential to designing appropriate policies that will reduce water consumption within a community.

2.1.3. Choice Experiments

To better understand users and their preferences and behaviour, researchers of water demand have incorporated psychological and economic theories into their studies (Harlan et al. 2009; Willis, Scarpa, and Acutt 2005; Kantola et al. 1983; Syme and Nancarrow 1992; Po et al. 2005; Willis et al. 2011; Lam 2006). These theories include rational choice theory, the theory of consumer behaviour (Lancaster 1966), the theory of reasoned action studies (Fishbein and Azjen 1975), and the theory of planned behaviour (Azjen 1991). However, many of these methods fail to "accommodate the multiattribute nature of trade-offs between alternative choices" (Haider and Rasid 2002, p. 338). For water managers, creating a statistical method to estimate the importance users attach to each attribute of a policy option would be a powerful tool to help evaluate competing policy options (Haider and Rasid 2002). One such widely used tool to analyze intended behaviour and evaluate tradeoffs between attributes and elicit respondent preferences in the process is the choice experiment (CE) (Haider and Rasid 2002).

The choice experiment (CE) is a multivariate stated preference method that allows researchers to model and predict respondents' actual behaviour. In general, whether stated or revealed, "choice analysis is about explaining variability in behavioural response in a sampled population of individuals" (Hensher, Rose, and Greene 2005, p. 72) or groups (i.e. households, firms, community groups, etc.). Psychology, economics, and statistics form the theoretical foundations of the CE method (Hoyos 2010). Based on random utility theory, CEs evaluate respondents' preferences and attitudes in relation to a wide suite of possible scenarios, including future or hypothetical scenarios (Bennett & Blamey 2001; Haider & Rasid 2002). Random utility theory assumes that respondents will select the option that maximizes their utility (Louviere, Hensher, and Swait 2000). Respondents are asked to make trade-offs between different profiles (i.e. alternatives) within a scenario (known as a choice set) (Train 2009).

Each alternative corresponds to a range of attributes that contribute to utility. The part-worth utility of each attribute level can be statistically determined by the researcher. Therefore, the likelihood that an alternative is chosen depends on the total utility of all attributes in a given alternative (Cooke et al. 2009). Individual respondents are presented with multiple choice sets consecutively and each choice set is composed of mutually exclusive hypothetical alternatives. Each respondent chooses the alternative that is most attractive to him/her by evaluating trade-offs between the levels of the attributes in the competing programs or management alternatives presented to him/her.

In practice, CEs can be used to model stakeholders' demand response to future management policies. Unlike other techniques such as conjoint analysis, CEs do not provide consumer preferences at an individual level but, instead, present results at an aggregate level (Breidert 2006; Haaijer and Wedel 2007). The CE approach is powerful because it can be used to identify heterogeneity in respondent preferences within the sample population (Hensher, Rose, and Greene 2005). By identifying heterogeneity, decision makers can target separate user segments to better understand and communicate with them. For example, Moon et al (2002) identified unique consumer groups based on preferences for environmental attributes of agricultural products. The authors identified environmentally conscious consumers as a unique, homogeneous segment suitable for green (i.e. environmental) marketing purposes (Moon et al. 2002). Identifying differences between user groups (e.g. current lawn scenario) is especially powerful to help identify existing policy gaps such as the need for education and public outreach (Moon et al. 2002). Researchers can use CEs to create decision support tools (DST) and examine changes in choice share for different policy alternatives. Though out of the scope of my analysis, CEs can also predict willingness to pay (WTP) for different attributes, policies, or products (Moon et al. 2002).

The CE is a versatile methodology to study individuals' stated preference behaviour and has been applied across many fields of study. For example, the CE was first applied to environmental resource management by Adamowicz et al. (1998) and since then, CEs have been applied to topics such as ecosystem service valuation (Hoyos 2010), recreation and tourism (Kelly et al. 2007; Semeniuk et al. 2009), fisheries (Dorow et al. 2009; Hunt, Gonder, and Haider 2010), and forestry (Berninger et al. 2010). Recently, the application of CEs to water management and planning is increasing.

2.1.4. Water and choice experiments

Recently, in research on water resource management, application of CE are increasing (Haider and Rasid 2002; Hurd 2006). In the literature, CEs have been used to explore residential water demand including the elasticity of price on water consumption (Martínez-Espiñeira 2003; Olmstead 2009; Miyawaki et al. 2011; Sebri 2013). This section will present findings from other choice experiments that will inform my study.

As mentioned above, CEs can measure stakeholders' response to different water management policies. Haider and Rasid (2002) utilized a CE to assess trade-off behaviour of residents of Thunder Bay, Ontario, Canada, based on preferences for the source of municipal water supply. Respondents were asked to choose their preferred water management option repeatedly from a set of choice cards. Each choice card displayed different configurations of water rate increases (2.5% to 5% over 10 years), water pressure (reduced, same, increased), and water taste (worse, same, improved) for three alternative sources of water supply – Bare Point, Loch Lomond (affected by a Boil Water Advisory), or a combined supply (Haider and Rasid 2002).

Their findings proved interesting because the preferences of the general public differed from expert opinion. While the expert-driven consultation process recommended the Bare Point option, respondents preferred the Loch Lomond option irrespective of water rates. This discrepancy bolsters the authors' argument that a formal survey – especially a CE – provides one type of insight about the public for decision makers.

In the Western United States, many communities and water managers are confronted with water shortage as water supplies are tight and populations continue to grow. At the household level, residential landscaping accounts for more than 50% of total residential water use, making it a prime target for water conservation studies and programs (Hurd 2006). This study concludes that, significant water savings ranging from 35% to 70% are possible from changes to outdoor residential water use. To measure behavioural factors affecting water conservation, Hurd (2006) implemented a CE examining landscaping choices of homeowners in three cities in New Mexico: Albuquerque, Las Cruces, and Santa Fe. Respondents were asked to choose their most preferred yard from a selection of four landscaping options (traditional turfgrass; ½ traditional turfgrass, ½ water conserving; ¼ traditional turfgrass, ¾ water conserving; and no turfgrass, 100% water conserving). Water use (gal/year), water cost ($/year), maintenance cost ($/year), and maintenance effort (hrs/year) were presented for each landscaping option. Each respondent was randomly assigned one of four slightly varying versions of the survey which differed across the four landscaping attributes: water use, water cost, maintenance cost, and maintenance effort.

Hurd (2006) found that water cost and the explanatory variables education and regional culture were significant determinants of landscaping choice. Interestingly, while top-down instruments such as price affect conservation behaviour, users' attitudes and preferences also influence the likelihood for water conservation. One joint mixed logit model was used to compare preferences for residents in all four cities. While the total sample size of 423 was adequate for statistical analysis and conclusions, sample sizes for each city were relatively small (Albuquerque = 109, Las Cruces = 157, and Santa Fe = 155). Therefore, differences in respondents' preferences between cities may not be representative of the larger populations.

Conserving fresh water is a universal issue and, in the United States, turfgrass consumes large quantities of water every day as it covers more area than any irrigated crop in the United States (Milesi et al 2005). Population growth and urban development have led to substantial increases in lawn coverage and, in turn, resource inputs (e.g. water, fertilizer) to manage residential turfgrass (Alig, Kline, and Lichtenstein 2004). Yue, Hugie, and Watkins (2012) designed a CE to investigate residential willingness to pay for several low-input attributes of turfgrasses in Minnesota, U.S.A. Respondents were presented with a series of choice scenarios and asked to choose between two different turfgrass plots consisting of nine different attributes (texture, colour, weed presence, native species, shade adaptation, irrigation requirement, fertility requirement, mowing requirement, and price). The authors used a mixed logit model to analyze choice data and estimate consumer WTP.

Results indicate that low-input maintenance attributes significantly influence the resident choice behavior as they preferred reduced irrigation times and less mowing. Therefore, Yue, Hugie, and Watkins (2012) conclude that introducing low-input turfgrasses could help reduce maintenance inputs and at the same time also reduce environmental and economic costs associated with residential lawn care. While these results are interesting, their sample size was relatively small (128 respondents) and participants were only recruited from the Minneapolis-St. Paul, Minnesota area. Therefore, results may not be representative of the United States.

The three studies above represent resent application of CEs to water resource management and provide both quantitative and qualitative data to inform water policy-making and planning. Though applying CEs to residential water management is relatively new, the studies described above indicate CEs can be used by researchers to provide consumer preference and behavioural data for decision-making process.

Determining public preferences is important for the benefit of better water management. However, it may also be the case that the public is wrong, or simply ill-informed, especially in the case of water management when there might be technical or financial limits to what is feasible. In this case, knowledge of user preferences from a CE can be used to design proper education campaigns and increase the general public's water literacy.

My study seeks to analyze the data collected in a CE on different lawn management alternatives in Kelowna, BC to gauge resident's preferences for altering their landscaping. The data analyzed in this study will inform water managers about what landscaping alterations are most acceptable to the general public, allowing decision-makers to create more effective policies to conserve water. My research seeks to demonstrate how planners can utilize consumer preference and behavioural information to inform water demand planning by incorporating residential influence into traditional planning processes. For example, even though detached homeowners with larger lawns in their yard indicate that they prefer smaller lawns, so far they frequently have not yet reduced the size of their own lawn. Typical barriers are lack of time or money, the effort required to make alterations, and landscaping knowledge, etc. By providing adequate financial incentives and supplying people with knowledge about how to make feasible retrofits, decision makers can use preference information to create incentive programs that encourage detached homeowners to reduce their lawn sizes thereby reducing water demand. Consequently, decreasing demand could reduce the need to build new supply infrastructure such as fresh water reservoirs. Unlike the CEs described above, traditional scenario-based planning relies on technocratic forecasts and future projections about cities' and regions' ecosystems and economies to inform current planning and policy decisions.

2.1.5. Scenario Planning

Every day, policymakers and planners face tough decisions about how to implement, manage, and maintain a variety of initiatives from land use and construction to conservation and resource management. Traditional planning approaches are often based on the notion that the most successful way to guarantee efficient and effective management is through the application of expert-based opinion (Peterson, Cumming, and Carpenter 2003). However, success of management decisions is often impacted by future situations that are not fully understood – beyond immediate influence – and may be a long ways out (Peterson, Cumming, and Carpenter 2003; Shearer et al. 2006). Future scenarios are impacted by a variety of contextual factors such as:

> macro-level performance of the economy, the introduction of new technologies, changes in population and demographics, the refocus and redirection of social priorities, the enactment of new laws and new regulations, the effects of natural disasters, and, perhaps most significantly, the actions of neighboring stakeholders (Shearer et al. 2006, p. 360).

One forecasting solution, scenario-based planning, seeks to accurately communicate long-term consequences of current decisions to decision makers by exploring the impacts of different contextual factors on current and future situations (Bryson 1995; van der Heijden 1996). In essence, "scenario planning is a systematic method for thinking creatively about possible complex and uncertain futures" (p.359) and centres around the idea that uncertainty can be used to inspire action because the future is not already determined (Peterson, Cumming, and Carpenter 2003). Similar to adaptive management, scenario planning explores alternative models of future situations and seeks to develop plans and policies to best tackle these alternatives and while accounting for uncertainty (Peterson, Cumming, and Carpenter 2003).

Scenario planning was originally developed by Herbert Kahn for forecasting possible military situations for the U.S. government and later as a business planning tool (Kahn and Wiener 1967). Since then, resource managers have used scenario planning in both top-down approaches such as to manage world oil prices using expert-based opinion (Wack 1985), and in bottom-up approaches to explore the future of ecosystem services amongst stakeholders (Peterson et al. 2003). By outlining a common future view to stakeholders, scenario planning allows for more coordinated decision-making Means et al 2005). Scenario planning can be applied to many different fields, such as park planning, to identify land-management strategies that produce sustainable parks (Peterson, Cumming, and Carpenter 2003) and water management through technical forecasting models (Cohen and Kulkarni 2001, Cohen and Neal 2008, Langsdale et al. 2009, DHI Water and Environment 2010, Janmaat 2010).

In the context of water management, governments and utilities usually rely on groups of experts (i.e. engineers, economists, water experts, etc.) who use technical tools such hydrological models to simulate water resource response to future conditions such as climate change, population growth, and new technologies. Results and outcomes of technical models inform policymaking and planning. For example, in 2000, the American Water Works Association Research Foundation used scenario planning to create a "robust water utility strategy for future success" (Means et al. 2005, p.69). Five different hypothetical scenarios were created that accounted for factors ranging from climate change to catastrophic events. The final outcome was the creation of nine "attributes of success" that would help a utility to succeed in the future. The system described above results in a technocratic, engineering style of managing water; experts determine future water supply requirements and, based on past trends, locate and develop new sources to meet future demand. Decision makers often rely on top-down models to inform policy and planning because these models represent the complexity of water systems without the need to model the complete system. For example, in BC, technical models are used to forecast the effect of policies on regional water supplies, infrastructures, and demands (Cohen and Kulkarni 2001, Cohen and Neal 2008, Langsdale et al. 2009, DHI Water and Environment 2010, Janmaat 2010). However, human-environment systems are complex consisting of many unpredictable interactions (Holling 2001).

Through bottom-up approaches, natural resource management and planning can account for the uncertainty of human-environment systems to effectively manage communities and their resources. To inform decision-makers, researchers have stressed the importance of incorporating wider public values and concerns for natural resource management with goals of professionals, industry, and government (Kimmins 2007; Jaccard 2009; Smith et al. 2012). Resource managers and planners can involve stakeholders in the scenario planning process to provide a forum for policy and planning creation and evaluation (Peterson, Cumming, and Carpenter 2003). For example, the Millennium Ecosystem Assessment utilized scenario planning to "describe the evolution of ecosystem services, human well-being, and their interactions over the next century" (p.1053) at the global and subglobal scale (Bohensky, Reyers, and Van Jaarsveld 2006). Stakeholders in the planning process included "ecologists, economists, and social science representing academia, research institutes, nongovernmental organizations, businesses, and indigenous groups" (Bohensky, Reyers, and Van Jaarsveld 2006, p.1053). Scenario planning can also be applied at the regional scale such as in the Gariep River basin in South Africa to inform policy and planning directions for food security, water, and energy (Bohensky, Reyers, an Van Jaarsveld 2006). Bottom-up approaches to scenario planning allow stakeholders to identify desirable and undesirable scenarios and acknowledge how their personal actions can move the system toward a desirable future (Peterson, Cumming, and Carpenter 2003). However, water management is fairly technical and traditionally was considered to not lend itself well to participatory decision-making processes. Another, approach to bottom-up planning is to use data gathered from the grassroots level (i.e. from residents in a community) to inform traditional top-down decision-making. Traditional predictive approaches – described above – do not account for people's preferences and how behaviour and intended behaviour influence demand. Therefore, adding bottom-up knowledge to water use planning can help account for users' behavioural complexity or uncertainty that is usually ignored by traditional top-down planning processes.

By accounting for user preferences and intended behaviour, especially when applying a CE, researchers and managers can fathom demand beyond the currently existing demand through exploring non-existing scenarios. Not only can knowledge gleaned from a CE be used as additional demand information in top-down planning, but it can also be used for bottom-up approaches in which participants or stakeholders learn about what the public wants beyond anecdotal evidence of process participants. My research seeks to fill knowledge gaps about detached homeowners' choices for lawn factors that influence water consumption in their yards by examining consumer preferences and behaviour in Kelowna, BC. The information gleaned from my study about stakeholders' views and preferences for water conservation can be used to inform top-down or bottom-up planning.

3. Methods

The layout for this chapter follows the standard framework for developing a choice experiment (CE) adapted from Hanley, Mourato, and Wright (2001) and Hensher, Hensher, Rose, and Greene, (2005). The development of the described choice experiment was a joint study with Steve Conrad but with significant analysis of the data conducted as part of this research.

3.1. Step 1: Characterisation of the Decision Problem

To promote water efficient residential landscaping practices, water managers can create policies and management packages for regions and municipalities such as the Okanagan and Kelowna. By focusing on the end uses of water, water use planning programs are relatively sustainable compared to other options for water supply security (White et al. 2007; Willis et al. 2011). Researchers can explore the psychology behind individuals' water use decisions to improve understanding of drivers of residential water demand (Russell and Fielding 2010).

In the Okanagan, the majority of residential water is used for outdoor landscaping applications such as irrigation and most outdoor water use occurs during summer months (OBWB 2012). Factors such as climate change increase potable water demand currently and will continue to do so in the future (Bates et al. 2008; Willis et al. 2011). If policymakers seek to develop new water management strategies for climate change adaptation, solutions must result in real changes to water consumption. Choice experiments were constructed as part of the Okanagan Water Study to measure public perceptions of and preferences for water use planning alternatives and gauge which management options the community will most readily accept. Several experiments were conducted including an agricultural drought response plan discrete choice experiment, and a discrete choice experiment investigating residential lawn management scenarios.

This document describes the development and results of the latter and the subsequent development of a decision support tool (DST) that allowed us to estimate public support for potential residential lawn management policies in Kelowna, BC.

3.2. Step 2: Selection of Attributes and Levels

To inform attribute selection we conducted a thorough review of the water use planning and conservation literature. Water management issues in the region were identified along with alternatives for addressing these issues (See Conrad et al. 2012 and Conrad et al. 2013). A central theme of the CE was adapting to climate change and managing short term drought. Exploring this theme, as well as regional issues that impact climate change and drought in the Okanagan, guided our literature review. For example, the Okanagan experiences arid and variable weather during summer months. Climate change expectations include warmer winters, lower snowpack, earlier spring runoffs, longer and drier growing seasons, and lower precipitation during the summer (Merritt et al. 2006; Neilsen et al. 2010; Harma et al. 2011).

Many different factors influence residential water use such as water price, time of year, and social and cultural norms. To focus and guide our experimental design and aid attribute selection, we identified key issues for urban water use planning such as demographics and land use (e.g. population, residential lot size, and housing type), water supply system, water usage practices (e.g. technical innovation, knowledge and awareness, income, and pricing), source substitution (e.g. grey water, effluent use, and rainwater catchment), and water using equipment (e.g. irrigation, and household appliances) (Turner et al. 2008). Residential water use is a policy and planning issue and, therefore, our CE should address possible actions water managers in the Okanagan could take. Policy and planning actions include improving system efficiency (e.g. leakage and pressure management), creating water use markets (e.g. metering, billing, pricing, education, and land use), promoting residential water use efficiency (e.g. incentives, retrofits, and regulation for appliances, fixtures, landscaping, and irrigation), and substituting potable use (e.g. rain tanks, grey water, and effluent reuse).

To determine policy actions we needed to address in our CE and gain context specific information about water management issues in Kelowna BC, we conducted one-on-one interviews and focus groups with regional experts and residents (See Conrad et al. 2012). These interviews and focus groups allowed us to gather expert and technical knowledge about current and future water contexts in Kelowna. This information helped us estimate current perceptions about water use and management and assist in survey development and attribute refinement. Two focus groups were carried out with water providers, regional water management and governance, agricultural water management, and the local academic community. To complement technical and expert knowledge gathered, we conducted three non-technical focus groups with regional residents.

One-on-one interviews and focus groups informed the survey design and shaped the design of the choice experiment. An important outcome of focus groups was the identification and prioritization of key issues and applicable policy options. Another outcome of focus groups was an assessment of water users' comprehension and understanding of policy options. Regional understanding of climate policy and management options is imperative to address context specific water management issues (Conrad et al. 2012). Regional water users' comprehension of policy options led to the elimination of several attributes for consideration in the final choice experiment: some attributes or management options were too vague or complex for residents to understand (i.e. top soil augmentation, water reuse, xeriscaping policies, service agreements, and remote irrigation scheduling) (Conrad et al. 2012).

To refine our attribute list, the final CE was designed to meet the following assumptions from the technical literature on CE: alternatives within the choice set are mutually exclusive and collectively exhaustive (Ben-Akiva and Lerman 1985); and individuals have full knowledge of the factors that influence their choice decision (Hensher, Rose, and Green 2005). To meet these assumptions, we initially developed a list of 36 possible attributes that influence household water demand (e.g. irrigation system standards, recycled/grey water use, appliance retrofitting, turf reduction, etc.). Data gathered from individual and group interview processes altered the study focus from residential irrigation and appliance technologies to residential landscaping. Consideration of private and public water use perceptions guided the project toward a choice experiment centred on outdoor lawn irrigation which is the greatest area of household water use (OBWB 2012). Earlier versions of the CE contained too many attributes covering a wider variety of landscaping choices which participants found overwhelming. Through multiple iterations of our CE design, stakeholder groups helped refine the CE context and its attributes to focus specifically on lawn management alternatives. Simplifying our CE from an experiment measuring a variety of water use choices within a household to an experiment addressing lawn choices only allowed respondents to make meaningful tradeoffs. Consultation with lawn experts identified important lawn attributes present in the final choice set. I detail the list of attributes and corresponding attribute levels for the final lawn choice experiment below (Table 3.1).

Figure 3.1 illustrates an example of a choice set that was presented to the respondents. The next sections describe the attributes in detail, and how some attributes were modified to accommodate the complexity of personalized information into choice sets.

Table 3.1. Attributes and levels for the lawn choice experiment.

Attribute	Levels
% of total landscape	25% 50% 75% 100%
Variety of turf	Traditional Water Conserving Artificial
Appearance during peak of summer	Very Green Mostly Green More Green than Brown More Brown than Green
One time Subsidy to reduce or replace	$125 $250 $375 $500
Price of water in 5 years	30% more 60% more 90% more

Figure 3.1. An example choice set.

3.2.1. Percentage of Turf in Total Yard

Different households use varying amounts of water to irrigate their lawns. Lawn size is of course a large factor in the amount of water consumed for residential irrigation. The amount of water required to maintain a lawn is proportional to the size of the lawn. Therefore, reducing turf is an important management alternative for decreasing residential water use (Hurd and Smith 2005). Compared to other water conservation alternatives such as water efficient irrigation system retrofits, limiting the size of lawns results in more water savings (Vickers 2007).

After reviewing Kelowna irrigation and water sustainability plans as well as consulting lawn experts, we selected lawn size as a viable attribute to measure consumption. For example, Schedule 4 of Bylaw 7900 (2012) in Kelowna suggests that 25% to 50% coverage by lawn in residential landscaping is ideal for meeting water efficiency standards. After testing with stakeholder groups, we chose the proportion of turf in detached homeowners' yards to represent lawn size instead of square footage or other, more precise measurements because percent turf was more easily understood by the test groups. Based on previous studies (Hurd 2006: Hurd, St. Hilaire, and White 2006) our final design consisted of four levels of percent turf: 25%, 50%, 75%, and 100% turf. To enhance respondent comprehension we presented percent turf visually, as has been suggested by others (Hurd 2006: Hurd, St. Hilaire, and White 2006), and now is a common approach for the presentation of attributes variables (Figure 3.1).

3.2.2. Variety of Turf

Turf variety directly influences the amount of water required to sustain a lawn (Vickers 2007; Hurd and Smith 2005). Relying on irrigation systems, fertilizers, pesticides, and large amounts of water are not necessarily vital to maintaining an attractive and vibrant lawn. Native species and water conserving grasses require less water to remain healthy and, in some cases, irrigation by rainwater can sustain grass (Vickers 2007). Xeriscaping practices such as substituting traditional bluegrass-type lawn for a water conserving lawn or artificial grass help reduce outdoor water use (Hurd and Smith 2005). In other semi-arid regions such as New Mexico, U.S.A., residents favour limiting traditional turfgrass in favour of water conserving varieties of grass and native plants (Hurd, St. Hilaire, and White 2006).

For our study, we compared respondents' preferences for three different grass types: 'traditional', 'water conserving', and 'artificial'. Traditional bluegrass-type lawn is the most common variety of turf planted in Kelowna. Bluegrass-type lawns require more water compared to water conserving and artificial lawns. For example, researchers at the University of California Riverside Turfgrass Research Facility found one-third of water savings from municipal turfgrass rebate programs can be attributed to switching from traditional turfgrass to water conserving and xeriscaping practices (Addink 2005). On the other hand, artificial turf does not require irrigation resulting in further water savings. Determining residents' preferences for each lawn type could influence policy decisions and allow decision makers to potentially mandate landscaping alterations and xeriscaping practises. Our final design consisted of four levels of lawn variety: traditional, water conserving, and artificial[1].

3.2.3. Appearance During the Peak of Summer

Similar to limiting lawn size, "limiting the size of or removing irrigation systems will do more to save water than retrofitting irrigation systems to improve efficiency" (Vickers 2007, p.89). Further, mandatory water restrictions – such as once-per-week water rules – consistently reduce outdoor water use (Vickers 2007). For example, since introducing one-day-per-week water restrictions, total water demands have declined the town of Franklin, Massachusetts (Vickers 2007). In 2007, the local water reservoir increased to its highest level in 30 years. Furthermore, real estate property values increased by over 35%, contrary to the notion that green lawns are essential to maintain housing prices (Vickers 2007).

Perceived aesthetic attributes such as how green or brown a lawn appears can affect landscaping choices and changes (Hurd and Smith 2005). For example, a majority of homeowners in cities such as Las Cruces, New Mexico found the aesthetics

[1] Traditional lawn was presented as two separate levels due to the vast majority of lawns in Kelowna being traditional bluegrass type.

of desert-type landscaping acceptable (Spinti, St. Hilaire, and Vanleeuwen 2004). However, adoption rates for these landscaping alterations were relatively low.

Stakeholder testing indicated more general statements about lawn appearance were easier to comprehend. Adapted from Gordon, Chapman, and Blarney (2000), we developed four levels to represent lawn appearance: 'very green', 'mostly green', 'more green than brown', and 'more brown than green'.

3.2.4. One Time Subsidy to Reduce or Replace Lawn

Policymakers and water managers can use incentives to encourage water conservation behaviour. Turfgrass rebate programs have been used successfully in the United States to reduce outdoor water use (Addink 2005). For example, Albuquerque, New Mexico's turf to xeriscape program resulted in average annual water savings of 19 gallons per square foot of bluegrass turf converted to xeriscape landscaping (Addink 2005). Similar programs have been offered in El Paso, Texas (Driver 2002) and Las Vegas, Nevada (Sovocool and Rosales 2001) to successfully reduce residential water consumption.

While most other subsidy programs offer rebates based on square footage reduction of turf, our study provided residents with four predetermined subsidy levels. We chose to present subsidies in this manner because discussions with project stakeholders emphasized that rebates above $500 were not feasible. Also, after testing with focus groups, one time subsidy levels were more tangible for respondents and, therefore, easier to trade-off with other variables compared to square footage based rebates. Based on our consultation, subsidy levels to reduce or replace turf included: $125, $250, $375, and $500.

3.2.5. Price of Water in 5 Years

The price of water is a powerful tool policymakers can utilize to encourage water conserving behaviour. However, understanding the public's reaction to increases in water price and determining acceptable price levels is vital to ensure public support for a policy. The price of water can limit or enhance the amount of water residents use in their homes and in their yards and most behavioural studies of water management alternatives tend to focus on price (Willis et al. 2005: Barton and Bergland 2010). By increasing water prices, water managers can support water efficient landscaping choices (Hurd and Smith 2005). The price of water is reflected in Kelowna residents' annual water bill. If increased enough, the price of water could encourage residents to reduce water consumption especially outdoors where most residential water is consumed.

Our CE was designed to measure the effects of price on residents' preferences for lawn alternatives. For our CE, however, we framed price as the percent increase in the price of water in five years instead of the actual dollar increase. Levels included 30%, 60%, and 90% increases in the price of water in five years. Testing with focus groups confirmed contextualizing price as a percent increase in five years provided circumstance to respondents and made the attribute more tangible. While price could be included in the attribute list, it applies universally to all attributes. Therefore, we used price as a context variable for our CE. We also supplied an estimated water cost over 5 years, personalised for each respondent, to provide further context for respondents' choices and allow respondents to make trade-offs more easily.

3.2.6. Water Use and Watering Cost

Estimates for summer water use and summer watering cost over five years were calculated separately for each respondent, based on the attribute levels of percentage of turf in total yard, variety of turf, appearance of lawn during the peak of the summer, and the respondent's personal property size collected earlier in the survey (Table 3.1). Therefore, water use and watering costs are products of other attributes and not attributes themselves. In other words, we used the information of personal water use and watering cost calculated for each scenario in each choice set to reflect the respondent's actual situation, to enhance their comprehension of the CE, and to allow them to make informed tradeoffs between alternatives.

Estimates for water use and watering cost were then included in the analysis to derive part worth utilities for each. Steve Conrad developed the algorithm to calculate water use and watering cost based on the following considerations.

First, an assumption about the amount of water required for maintaining a healthy lawn varies during the yearly watering period (e.g. April – October). Second, the amount of water required depends on the individual respondent's size of the property (i.e. square feet) and percentage of turf in the yard. Third, different lawn varieties require different amounts of water to maintain their health. Traditional lawn varieties require more lawn than water conserving varieties and artificial lawns require no water. Fourth, it is assumed that the amount of water required to maintain a very green lawn is greater than the amount of water required to maintain the average green lawn. Conversely, it is assumed that residents who allow their lawn to turn brown during the summer use less water than users maintaining an average green lawn.

In the end, watering cost is a function of water use and water pricing. The City of Kelowna prices residential water based on an incrementing four-tiered pricing structure. Thus the calculation of watering cost must consider not only the volume of water used in a year but the amount of water used during a monthly billing cycle. Additionally, as residents pay for indoor and outdoor water use during the same billing cycle, watering cost calculations must include indoor water use to determine which tier(s) at which lawn water usage should be priced.

It is estimated that total water use (W_{use}) is calculated by the product of water needed in each month (i) per ft^2 of turf for each variety (j) ($need_{ij}$), property size (in ft^2), the % turf in each yard, and a scaling factor determined from the appearance of the lawn (l_a = [very green = +15%, mostly green = 0%, more green than brown = - 15%, more brown than green = -25%]):

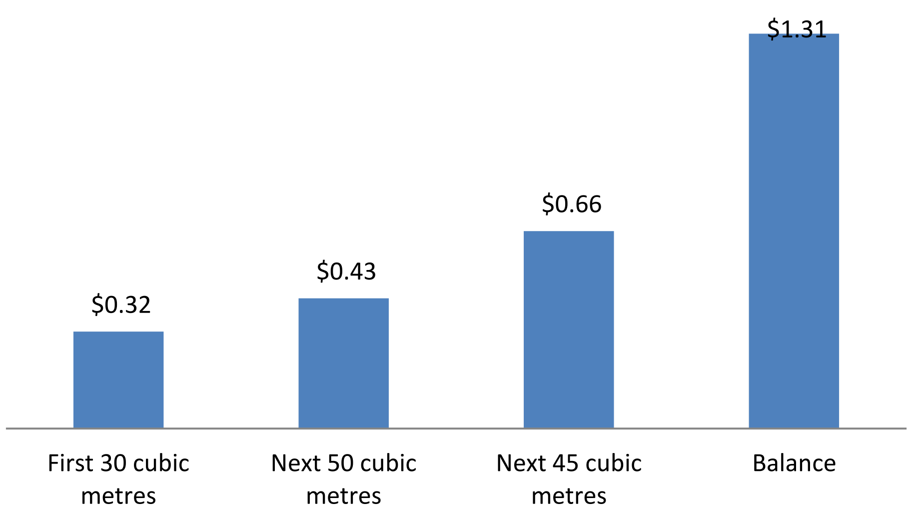
$$W_{use} = \sum_{i\,=\,April}^{October} need_{ij} * \ property\ size * \%\ turf * l_a$$

The product of water use in each month (i) and water price can then determine watering cost; however, as water pricing in the City of Kelowna is graduated, one must adjust water price as water use increases. Figure 3.2 illustrates the water pricing structure for the City of Kelowna. Residential customers pay \$.32 for the first 30 m^3 of water, then \$.43 for the next 50 m^3, then \$.66 for the next 45 m^3, and then \$1.31 for any m^3 of water over 125 m^3. A resident who uses 123 m^3 of water during the month would pay $59.48 (30 * $.32 + 50 * $.43 + 43 * $.66) whereas a resident who uses 128 m^3 (3.9% more) would pay $64.73 (30 * $.32 + 50 * $.43 + 45 * $.66 + 3 * $1.31) or 8.1% more than the former resident. Increasing-block rate tariffs (IBTs) – such as Kelowna's tiered water rates – work by setting the upper-block rates "to approximate the marginal cost of water supply [and setting] the lower block rates... so the agency does not exceed its revenue requirement" (Mitchell and Chesnutt 2009). While IBTs promote water conservation by penalizing larger water consumers (Griffin 2006), only the upper block is typically priced at a rate equal to marginal cost (Boland and Whittington 2000). Therefore, users at lower block rates are incentivised to consume more water than they would if they had to pay the true cost for each unit of water (Clarke 2013).

To estimate watering cost in the set of alternatives in the CE (*C*), Steve Conrad developed a recursive computer algorithm that would determine residential water use in a month, apportion the water use through each of the four tiers, and total water use in each of the four tiers. The sum of watering cost in each month (i), along with the estimate of water price increase for the set (P), provides total watering cost:

$$W_{cost} = \sum_{i=April}^{October} Cost_{total_i} - Cost_{indoor\ use_i} * P$$

Figure 3.2. City of Kelowna tiered water rate.



3.3. Step 3: Choice of Experimental Design

Choice experiments must be configured in a manner that allows the researcher to test the effects of attribute levels on respondents' choices. Preferably, respondents would see all possible combinations of attributes and levels in the experiment. However, our design produces (4^8*3^1 =) 196,608 different profiles and, therefore, would require a large sample population to commit an infeasible amount of time per respondent to determine the significance of all attributes and combinations. To reduce the number of profiles, an orthogonal fractional factorial main effects design consisting of 48 choice sets made up of eight blocks producing six choice sets per respondent is sufficient to estimate all main effects (Addelmann 1962; Louviere Hensher and Swait 2000). A fractional factorial design includes only a subset or sample of complete factorials to measure effects studied as efficiently as possible (Louviere, Hensher, and Swait 2000). Orthogonality ensures the main effects of attributes are statistically independent of one another (Hensher, Rose, and Greene 2005). In the survey, each choice set consisted of 2 profiles representing two alternatives.

As a third alternative we included an individualized status quo option for each respondent. The status quo was generated individually for each respondent based on a respondent's answers to landscaping design questions posed at the beginning of the survey. The status quo remained consistent over all six choice sets per respondent. This methodology has been used in previous studies to create individual-specific CE designs (Rose et al. 2008). In the literature, the status quo is often referred to as the reference alternative. Stemming from prospect theory (Kahneman and Tversky 1979) which argues that individuals draw from their experiences when making choices, the use of individual-specific reference alternatives is based on the idea that the "context in which a decision by each individual is made is an important determinant of the selection of choice-heuristic" (Rose et al. 2008, p.396). In our design, level constraints were used to ensure artificial turf lawn variety was always 'very green' in appearance, and no identical alternatives were shown in a given choice set. Sections 3.4 and 3.5 describe the construction and analysis of the survey instrument.

3.4. Step 4: Construction of Survey

We designed and constructed our survey to address critical project objectives. Fundamental survey objectives included:

1. Identifying residential preferences for water conservation and efficiency behaviour;
2. Understanding contributing factors and signals relating to residential support for efficiency behaviour;
3. Determining preferences toward beneficial water use;
4. Determining attitudes about water and water use; and
5. Determining what policy approaches residents might support as well as understanding policy considerations.

We organised our survey into five sections for a total of 24 web pages. Section one (3 pages) welcomed respondents to the survey and briefed respondents with our project's problem statement and study overview. Section two (7 pages) asked respondents about their residence (i.e. residence type, number of people living in residence, residence ownership, etc.) and personal water use (i.e. the proportion of turf in a yard and variety, lawn watering frequency, lawn appearance, etc.). Section three (7 pages) introduced respondents to the choice experiment and presented them with 6 choice sets. Section four asked about their perspective on water use in the Okanagan. Finally, section five collected socio-demographic information and suggestions or comments about the survey. The last page of the survey thanked respondents for participating and provided a link to future study results.

To 'warm-up' residents to the questionnaire process and prepare them for the choice experiment, section two included questions about respondents' residence. Data gathered from these questions was used in the CE to create the individualized status quo option for each respondent by asking about the proportion of turf in their yard, variety of turf used in their lawn, appearance of their lawn during the summer, and property size. At the same time, these questions also helped familiarize respondents with concepts used throughout the survey.

3.5. Step 5: Data Collection and Analysis

Using a modified tailored design method (Dillman 2007), residents were contacted by the City of Kelowna and the South East Kelowna Irrigation District (SEKID) via a letter outlining the project and containing a link to the survey website. Three weeks later, residents who did not respond to the survey initially were contacted via a follow-up postcard. At five weeks a final contact letter was mailed to any resident who had not responded at the time. A total of 2,100 households were contacted. For City of Kelowna residents, a random sampling of 1,500 households were selected from a customer list of 13,505 (total domestic single family detached households in the City of Kelowna water utility service area). For SEKID residents, a random sampling of 600 domestic households was selected (these included housing of all types). To encourage respondents to access our website and complete the online questionnaire, respondents who completed the survey were eligible to enter a prize draw to win either one $250 Home Depot Gift Card or one of three $50 Visa gift cards.

Survey responses were compiled in a MYSql database. IBM SPSS Statistics 21 was used to accumulate results from the database for the statistical analysis of demographics and attitudinal responses. Latent Gold 4.0 (Vermunt and Magidson 2005) was used for the choice model estimation.

For this research, I analyzed only the responses within the City of Kelowna, which contained only residents living in detached homes that had at least some turf in their yard. Thus, my analysis may not be representative of Kelowna's population as a whole.

I hypothesized that turf size would be an important factor driving respondents' intended behaviour, and the initial data analysis was consistent with this hypothesis. Therefore, my entire analysis includes a segmentation of the sample population by their current turf size. To identify significant differences between variables, I performed a series of statistical test. I used Pearson's chi-square test to determine significant relationships between two categorical variables. The Pearson's chi-square test assumes a null hypothesis that the variables tested are independent of each other. Significance was determined at the 95% confidence interval ($p<0.05$). For continuous data, I performed independent samples t-tests to identify significant relationships between two groups and one-way Analysis of Variance (ANOVA) tests to determine significant differences in the means between multiple groups at the 95% confidence interval. For the ANOVAs, Fisher's Least Significant Difference (LSD) test was used to determine significance. Choice model analysis is explained in the subsequent sections below.

3.6. Step 6: Estimation Procedure

The analysis of the CE data is based on statistical models used to determine how different attribute levels affect respondents' choices for lawn management alternatives. This section provides a background to these models used to measure different attributes in our study. Random utility theory (RUT), logit models, and welfare estimation constitute the statistical foundation of the models described below (Louviere 1988).

3.6.1. Random Utility Theory

Random utility theory (RUT) revolves around a discrete choice between alternatives (i.e. goods or services); these goods or services are associated with a range of attributes that contribute to utility (i.e. importance) (Cooke et al. 2009). RUT assumes the probability of an option being chosen is proportional to the total utility derived from the individual utility contribution of each attribute in an option (Cooke et al. 2009). Another assumption of RUT is individuals are rational decision makers seeking to maximize their utility (Hensher et al. 2005). In other words, respondents will choose an option or good that gives them the highest total utility compared to other alternatives. This utility maximizing relationship is described in the formula below:

$$P_{ij} = \text{Prob}(\text{U}_{ij} > \text{U}_{iq}) \tag{1}$$

Where, RUT assumes the probability of an individual *i* choosing an alternative *j* equals the probability that the utility *U* of alternative *j* exceeds the utility of alternative *q* (for all q in a given choice set where *j* ≠ *q*) (Louviere, Hensher, and Swait 2000).

However, variability exists at the individual decision-making level. This variability is known as unobserved variability and is vital to explaining the choice made by an individual (Hensher, Rose, and Greene 2005). While sources of variability are initially unobserved by the researcher, sources are known, with certainty, to the decision maker (Hensher, Rose, and Greene 2005). Therefore, to more accurately model and understand respondent's preferences and choices, researchers need to capture and account for unobserved variability. From the researcher's perspective, utility is composed of observable and unobservable qualities that are additive and independent (Hensher, Rose, and Greene 2005):

$$U_{ij} = V_{ij} + \varepsilon_{ij} \tag{2}$$

Where, U_{ij} is the overall utility of individual *i choosing* alternative j, V_i is the observable (or deterministic) component of utility, and ε_i is the unobservable (or stochastic) component of utility.

Equation (2) can be broken down further to explain V_{ij} as the sum of the characteristics of a good and the characteristics of an individual:

$$U_{ij} = (Z_{ij} + S_i) + \varepsilon_{ij} \tag{3}$$

Where, Z_{ij} represents the characteristics of the good or service associated with alternative *j* and S_i represents the socio-demographic (or attitudinal and psychometric) variables associated with individual *i*. Characteristics of the good or service are defined as the attributes from the specific choice set individual *i* saw.

Often referred to as the "representative component of utility" (Hensher, Rose, and Greene 2005, p. 76), V_{ij} can be expanded to account for all attribute and socio-demographic, or any other relevant variables:

$$V_{ij} = [\beta 0_{ij} + \beta 1_{ij} Z1_{ij} + \beta 2_{ij} Z2_{ij} + \cdots + \beta_{nij} Z_{nij}] + [\beta_{aij} S_{ai} + \beta_{bij} S_{bi} + \cdots + \beta_{kij} S_{ki}] \tag{4}$$

In other words, V_{ij} consists of *1* through *n* attributes represented by *Z* associated with alternative *j* individual *i* chose. It may also contain *a* through *k* socio-demographic variables of individual *i*. In this model, socio-demographic variables are included as explanatory variables (i.e. ‘predictor variables’). Each β represents the unique weight (i.e. parameter or coefficient) that accounts for the marginal utility of each attribute *Z* or socio-demographic variable *S* (Hensher, Rose, and Greene 2005). For example, β_{1ij} is the weight associated with attribute Z_1 for alternative *j* and individual *i*. β_{0ij} is the intercept (or alternative specific constant, ASC), a parameter not associated with any of the observed and measure attributes and represents, on average, the role of all unobserved sources of utility (Hensher, Rose, and Greene 2005). Associating attribute and socio-demographic parameters with each individual suggests, for a given population, weights are heterogeneous and, therefore, segments can be modelled within the population (Hensher, Rose, and Greene 2005). In my study, I will use personal characteristics of turf, yard, and water consumption, which are treated as predictor variables. Not only are these variables explanatory in the classical sense of choice modelling, but they are also used at the same time used to personalise the choice sets each respondent evaluated. Therefore, these predictor variables are crucial for my analysis, and account for heterogeneity in the population. For this reason, the more classical analysis for heterogeneity – such as a priori segmentation or latent class segmentation – is no longer applicable with these socio-demographic variables.

The formulas above explain the observable components of utility. However, reflecting on equation (2), a challenge facing RUT and choice models is dealing with and interpreting the unobservable components of utility represented by ε.

3.6.2. Multinomial Logit Model

To better understand ε one must acknowledge the assumptions associated with unobservable utility. Assuming the distributional characteristics of ε is crucial for the operationalization of the CE. The multinomial logit model (MNL) is a statistical operationalization of RUT and allows researchers to better understand ε by acknowledging a set of assumptions associated with unobservable utility. First, the unobservable utility associated with an individual exists on an unknown distribution and is allocated to each sampled individual (Hensher, Rose, and Greene 2005). Second, each alternative has a specific unobserved component that exists on an unknown distribution (Hensher, Rose, and Greene 2005). Third, the set of unobserved components (i.e. the error term) are independent and identically distributed across individuals and with Type I, extreme value distribution (Louviere, Hensher, and Swait 2000; Hensher, Rose, and Greene 2005). This set of assumptions is known as the independently and identically distributed (IID) condition.

Mentioned above, researchers can use discrete choice analysis to estimate the probability that an individual will choose a specific alternative. To accomplish this, one can derive a function from the utility equations above to ascertain a relationship between observed attributes, unobserved attributes, and stated (or observed) choice outcome (Hensher, Rose, and Greene 2005). Derivation of this equation results in the multinomial logit (MNL) model used as the basis for analyzing choice experiments (Adamowicz et al. 1998; Louviere et al. 2000; Hensher, Rose, and Greene 2005). Mentioned above, the MNL model predicts the probability that an individual will choose an alternative:

$$\mathrm{P_{ij}} = \frac{\exp V_j}{\sum_{\mathrm{h}} \exp V_q}; \quad \text{(for all q in choice set C where j} \neq \text{q)} \tag{6}$$

Where, P*ij* is the probability of an individual *i* choosing alternative *j* out of the set of *q* alternatives. The MNL is often considered to be the core or workhorse model for CE analysis because it is computationally simple and efficient to estimate relative to other models (Rolfe 2006). However, the MNL model assumes homogeneity in preferences across respondents, and, therefore, limitations exist surrounding the explanatory power of the model (Colombo, Hanley, and Louviere 2009). To increase a model's explanatory power, researchers can explore heterogeneity in respondents' preferences. This is usually done by a priori segmentation or latent class segmentation (Vermunt and Magidson 2005) but these approaches are not applicable to this study because of the individualisation of respondents' status quo. Therefore, I had to include demographic characteristics of respondents in the MNL model as predictors. For my research, I am interested in the effects of respondents' personal lawn conditions on their lawn choices and I accounted for this by incorporating respondents' lawn characteristics as predictors into the MNL model (described below).

3.6.3. Predictors

Throughout the qualitative phase of our research, including focus groups and expert interviews, indications emerged that turf size is an important factor driving people's lawn management choices. Because of this, we designed the CE so that some personal descriptions of the personal lawn characteristics entered the design. Therefore, the analysis of the CE also needed to account for these individual measures within the model. One way of doing this is by entering the individual characteristics as predictors.

Predictors are characteristics of replications and serve to refine the MNL model (Vermunt and Magidson 2005). While attributes are characteristics of the alternatives, "predictors are characteristics of the replication or person, and take on the same value across alternatives" (Vermunt and Magidson 2005, p.11). For this study, I used respondents personalized lawn characteristics (i.e. the proportion of turf, variety, appearance and associated watering costs) as predictors to refine the MNL model. In other words, in the model, predictors control for detached homeowners' current lawn situation. Like attributes, these predictors enter in the regression model for choices but are not part of the original CE. For example, equation (11) characterizes the probability of a conditional logit model (Vermunt and Magidson 2005):

$$P\left(y_{it} = j \middle| z_{it}^{att}, z_{it}^{pre}\right) \tag{11}$$

Where the regression model represents the probability individual *i* selects alternative *j* at replication *t* given attribute values z_{it}^{att} and predictor values z_{it}^{pre} for all responses y_{it}. The conditional logit model has the form (Vermunt and Magidson 2005):

$$P\left(y_{it} = j \middle| z_{it}^{att}, z_{it}^{pre}\right) = \frac{\exp\left(\eta_{j|z_{it}}\right)}{\sum_{j'=1}^{J} \exp\left(\eta_{j'|z_{it}}\right)} \tag{12}$$

Where $\eta_{j|z_{it}}$ is the systematic component in the utility of alternative *j* for case *i* at replication *t.* From McFadden (1974), the term $\eta_{j|z_{it}}$ is a linear function of the ASC β_j^{con}, attribute effects β_p^{att}, and predictor effects β_{jq}^{pre}. The indices p and q refer to particular attributes and predictors. The total number of attributes and predictors is denoted by P and Q respectively (Vermunt and Magidson 2005):

$$\eta_{j|z_{it}} = \beta_j^{con} + \sum_{p=1}^{P} \beta_p^{att} z_{itjp}^{att} + \sum_{q=1}^{Q} \beta_{jq}^{pre} z_{itq}^{pre} \tag{13}$$

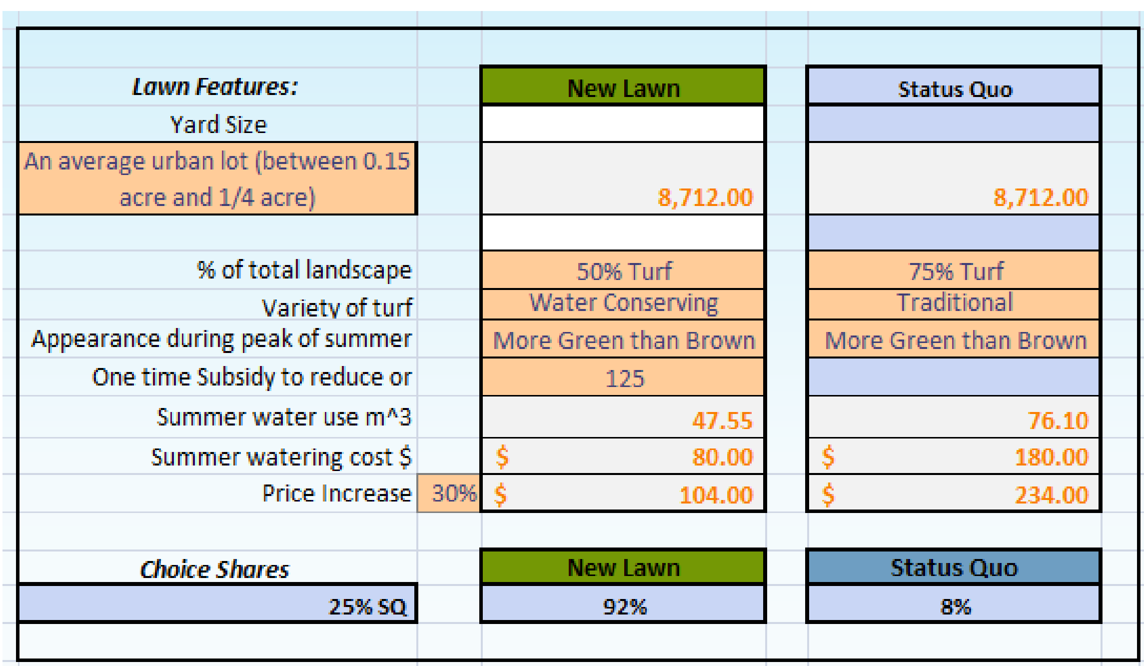
Where, for effect coding, $\sum_{j=1}^{J} \beta_j^{con} = 0$, and $\sum_{j=1}^{J} \beta_{jq}^{pre} = 0$ for $1 \leq q \leq Q$.

3.7. Step 7: Decision Support Tool and Planning Implications

To study the effects of the entire model – as opposed to individual parameter estimates – on people's management choices, we developed a decision support tool (DST) in Excel. The DST is based on the parameter estimates of the statistical model (i.e. Equation 11), which predicts the likelihood of choice for any one scenario (i.e. combinations of attributes) in the context of the presented alternatives. Employing Equation 11 to power the DST, we used parameter estimates (i.e. part worth utility) from the CE to calculate overall utility of different lawn management scenarios allowing us to approximate the probability of choice for one alternative over another (Hensher, Rose, and Greene 2005). In its simplest form, a DST can be designed in Excel, by replicating the layout of the CE in the survey, i.e. in this case with the scenarios A and B, as well as a status quo. After programming, the levels for each attribute can be changed and the program reacts instantaneously to these changes by re-calculating the likelihood of choice for any one of the scenarios. In this study, two different types of research questions can potentially be pursued with such a DST: 1) with the exact replication of the original CE used in the survey (two hypothetical scenarios A and B, and the status quo), one can observe the relative changes between hypothetical scenarios of A vs. B, as well as their changes vis-à-vis the status quo alternative; when changing the configurations of A and B, the likelihood of choice for the status quo also changes. 2) If the intent is to understand the relationship between the status quo and a management scenario, it is more useful to keep the scenarios A and B identical, or to present the two as one scenario only. I used this second layout for the DST in this study (Figure 3.3). To achieve this, parameter estimates for Lawn A and Lawn B for the ASC and all predictors were combined (by summing the estimates for Lawn A and Lawn B together) allowing me to compare respondents' intended behaviour for choosing either one 'new lawn' scenario versus their 'current lawn' (status quo).

Thus, I can compare how many respondents (i.e. what percentage of the sample population) would choose to stay with their status quo situation or move to a 'new lawn' alternative. The DST provides decision makers with increased knowledge about residents' preferences and intended choices allowing managers to make more informed decisions about water planning. For example, our DST allows water managers and planners to test the effect of limiting certain lawn attributes – such as reducing lawn size (percentage of total yard) – on users' support for different lawns. This information can inform planners about land management strategies that may be appropriate for a city or region. Further, information from the DST can reveal to managers whether or not incentive programs or education programs (or a combination of both) are more appropriate for encouraging users to reduce water consumption. The DST can be shown to regional water managers, water utilities, residents, and other stakeholders to demonstrate how changing one's behaviour (i.e. landscaping retrofits) can affect positive change.

Figure 3.3. Screenshot of the DST.



Lawn Features:		New Lawn	Status Quo
Yard Size			
An average urban lot (between 0.15 acre and 1/4 acre)		8,712.00	8,712.00
% of total landscape		50% Turf	75% Turf
Variety of turf		Water Conserving	Traditional
Appearance during peak of summer		More Green than Brown	More Green than Brown
One time Subsidy to reduce or		125	
Summer water use m^3		47.55	76.10
Summer watering cost $		$ 80.00	$ 180.00
Price Increase	30%	$ 104.00	$ 234.00
Choice Shares		New Lawn	Status Quo
25% SQ		92%	8%

4. Results

This chapter presents the survey results including my descriptive presentation of the responses to the survey questions, simple analysis, and modelling of the CE. To begin, survey response rates are detailed, followed by an analysis of the sample population's socio-demographic characteristics. Next, the results of attitudinal questions are presented including a priori segmentation of respondents into segments based on current proportions of turf in respondents' yards (25% turf, 50% turf, and 75% to 100% turf). Subsequently, the part-worth utilities estimated from the MNL with Predictors choice model is shown and compared. As mentioned previously, results are only presented for City of Kelowna residents living in detached houses with turf in their yard and who completed the choice experiment.

4.1. Survey Response Rates

Using a modified tailored design method (Dillman 2007), 2,100 households were contacted in Kelowna, B.C. While Kelowna residents live in a variety of households, only those living in detached homes were contacted for and included in the analysis for this study. During the data collection period from March 2012 to the end of May 2012, a total of 951 visits to the water study website occurred representing a 45% contact rate. Respondents who did not complete the survey were removed including 41 who did not proceed past the survey introduction. Protest and invalid responses were also identified and eliminated, yielding a sample size of 792 (completion rate of 83% and actual response rate of 38%). The CE was presented to only respondents that indicated their primary water provider was the City of Kelowna Water Utility. Of the total responses remaining 399 respondents completed all six choice sets (50% of the 792 respondents) and provided the sample population used in my analysis.

4.2. Socio-demographics

The following sections describe respondents' socio-demographic characteristics including age, gender, income, and education. Table 4.1 compares the sample population with 2006 census data for Kelowna (Government of Canada 2011). Our survey's target sample included only residents of 18 years of age and older and, therefore, the census data have been adjusted accordingly (Table 4.1). Compared to census data, the sample population is skewed toward older age ranges above 35 years of age. Also, almost one third of the sample population were retired. Respondents to the survey were relatively evenly split between males and females. On average, the sample population earned higher incomes and were more educated than the census population.

Table 4.1. Socio-demographic comparison of sample population and census data for Kelowna (2006).

Socio-Demographic Characteristics		Sample Population (%)*	Census Population (%)**	Adjusted Census Population (%)
Age (n=404)	Under 20	0.0	21.9	N/A
	20 to 24	1.2	7.0	9.0
	25 to 34	7.7	11.1	14.2
	35 to 44	15.1	13.6	17.4
	45 to 54	29.5	15	19.2
	55 to 65	27.5	11.9	15.2
	65 or over	19.1	19.4	24.8
Retired (n=399)	Yes	31.8	N/A	
	No	68.2	N/A	
Gender (n=399)	Male	47.0	48.0%	
	Female	53.0	52.0%	
Income (n=373)	Median	$80,000 to $99,000	$48,859	
Education (n=396)	Less than high school	1.3	19.8	
	Completed high school	23.5	29.6	
	University, trades, non-university certificate/diploma	75.3	50.6	

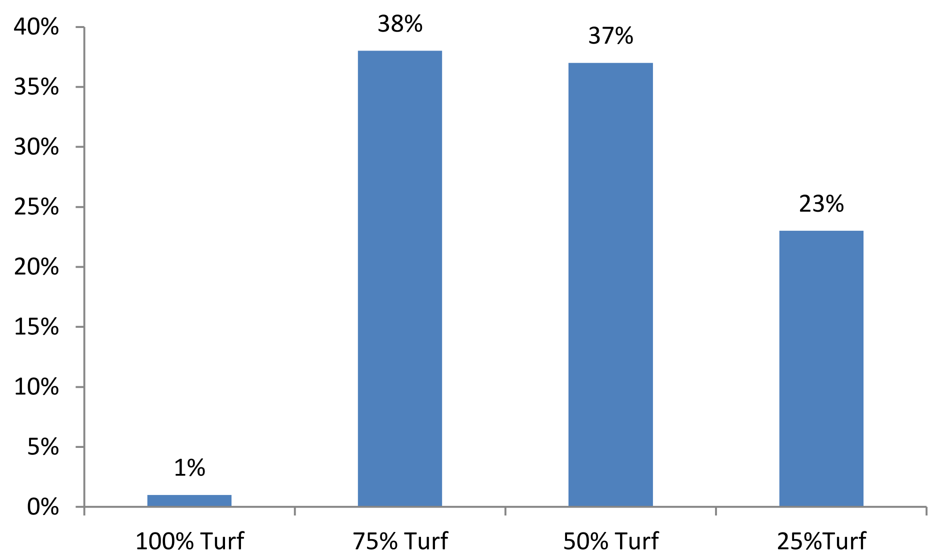
*Survey was exclusive to individuals 18 years of age and older.
**Census data includes individuals 15 years of age and older.

4.3. Current Residential Landscaping

Respondents were asked to describe their current yard features including the overall property size, percentage of turf in landscape, lawn variety, and lawn appearance they try to maintain during the peak of summer. These features determine how much water is required to maintain a respondent's lawn and assists with later segmentation. As the percentage of turf in the overall yard was suspected to be a crucial variable in the context of household water management, this report will compare all survey responses by proportion of turf. Therefore, I split the population into three segments: 25%, 50%, and 75% and 100% turf combined. Statistical tests of significance between these segments will be performed on all questions (see section 3.5 above),

The majority of detached homeowners lived on properties containing approximately 75% turf or lawn or 50% turf or lawn while about one quarter had yards with approximately 25% turf (Figure 4.1) [2]. Five respondents had yards with almost 100% turf.

Figure 4.1. Proportion of lawn (turf) cover in respondents' yards.



Chi-square tests showed that detached homeowners' property size was independent of the current proportion of turf in their landscape (Figure 4.2), and that lawn variety is independent of current proportion of turf (Figure 4.3)[3]. However, lawn appearance is dependent on the current to proportion of turf in one's yard (Figure 4.4).

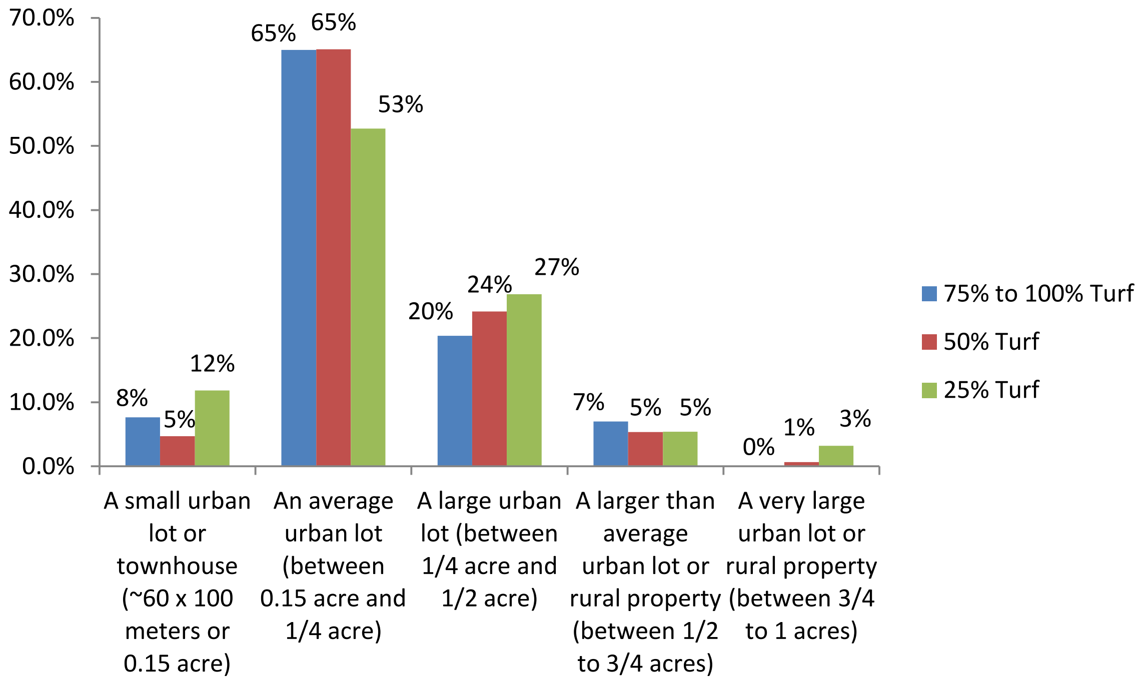
A large majority of respondents lived on an average urban lot between 0.15 and 0.25 acres with about a quarter of the sample population living on large urban lots between 0.25 and 0.5 acres (Figure 4.2). No respondents in the final sample lived on

[2] Respondents were asked to only consider the yard surrounding their home, driveway and patios.

[3] The p-values for these two chi-square tests were greater than 0.05 indicating that the null hypothesis should not be rejected at the 95% confidence interval.

properties greater than ¾ to 1 acre. Surprisingly, the proportion of turf did not differ strongly by lot size, but was marginally significant (chi-square p=0.096)

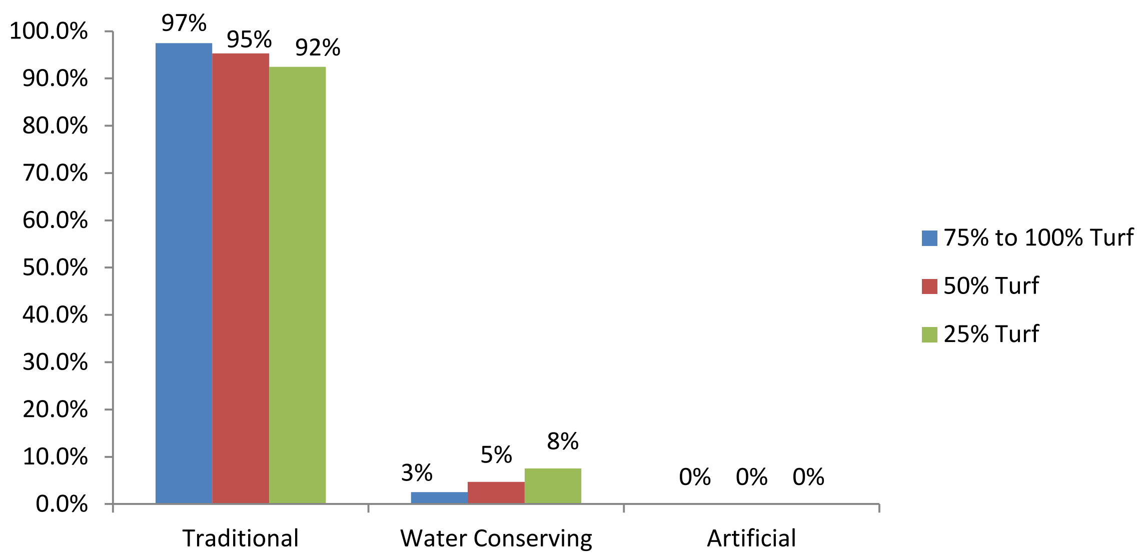
Figure 4.2. Property sizes by proportion of turf.



Pearson's chi-square=13.504, p=0.096.

Almost all detached homeowners used a traditional variety of turf (i.e. Kentucky blue grass or ryegrass) in their lawn compared to water conserving or artificial varieties (Figure 4.3).

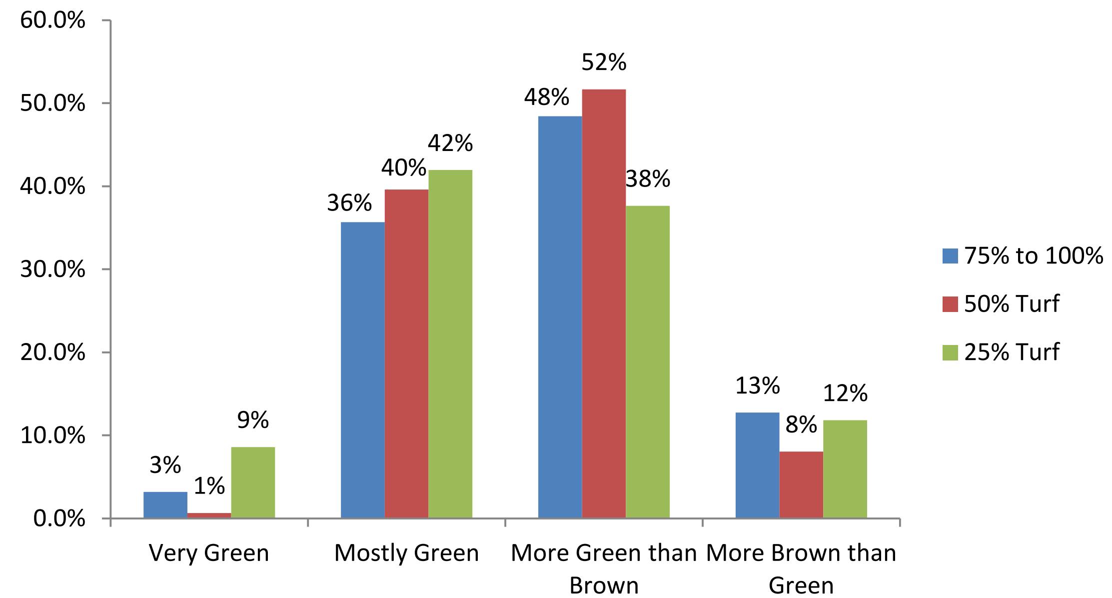
Figure 4.3. Lawn varieties by proportion of turf.



Pearson's chi-square=3.380, p=0.184.

Also, during the peak of summer, the majority of respondents maintained lawns that they felt were either 'mostly green' or 'more green than brown' (Figure 4.4).

Figure 4.4. Appearance of own lawn during the peak of summer by proportion of turf.



Pearson's chi-square=15.168, p=0.019.

4.4. Attitudinal Responses

Attitudinal responses provide researchers insight into detached homeowners opinions about different issues in the Okanagan including respondents' level of agreement with the acceptability of, or the importance of, general statements about their yard's appearance, water use in the Okanagan Basin, the Okanagan's water resources, drought programs, water uses during times of water scarcity, and general statements about their own yard's appearance.

4.4.1. Landscaping Appearance

Generally, detached homeowners expressed contentment with their present landscaping and that they would like to increase their knowledge about their outdoor water use (Table 4.2). For example, respondents were interested in learning more about water requirements for landscaping as well as selecting drought tolerant varieties of plants, possibly indicating a willingness to conserve water. Further, respondents were not concerned that their neighbours might disapprove of their lawn reduction. However, standard deviations for all the statements indicated that respondents' opinions about landscaping varied widely. ANOVA tests revealed that respondents' opinions about being content with their landscaping, their desire to reduce their lawn size, and time and money as barriers to outdoor water conservation statements varied with current proportion of turf in their home landscape. Respondents with medium and larger lawns shared similar landscaping opinions but differed from those with smaller lawns. For example, respondents with smaller lawns were more content with their present landscaping and less interested in reducing their lawn size. Also, respondents with medium and larger lawns were more likely to believe that time and money constituted barriers to retrofitting their yard.

Table 4.2. Agreement with statements on landscaping appearance by proportion of turf.

	Total Mean	s.d.[d]	ANOVA p-value[e]	Segmented Mean		
Statement				25%[a]	50%[b]	75%[c]
I am content with my present landscape	2.60	1.09	0.004**	2.27[bc]	2.67[a]	2.72[a]
I would like to reduce the amount of lawn in my yard	2.99	1.20	0.024*	3.28[bc]	2.91[a]	2.88[a]
I would like to learn more about landscape water requirements before deciding on any changes	2.46	0.91	0.252	2.59	2.45	2.39
I would like to eventually select more drought tolerant varieties of plants	2.20	0.921	0.564	2.26	2.23	2.14
I do not think my neighbours would accept changes in my landscape that reduce the amount of lawn	3.71	0.979	0.370	3.84	3.66	3.68
I would like to reduce the amount of water my landscape uses, but I do not have the time to make changes	2.96	1.04	0.000**	3.34[bc]	2.94[a]	2.75[a]
I would like to reduce the amount of water my landscape uses, but I do not have the money to make changes	2.55	1.10	0.000**	3.08[bc]	2.55[a]	2.24[a]

The score is based on a Likert scale ranging from 1 (strongly agree), 3 (nether agree nor disagree), and 5 (strongly disagree).

[a]25% Turf; [b]50% Turf; [c]75% to 100% Turf

[d]Standard deviation

[e]The p-value (ANOVA) indicates that the means are significantly different from each other.

***Significance at the 95% and **99% confidence interval indicated by Fisher's Least Significant Difference (LSD) Test Statistic.**

4.4.2. Managing Water Resources

Table 4.3 suggests that the majority of detached homeowners believed that water use in major categories of water use (e.g. agriculture, industrial, etc) in the Okanagan has increased over the last 10 years. However, respondents' believed that water available for the natural environment has decreased. ANOVA tests indicate that the proportion of turf segments exhibited very similar opinions about trends in water consumption in the Okanagan.

Table 4.3. ***Reported mean opinion about water use changes by proportion of turf.***

	Total Mean	s.d.[d]	ANOVA p-value[e]	Segmented Mean		
Statement				**25%[a]**	**50%[b]**	**75%[c]**
Water used by residents	1.59	0.810	0.264	1.43	1.68	1.59
Water used by agriculture	1.78	0.757	0.651	1.69	1.82	1.80
Water used by businesses	1.49	0.644	0.079	1.31	1.58	1.49
Water used by parks	1.83	0.782	0.569	1.74	1.89	1.82
Water used by golf courses	1.47	0.643	0.052	1.26	1.49	1.55
Water available for the natural environment	2.42	0.676	0.449	2.38	2.37	2.49

The score is based on a Likert scale ranging from 1 (increased), 2 (not changed), and 3 (decreased).

[a]25% Turf; [b]50% Turf; [c]75% to 100% Turf

[d]Standard deviation

[e]The p-value (ANOVA) indicates that the means are significantly different from each other.

***Significance at the 95% and **99% confidence interval indicated by Fisher's Least Significant Difference (LSD) Test Statistic.**

The majority of respondents were concerned about water conservation issues and believed that water conservation programs should allow for users to alter their behaviour (Table 4.4). Respondents were fairly neutral in their beliefs that they are doing all they can to conserve water (mean=2.94, s.d.=0.966), their neighbours use more water than them (mean=2.65, s.d.=0.902), and technology is the only way to permanently conserve water (mean=3.06, s.d.=1.06) but the standard deviations indicate that individual opinions differ widely on this issue. ANOVA tests revealed that, compared to medium and larger turf groups, respondents with smaller lawns were more likely to believe that they are doing all they can to conserve water. Further, respondents with smaller lawns also tended to believe that they use less water than their neighbours.

Table 4.4. Reported mean agreement with statements about Okanagan Basin water use by proportion of turf.

	Total Mean	s.d.[d]	ANOVA p-value[e]	Segmented Mean		
Statement				**25%[a]**	**50%[b]**	**75%[c]**
I am doing all I can to conserve water	2.94	0.966	0.022*	2.67[bc]	2.98[a]	3.06[a]
My neighbours currently use more water than I do	2.65	0.902	0.014*	2.37[bc]	2.70[a]	2.74[a]
Water conservation is an issue I am personally concerned about	2.12	0.720	0.396	2.01	2.16	2.13
Water conservation programs should include options for changing water users' behavior	2.03	0.743	0.120	1.87	2.09	2.06
Using technology is the only way we will permanently reduce the amount of water we use	3.06	1.06	0.824	3.06	3.10	3.02

The score is based on a Likert scale ranging from 1 (strongly agree), 3 (nether agree nor disagree), and 5 (strongly disagree).

[a]25% Turf; [b]50% Turf; [c]75% to 100% Turf

[d]Standard deviation

[e]The p-value (ANOVA) indicates that the means are significantly different from each other.

***Significance at the 95% and **99% confidence interval indicated by Fisher's Least Significant Difference (LSD) Test Statistic.**

High standard deviations indicated that respondents' opinions about managing the Okanagan's water resource varied widely (Table 4.5). For example, while, on average, respondents felt neutral about mandatory water restrictions, the standard deviation indicate that opinions on this issue are diverse (mean=3.22, s.d.=1.18). The majority of respondents believed that planning is required to manage water scarcity. Generally, respondents believed that city growth (mean=2.34, s.d.=0.987) should be limited to manage water scarcity and that public money (mean=2.50, s.d.=0.915) should be used to develop and acquire new water resources. However, high standard deviations imply that respondents' opinions vary widely for these statements. Respondents displayed uncertainty about their satisfaction with the current system of water management and were unsure if water policy makers understood their priorities for water use. ANOVA test results indicated that detached homeowners' opinions about managing the Okanagan's water resources were relatively similar between proportion of turf segments.

Table 4.5. ***Reported mean agreement with statements about managing the Okanagan's water resources by proportion of turf.***

	Total Mean	s.d.[d]	ANOVA p-value[e]	Segmented Mean		
Statement				**25%[a]**	**50%[b]**	**75%[c]**
Water restrictions should be voluntary rather than mandated by the government	3.22	1.18	0.343	3.37	3.24	3.12
Regional land use and water planning is needed to manage water scarcity	1.90	0.690	0.843	1.90	1.90	1.932
Growth of cities should be limited to manage water scarcity	2.34	0.987	0.657	2.34	2.40	2.33
Public money should be used to develop or acquire new water resources	2.50	0.915	0.389	2.50	2.41	2.54
I am satisfied with the current system of management	2.91	0.847	0.456	2.91	2.98	2.87
Water policy makers understand my priorities for water use	3.10	0.774	0.327	3.10	3.06	3.17

The score is based on a Likert scale ranging from 1 (strongly agree), 3 (nether agree nor disagree), and 5 (strongly disagree).

[a]25% Turf; [b]50% Turf; [c]75% to 100% Turf

[d]Standard deviation

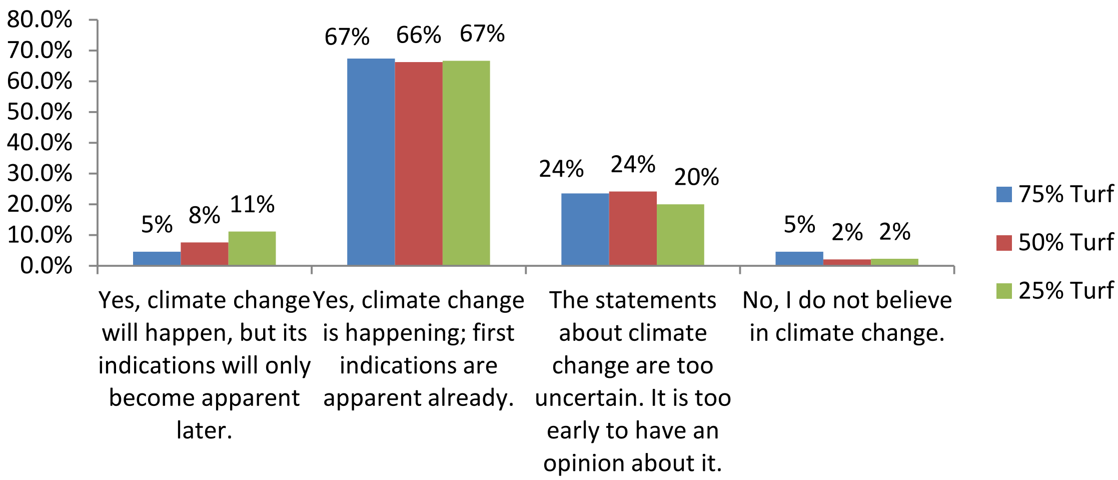
[e]The p-value (ANOVA) indicates that the means are significantly different from each other.

***Significance at the 95% and **99% confidence interval indicated by Fisher's Least Significant Difference (LSD) Test Statistic.**

A majority of respondents (66%) believed that climate change is already occurring (Figure 4.5). However, a large segment of respondents (22%) expressed uncertainty about climate change and believed that it is too early to have an opinion about climate change. Very few respondents (3%) indicated they do not believe in climate change. Pearson's chi-square tests revealed that residents' opinions about climate change in the Okanagan are independent of their current proportion of turf (chi-square=5.664, p=0.462)[4].

[4] p-values for all statements were above 0.05. Therefore, I did not reject the null hypothesis.

Figure 4.5. Opinions about climate change in the Okanagan.



Pearson's chi-square=5.664, p=0.462.

Standard deviations indicate that, as a whole, respondents' opinions varied about believing that the amount of rainfall during the summer has 'increased,' 'not changed,' or 'decreased' (mean=2.10, s.d.=0.723). Similarly, respondents' opinions about the frequency of water shortages were split between 'increased' and 'not changed' (Table 4.6). This trend indicates that there may not be a consensus amongst detached homeowners about water availability in the Okanagan. Conversely, respondents felt that the severity of winters has decreased. Similar to climate change opinions, ANOVA tests indicated that respondents' opinions about changes in climate events were independent of their proportion of turf.

Table 4.6. Reported mean opinions about changes in climate events in the Okanagan by proportion of turf.

	Total Mean	s.d.[d]	ANOVA p-value[e]	Segmented Mean		
Statement				**25%[a]**	**50%[b]**	**75%[c]**
The amount of rainfall during the summer has…	2.10	0.723	0.540	2.20	2.09	2.07
The severity of winters has…	2.50	0.677	0.455	2.43	2.56	2.47
The frequency of water shortages has…	1.58	0.583	0.164	1.46	1.58	1.65

The score is based on a Likert scale ranging from 1 (increased) , 2 (not changed, and 3 (decreased).

[a]25% Turf; [b]50% Turf; [c]75% to 100% Turf

[d]Standard deviation

[e]The p-value (ANOVA) indicates that the means are significantly different from each other.

***Significance at the 95% and **99% confidence interval indicated by Fisher's Least Significant Difference (LSD) Test Statistic.**

Respondents' opinions about water management programs varied widely as indicated by high standard deviations for all the statements below (Table 4.7). The majority of respondents believed that water restrictions on private and public lawns and yards were acceptable water management practices that could be used to reduce water consumption. Also, the majority of respondents found water restrictions for industry and business to be acceptable management options. However, in general, respondents indicated 'temporarily paying farmers to reduce production' was unacceptable. Also, the majority of respondents indicated that 'allowing local lakes and reservoirs to drain' and 'reducing the amount of water available for wildlife and fish habitats' were unacceptable. ANOVA tests illustrate that, between turf groups, opinions about water management programs are relatively homogeneous.

Table 4.7. Reported mean opinions about water management programs by proportion of turf.

	Total Mean	s.d.[d]	ANOVA p-value[e]	Segmented Mean		
Statement				**25%[a]**	**50%[b]**	**75%[c]**
Restricting the amount of water that can be used on private lawns and landscapes	3.90	1.03	0.918	3.87	3.92	3.90
Restricting the amount of water that can be used on public landscapes	4.12	0.945	0.586	4.20	4.07	4.13
Temporarily paying farmers to reduce production	2.22	1.05	0.658	2.29	2.18	2.27
Restricting the amount of water that can be used by industry and businesses	3.43	1.06	0.095	3.41	3.30	3.57
Allowing local lakes and reservoirs to drain	1.84	0.984	0.999	1.83	1.83	1.83
Reducing the amount of water available for wildlife and fish habitats	1.57	0.876	0.660	1.56	1.62	1.52

The score is based on a Likert scale ranging from 1 (very unacceptable), 3, and 5 (very acceptable).

[a]25% Turf; [b]50% Turf; [c]75% to 100% Turf

[d]Standard deviation

[e]The p-value (ANOVA) indicates that the means are significantly different from each other.

***Significance at the 95% and **99% confidence interval indicated by Fisher's Least Significant Difference (LSD) Test Statistic.**

In times of water scarcity or drought, municipalities may require residents to use less water in households. Therefore, it is important for water planning and conservation to identify possible targets for water conservation by evaluating water uses which residents would most likely be willing to reduce. Overall, the willingness to reduce water consumption is very significant at times of water shortage. On any one of the categories, respondents were willing to reduce their water consumption by at least one third, and when it comes to outdoor water usage by more than half (Table 4.8). Furthermore, ANOVA tests revealed no significant differences emerged on this question between the a priori segments by proportion of turf.

Table 4.8. Reported mean willingness to reduce the amount of household water use reduction by proportion of turf.

	Total Mean	s.d.[d]	ANOVA p-value[e]	Segmented Mean		
Statement				**25%[a]**	**50%[b]**	**75%[c]**
Summer lawn watering	53.3%	26.4%	0.768	53.3%	52.3%	54.5%
Length of showering or bathing	39.9%	25.4%	0.596	40.0%	41.6%	38.6%
Frequency of flushing toilets	37.6%	26.8%	0.319	37.7%	40.0%	35.3%
Frequency of using a dishwasher	47.6%	32.3%	0.108	48.0%	52.1%	46.7%
Frequency of using a clothes washer	36.6%	26.4%	0.744	37.0%	38.3%	36.3%

The score is based on a scale ranging in 10% increments from 0% to 100% in water use reduction.

[a]25% Turf; [b]50% Turf; [c]75% to 100% Turf

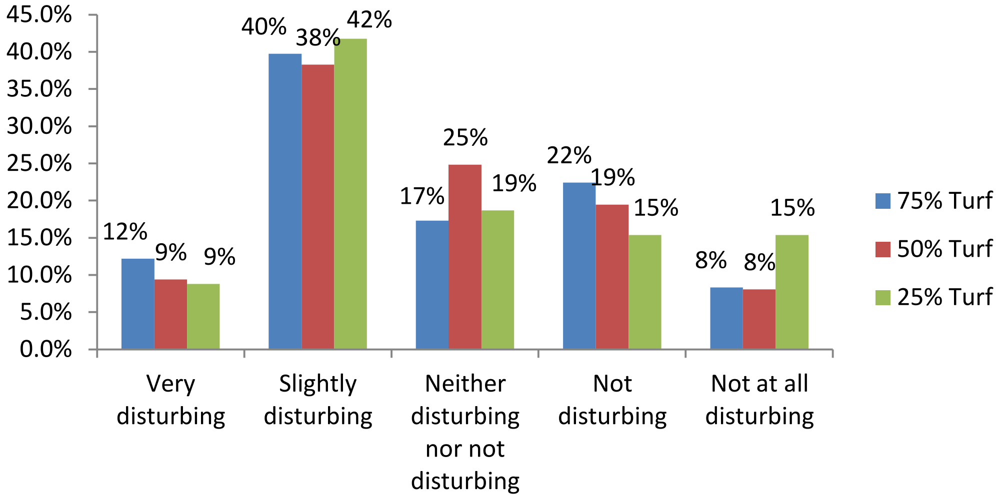
[d]Standard deviation

[e]The p-value (ANOVA) indicates that the means are significantly different from each other.

***Significance at the 95% and **99% confidence interval indicated by Fisher's Least Significant Difference (LSD) Test Statistic.**

To conserve water during dry summer months, municipalities and utilities can develop policies that restrict water irrigation of public and private green spaces. Evaluating residents' opinions about the appearance of public and private green spaces may provide researchers and managers with insight about public acceptability of reducing water use for these spaces. During a hypothetical summer where the Okanagan expected to receive 35 percent less rainfall than average, approximately half the respondents believed that letting public (Figure 4.6) or private (Figure 4.7) green spaces turned brown would be disturbing for them. The other half of the sample population believed letting public or private green spaces turn brown was 'neither disturbing nor not disturbing,' 'not disturbing,' or 'not at all disturbing' indicating the public's opinion is split on this issue for both public and private green spaces.

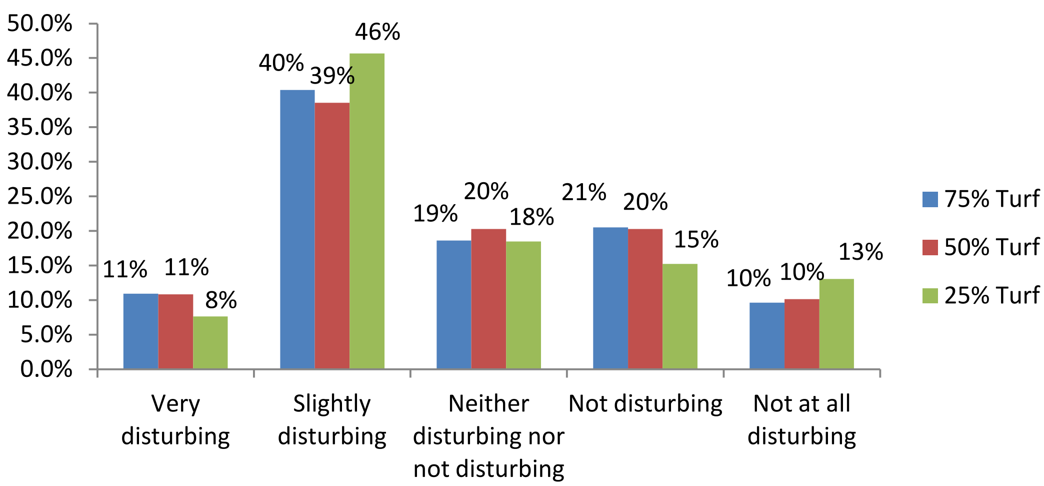
Figure 4.6. Perceptions of public green spaces turning brown.



Pearson's chi-square tests: chi-square=8.456, p=0.390

Respondents' perceptions of public and private green spaces turning brown were relatively homogeneous across the three percentages of turf and independent samples t-test revealed no significant differences between perception of public and private green spaces at the 95% confidence interval ($p<0.05$). As well, Pearson's chi-square tests revealed that residents' perceptions of public and private green spaces turning brown are independent of the current proportion of turf in their yard.

Figure 4.7. Perceptions of private green spaces turning brown.



Pearson's chi-square=3.285, p=0.915.

The majority of respondents indicated water for agriculture, wildlife and the natural environment, and household indoor use were among the most important uses during water scare events (Table 4.9). Conversely, a majority of respondents believed water for municipal and private landscape irrigation were not as important. Generally, respondents' opinions about important water uses varied among the segments indicated by high standard deviations. For example, opinions varied widely about water for recreational purposes as indicated by a high standard deviation (mean=3.05, s.d.=1.05). ANOVA tests revealed that respondents with larger lawn proportions viewed water for agricultural purposes as less important compared to those with moderate proportions.

Table 4.9. Reported mean opinions about important water uses by proportion of turf.

	Total Mean	s.d.[d]	ANOVA p-value[e]	Segmented Mean		
Statement				25%[a]	50%[b]	75%[c]
Water for agriculture	4.48	0.735	0.035*	4.48	4.58[c]	4.35[b]
Water for municipal landscape irrigation	2.42	0.939	0.987	2.42	2.41	2.41
Water for recreation	3.05	1.05	0.765	2.97	3.06	3.06
Water for wildlife and the natural environment	4.42	0.822	0.824	4.44	4.39	4.40
Water for household indoor use	3.89	0.895	0.810	3.96	3.87	3.86
Water for private landscape irrigation	2.35	0.924	0.219	2.20	2.41	2.36
Water for commercial and industrial use	2.86	0.975	0.307	2.87	2.93	2.76

The score is based on a Likert scale ranging from 1 (not very important), 3, and 5 (very important).

[a]25% Turf; [b]50% Turf; [c]75% to 100% Turf

[d]Standard deviation

[e]The p-value (ANOVA) indicates that the means are significantly different from each other.

***Significance at the 95% and **99% confidence interval indicated by Fisher's Least Significant Difference (LSD) Test Statistic.**

4.5. Choice Experiment

4.5.1. Choice model results

To control for the respondents' individual lawn features, a one class MNL Model with Predictors was specified and its part worth utilities are presented below (Table

4.10). In this model, all attributes of the choice experiment were effects coded, except for ‘watering cost’ which was coded linearly and ‘subsidy’ which was coded in linear and quadratic terms to allow for the designation of different functional forms. The MNL Model with Predictors is based on 399 respondents. The model presents the estimated coefficient (part worth utility), standard error, and z-value (significance of an attribute level) for each attribute level. Also, a Wald statistic – representing the significance of an attribute – is shown for each attribute. Graphed welfare estimates for attributes are shown below (Figure 4.8).

Table 4.10. The MNL Model with Predictors for proportion of turf in yard, variety, appearance, and property size.

Attribute	Attribute Level	Coef[a]	St.Er[b]	z-value	Wald (p-value)
Intercept	Lawn A	-0.215	0.184	-1.169	9.70 x10-5
	Lawn B	-0.443	0.185	-2.395**	
	Current Lawn	0.658	0.155	4.247**	
Proportion of Turf in Yard	100% Turf	-1.356	0.113	-11.988**	2.40 x 10-41
	75% Turf	-0.090	0.074	-1.209	
	50% Turf	0.781	0.068	11.548**	
	25%Turf	0.665	0.079	8.464**	
Lawn Variety	Artificial	-0.239	0.107	-2.228**	2.10 x 10-12
	Traditional	-0.180	0.070	-2.581**	
	Water Conserving	0.419	0.068	6.162**	
Lawn Appearance	Very Green	-0.188	0.077	-2.426**	2.30 x 10-7
	Mostly Green	0.293	0.069	4.228**	
	More Green than Brown	0.172	0.066	2.610**	
	More Brown than Green	-0.277	0.072	-3.836**	
Subsidy (Linear)		-0.002	0.017	-0.144	0.890
Subsidy (Quadratic)		0.064	0.039	1.650*	0.099
Lawn Watering Cost (Linear)		-0.0008	0.0002	-3.8294	1.3 x 10-4

[a]Coefficient; [b]Standard Error; [c]Wald (p-value): a p-value below 0.05 indicates the attribute is significant.
**** Significant at 0.05**
*** Significant at 0.05**

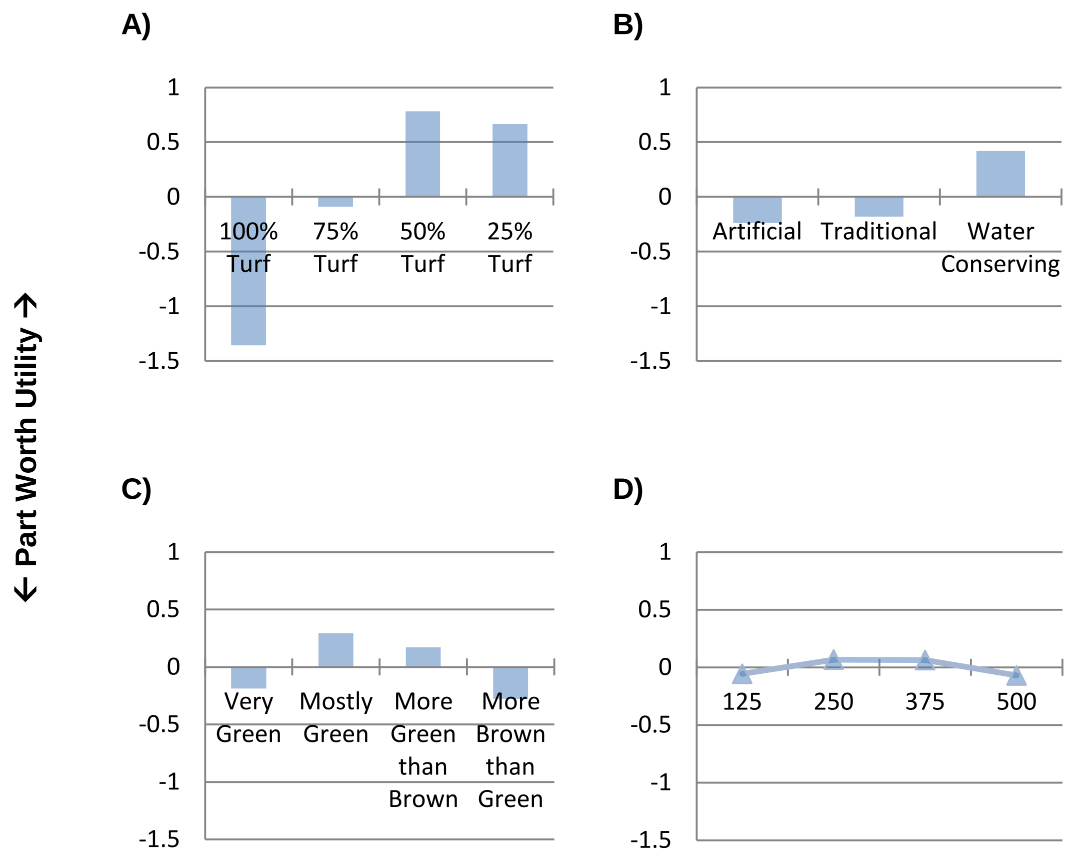
Table 4.10. The MNL Model with Predictors (Continued).

Attribute	Attribute Level	Coef	St.Er	z-value	Wald (p-value)
Proportion of Turf in Yard Predictors	Lawn A	0.440	0.223	1.976**	3.10×10^{-43}
100% Turf	Lawn B	0.098	0.231	0.426	
	Current Lawn	-0.538	0.210	-2.559**	
	Lawn A	0.093	0.089	1.046	
75% Turf	Lawn B	0.326	0.091	3.597**	
	Current Lawn	-0.419	0.082	-5.134**	
	Lawn A	-0.142	0.092	-1.547	
50% Turf	Lawn B	-0.017	0.093	-0.180	
	Current Lawn	0.159	0.082	1.939**	
	Lawn A	-0.391	0.106	-3.685**	
25% Turf	Lawn B	-0.408	0.109	-3.754**	
	Current Lawn	0.799	0.089	8.957**	
Lawn Variety Predictors	Lawn A	0.090	0.104	0.862	0.024
	Lawn B	0.127	0.107	1.182	
Traditional	Current Lawn	-0.217	0.079	-2.738**	
	Lawn A	-0.090	0.104	-0.862	
Water Conserving	Lawn B	-0.127	0.107	-1.182	
	Current Lawn	0.217	0.079	2.738**	

Table 4.10. The MNL Model with Predictors (Continued).

Attribute	Attribute Level	Coef	St.Er	z-value	Wald (p-value)
Lawn Appearance Predictors	Lawn A	-0.049	0.170	-0.287	0.200
Very Green	Lawn B	-0.103	0.174	-0.593	
	Current Lawn	0.152	0.138	1.103	
	Lawn A	-0.126	0.079	-1.602	
Mostly Green	Lawn B	0.105	0.079	1.332	
	Current Lawn	0.021	0.064	0.328	
	Lawn A	-0.029	0.075	-0.383	
More Green than Brown	Lawn B	0.063	0.076	0.830	
	Current Lawn	-0.034	0.062	-0.551	
	Lawn A	0.204	0.098	2.081**	
More Brown than Green	Lawn B	-0.065	0.102	-0.639	
	Current Lawn	-0.139	0.085	-1.640	
Property Size Predictors	Lawn A	-0.041	0.164	-0.252	0.130
Small Urban Lot	Lawn B	0.015	0.162	0.092	
	Current Lawn	0.026	0.134	0.195	
	Lawn A	-0.090	0.130	-0.693	
Average Urban Lot	Lawn B	0.055	0.129	0.427	
	Current Lawn	0.035	0.102	0.345	
	Lawn A	-0.157	0.138	-1.138	
Large Urban Lot	Lawn B	0.064	0.137	0.471	
	Current Lawn	0.093	0.101	0.919	
	Lawn A	0.298	0.168	1.774*	
Larger than Average Urban Lot/Rural Property	Lawn B	0.079	0.175	0.450	
	Current Lawn	-0.377	0.141	-2.684**	
	Lawn A	-0.010	0.463	-0.021	
Very Large Urban Lot/Rural Property	Lawn B	-0.213	0.461	-0.463	
	Current Lawn	0.223	0.322	0.694	

Figure 4.8. MNL Model with Predictors - Part worth utility estimates for A) proportion of turf in yard; B) Lawn Variety; C) Lawn Appearance; and D) Subsidy.



For the MNL with Predictors, all lawn attributes presented in the CE were significant at the 95% confidence interval except for subsidy which was significant at the 90% confidence interval. With respect to the proportion of turf in yards, detached homeowners in Kelowna generally prefer smaller percentages of lawns over landscapes with larger percentages of lawn. Utility increases as proportion of turf shrinks despite the majority of respondents having medium and larger lawns. For the total sample population, maximum utility is indicated at landscapes with 50% turf with the MNL model with Predictors indicating slightly less utility from 25% turf. A yard with 75% turf is already much less preferred, and the very negative estimate for 100% turf indicates residents view larger lawns as not desirable. Compared to other attributes, part worth utilities for percentage of turf in landscape are relatively large, indicating that the attribute percentage of turf in landscape influences residents' choices heavily.

Though variation is not as extreme as proportion of turf in yard levels, residents prefer water conserving lawns over traditional and artificial lawns. The lower utility for traditional and artificial lawns is relatively similar.

Unlike proportion of turf in yard and lawn variety, the utility trend for lawn appearance represents an inverted *U* with residents receiving lower utility for the outer levels 'very green' and 'more brown than green'. Residents view lawns with appearances of 'more brown than green' as least desirable. They receive positive utility for both 'mostly green' and 'more green than brown' lawns with 'mostly green' lawns being most desirable.

Similar to lawn appearance, utility for a onetime subsidy to reduce or replace lawn also exhibited an inverted *U* curve with residents viewing subsidy levels of $125 and $500 as less desirable than $250 and $375. While the quadratic estimate for subsidy is significant at the 90% confidence interval, the linear estimate is not significant indicating subsidy, within the range defined in this study, is not a large influence on residents' landscaping choices.

Mentioned earlier, watering cost to maintain a particular lawn was a variable calculated as a product of the individual respondent's proportion of turf in yard, variety, and appearance and, therefore, is not a CE attribute by itself. Watering cost displayed a significant, linear trend with a slightly negative slope indicating residents receive less utility from higher watering costs. The CE also included a water price increase as an attribute (i.e. 30%, 60%, and 90% price increases). However, this price increase was not significant in the analysis – possibly due to its equal effect on all choices and below a threshold to influence respondents' preferences – and therefore is not presented in my results.

The intercept represents whether respondents are more willing to choose alternative Lawn A or Lawn B versus their Current Lawn. Modelling indicates that overall respondents have a positive utility for choosing their 'current lawn' over an alternative lawn. Predictor variables represent respondents' 'current lawn' situation as they influence the probability of an individual choosing an alternative (i.e. Lawn A or Lawn B) or the status quo. Each predictor variable in Table 4.10 is estimated separately for each attribute level, and for each of the three choice alternatives.

The variables percentage of turf in landscape and lawn variety were the only predictors (i.e. variables describing the current condition of the respondent) that illustrated significance for all levels. However, z-scores indicated that each predictor is associated with at least a select few significant levels for each attribute. The significant estimates for the predictors percentage of turf in landscape and lawn variety imply that these two predictors influence respondents' probability to choose an alternative more than other predictors. Respondents with larger proportions of lawn in their landscape (75% lawn and 100% lawn) are more likely to choose a new alternative over the status quo (their 'current lawn'). Conversely, residents with smaller proportions of lawn in their landscape (50% and 25%) are more likely to choose the status quo over an alternative. The predictors on lawn variety imply that residents with traditional varieties of turf in their yard will more likely choose an alternative lawn versus their 'current lawn' while those with water conserving varieties will more likely choose to stay with their current situation.

Generally, predictors for lawn appearance were not statistically significant indicating that one's current lawn appearance does not influence their lawn choices as highly as other lawn characteristics. Similarly, significant of predictor values for property size varied across levels indicating that one's property size does not significantly impact their lawn choices. However, respondents with larger than average urban lots or rural properties do not prefer the status quo.

In some cases – such as for the lawn appearance predictor levels 'mostly green' and 'more brown than green' – significant sign changes occur between the predictor estimates for Lawn A and Lawn B. Given the symmetry in the statistical design used for the creation of the choice scenarios, this phenomenon should not occur and probably indicates a response bias, likely that respondents prefer to click one of the alternatives over the other.

The complexity of the MNL Model with Predictors constitutes a challenge for graphical presentation of results. Therefore, using a DST, I performed a sensitivity analysis, which shows how all parameters in the model jointly affect respondents' choices. I will discuss the DST and my sensitivity analysis in my discussion below.

4.6. Decision Support Tool Analysis

I created a DST in Excel to calculate the detached homeowners' intended support for different hypothetical lawn scenarios (described in section 3.7). By changing the levels of individual attributes, I used the DST to estimate the effect of attributes and their levels on respondents' choices[5]. For the purpose and scope of my research, I compared detached homeowners' choice between staying with their status quo ('current lawn') situation, or choosing an alternative ('new lawn') in a sensitivity test where I systematically changed and compared the effect of individual design attributes on the intended choices of the sample population (i.e. choice shares). The sensitivity analysis revolves around the same segmentation of respondents by their actual turf size as was presented throughout this results chapter.

While the DST does not directly measure respondents' support for or against specific water conservation management strategies, it does indicate respondents' support for lawn features that could be affected by new and current strategies. Results of my sensitivity analysis will be used for discussion of planning implications in subsequent sections of this paper. Design variables from the MNL Model with Predictors were used to generate attributes for 'new lawn' scenarios. Predictor estimates from the MNL Model with Predictors were used to create attributes for 'current lawn' scenarios.

For the scope of my research, I am predominantly interested in residents' choices between their 'current lawn' and a 'new lawn' (i.e. I did not explore residents' choices between alternatives). Therefore, as mentioned in section 3.7, I collapsed all parameter estimates for Lawn A and Lawn B within the DST. This allowed me to compare respondents' intended behaviour for choosing either one 'new lawn' scenario or

[5] Only residents who had turf in their landscape and participated in the choice experiment were considered in my DST analysis.

remaining with their status quo (‘current lawn’). The DST allows researchers and decision makers to alter new lawn and status quo attribute levels and observe the effects of respondents’ ‘current lawn’ situation on their lawn management choices. The sensitivity analysis allows me to observe the effects of altering individual lawn attributes on respondents’ choices. For each status quo scenario, the DST estimates the likelihood the sample population with that status quo would choose the ‘new lawn’ alternative or stay with their current situation. An example DST scenario is shown in Figure 4.9. Each orange cell represents variables that can be manipulated by the decision maker allowing them to estimate detached homeowners’ choice sensitivity between choosing a new lawn or staying with their status quo given different levels of lawn features.

Figure 4.9. Screenshot of the DST.

Lawn Features:		New Lawn	Status Quo
Yard Size			
An average urban lot (between 0.15 acre and 1/4 acre)		8,712.00	8,712.00
% of total landscape		50% Turf	75% Turf
Variety of turf		Water Conserving	Traditional
Appearance during peak of summer		More Green than Brown	More Green than Brown
One time Subsidy to reduce or		125	
Summer water use m^3		47.55	76.10
Summer watering cost $		$ 80.00	$ 180.00
Price Increase	30%	$ 104.00	$ 234.00
Choice Shares		New Lawn	Status Quo
		92%	8%

The number of different ‘current lawn’ conditions in the study provides a large number of possible of alternatives to be setup and studied within the DST. Analyzing all these possible scenarios would be tedious and not necessarily representative of detached homeowners’ lawn management practices. Thus, for the scope of my research, I focused on status quo scenarios representative of the majority of detached homeowners’ current situation. For example, a majority of the sample population lived on average sized properties (62%). As a result, my DST analysis was standardized around average sized properties. However, I comment on any trends in the choice share effects for increasing or decreasing lot size.

The DST using the MNL model with predictors, in which the status quo represents each individual respondent's personal situation, amounts to a segmentation by the predictor variables. Given the emphasis that the percentage of turf in landscapes had on other results of this study I used the same variable as a segmentation variable in the DST sensitivity analysis. Also, the majority of detached homeowners in this study had traditional varieties of turf in their yard and, therefore, all status quo segments were assumed to have traditional turf. Further, a large majority of the sample population had 'mostly green' (39%) or 'more green than brown' (47%) lawns and initial DST exploration revealed that the sample population behaved very similarly for both lawn appearances. Therefore, I used 'more green than brown' lawn to represent status quo appearance features in my analysis. The status quo variants were kept throughout my sensitivity analysis (effectively representing respective segments defined by the current yard situation of the homeowners) and are shown in Figure 4.10 below.

Figure 4.10. Status quo configurations for sensitivity analysis.

Lawn Features:	**Status Quo 25 (SQ25)**	**Status Quo 50 (SQ50)**	**Status Quo 75 (SQ75)**
Size**	***25% Turf***	***50% Turf***	***75% Turf***
Variety**	Traditional	Traditional	Traditional
Appearance**	More Green than Brown	More Green than Brown	More Green than Brown
Subsidy**	N/A	N/A	N/A
Summer water use*	38.03m^3	50.07m^3	76.10m^3
Summer watering cost*	$50.00	$110.00	$180.00

**** Choice experiment design variables.**
*** Calculated variables based on attribute levels and demographic characteristics.**

In the sensitivity analysis that follows (Figure 4.11 to Figure 4.14) the columns will always represent the different actual situation of respondents' percentage of turf in landscape, thus effectively representing a segmentation by that variable. Each table contains the sensitivity of level changes within that attribute (the results of changes associated with introducing a different level are shown in the respective rows). [6]. The important result of the sensitivity analysis is the 'choice share' between the current lawn configuration and the 'new lawn' configuration, and how these proportion shift within rows and columns. For example, to explore effects that changing the percentage of turf in landscape had on residents' choices, I set up a configuration of the DST with identical features for the alternative lawn ('new lawn') and status quo ('current lawn') and varied the 'new lawn' proportion of turf from 25% to 75% (represented by rows in Figure 4.11). Within each 'new lawn' scenario row (i.e. 25% turf, 50% turf, and 75% turf scenario), I provided separate DST results pairs for each of the three status quo scenarios (represented by columns in Figure 4.11)[7]. When examining respondents' preference for 25% turf (i.e. the top row in Figure 4.11), the choice shares illustrate that respondents with smaller lawns tend to choose their own lawn over the new lawn, respondents with medium sized lawns are split between choosing the new lawn and their status quo, and the majority of those with larger lawns would select the smaller 'new lawn' alternative. Demonstrated in the example above, the DST helps to illustrate the effects of an individuals' current lawn situation on their landscaping choices.

I repeated this sensitivity game for all design attributes to explore how lawn variety (Figure 4.12), and lawn appearance (Figure 4.13) affect residents' choices individually. Initial analysis of the choice model revealed that subsidy had a very small effect on residents' choices. Therefore, I did not present DST results for subsidy level effects and, instead, kept subsidy constant at its lowest design level ($125).

[6] Price increase was not significant in the 1-class model and, therefore, was set at 30% for all DST results.

[7] Each new lawn and current lawn pair (i.e. Status Quo 1 (25% Turf), Status Quo 2 (50% Turf), and Status Quo 3 (75% Turf)) represents different DST results. Choice shares represent 100% of the sample population for each status quo segment.

Figure 4.11. Scenario analysis for residents' lawn management: Effects of the proportion of turf in yard.

Attribute Sensitivity: ***25% Turf***

Lawn Features:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
Size***	**25% Turf**	**SQ25**	**25% Turf**	**SQ50**	**25% Turf**	**SQ75**
Variety***	Traditional		Traditional		Traditional	
Appearance***	More Green than Brown		More Green than Brown		More Green than Brown	
Subsidy***	$125		$125		$125	
Summer water use**	38.03m^3		38.03m^3		38.03m^3	
Summer watering cost**	$50.00		$50.00		$50.00	

Choice Shares:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
	20%	**80%**	**47%**	**53%**	**74%**	**26%**

Attribute Sensitivity: ***50% Turf***

Lawn Features:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
Size***	**50% Turf**	**SQ25**	**50% Turf**	**SQ50**	**50% Turf**	**SQ75**
Variety***	Traditional		Traditional		Traditional	
Appearance***	More Green than Brown		More Green than Brown		More Green than Brown	
Subsidy***	$125		$125		$125	
Summer water use**	57.07m^3		57.07m^3		57.07m^3	
Summer watering cost**	$110.00		$110.00		$110.00	

Choice Shares:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
	22%	**78%**	**50%**	**50%**	**76%**	**24%**

**** Choice experiment design variables.**

* Calculated variables based on attribute levels and demographic characteristics.

Figure 4.11. Scenario analysis for residents' lawn management: Effects of the proportion of turf in yard (Continued).

Attribute Sensitivity: ***75% Turf***

Lawn Features:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
Size***	**75% Turf**	SQ25	**75% Turf**	SQ50	**75% Turf**	SQ75
Variety***	Traditional		Traditional		Traditional	
Appearance***	More Green than Brown		More Green than Brown		More Green than Brown	
Subsidy***	$125		$125		$125	
Summer water use**	76.10m^3		76.10m^3		76.10m^3	
Summer watering cost**	$180.00		$180.00		$180.00	

Choice Shares:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
	4%	**96%**	**13%**	**87%**	**33%**	**67%**

Figure 4.12. Scenario analysis for residents' lawn management: Effects of variety levels.

Attribute Sensitivity: ***Water Conserving Lawn***

Lawn Features:	**New Lawn**	**Status Quo**	**New Lawn**	**Status Quo**	**New Lawn**	**Status Quo**
Size***	25% Turf	**SQ25**	50% Turf	**SQ50**	75% Turf	**SQ75**
Variety***	**Water Conserving**		**Water Conserving**		**Water Conserving**	
Appearance***	More Green than Brown		More Green than Brown		More Green than Brown	
Subsidy***	$125		$125		$125	
Summer water use**	33.28m^3		47.55m^3		61.83m^3	
Summer watering cost**	$30.00		$80.00		$120.00	

Choice Shares:	**New Lawn**	**Status Quo**	**New Lawn**	**Status Quo**	**Status Quo**	**Status Quo**
	46%	**54%**	**78%**	**22%**	**64%**	**36%**

Attribute Sensitivity: ***Artificial Lawn***

Lawn Features:	**New Lawn**	**Status Quo**	**New Lawn**	**Status Quo**	**New Lawn**	**Status Quo**
Size***	25% Turf	**SQ25**	50% Turf	**SQ50**	75% Turf	**SQ75**
Variety***	**Artificial**		**Artificial**		**Artificial**	
Appearance***	Very Green		Very Green		Very Green	
Subsidy***	$125		$125		$125	
Summer water use**	N/A		N/A		N/A	
Summer watering cost**	N/A		N/A		N/A	

Choice Shares:	**New Lawn**	**Status Quo**	**New Lawn**	**Status Quo**	**New Lawn**	**Status Quo**
	20%	**80%**	**53%**	**47%**	**38%**	**62%**

Figure 4.13. Scenario analysis for residents' lawn management: Effects of appearance levels.

Attribute Sensitivity: *Very Green Lawn*

Lawn Features:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
Size***	25% Turf	SQ25	50% Turf	SQ50	75% Turf	SQ75
Variety***	Traditional		Traditional		Traditional	
Appearance***	**Very Green**		**Very Green**		**Very Green**	
Subsidy***	$125		$125		$125	
Summer water use**	44.75m^3		70.51m^3		96.26m^3	
Summer watering cost**	$70.00		$160.00		$280.00	

Choice Shares:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
	10%	*90%*	*31%*	*69%*	*16%*	*84%*

Attribute Sensitivity: *Mostly Green Lawn*

Lawn Features:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
Size***	25% Turf	SQ25	50% Turf	SQ50	75% Turf	SQ75
Variety***	Traditional		Traditional		Traditional	
Appearance***	**Mostly Green**		**Mostly Green**		**Mostly Green**	
Subsidy***	$125		$125		$125	
Summer water use**	41.39m^3		63.79m^3		86.18m^3	
Summer watering cost**	$60.00		$130.00		$220.00	

Choice Shares:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
	24%	**76%**	**55%**	**45%**	**36%**	**64%**

Figure 4.13. Scenario analysis for residents' lawn management: Effects of appearance levels (Continued).

Attribute Sensitivity: ***More Brown than Green Lawn***

Lawn Features:	**New Lawn**	**Status Quo**	**New Lawn**	**Status Quo**	**New Lawn**	**Status Quo**
Size***	25% Turf	**SQ25**	50% Turf	**SQ50**	75% Turf	**SQ75**
Variety***	Traditional		Traditional		Traditional	
Appearance***	**More Brown than Green**		**More Brown than Green**		**More Brown than Green**	
Subsidy***	$125		$125		$125	
Summer water use**	35.80m^3		52.59m^3		69.39m^3	
Summer watering cost**	$40.00		$90.00		$150.00	

Choice Shares:	**New Lawn**	**Status Quo**	**New Lawn**	**Status Quo**	**New Lawn**	**Status Quo**
	9%	**91%**	**30%**	**70%**	**17%**	**83%**

Consistent with model parameter estimates, percentage of turf in landscape has a strong association with detached homeowners' intended choices compared to other lawn attributes. For example, detached homeowners with medium (50% turf) to larger proportions of turf (75% turf) were more likely to choose the 'new lawn' alternative if the 'new lawn' size is smaller than their 'current lawn' (Figure 4.11). This trend is likely due to relatively large savings in watering cost attributed to switching from a larger, more water intensive lawn, to a smaller, water efficient lawn. Conversely, respondents were more likely to choose to stay with their status quo configuration if the size of the 'new lawn' is larger than their 'current lawn'. When lawn configurations are equal between the 'new lawn' and status quo, residents' with 50% turf in their present yard were evenly polarized between choosing the new lawn and staying with their status quo. This split could be due to the presence of a $125 subsidy in the new lawn. However, likely due to strong predictor estimates, residents' with smaller lawns in their yard are less likely to choose an alternative scenario over their current situation. Similarly, when 'new lawn' and status quo scenarios are the same, residents with current turf proportions of 75% turf choose to stay with the status quo because the subsidy has a smaller effect on their total watering cost. DST scenarios indicate restricting the proportion of turf in landscapes to 50% may be acceptable and assist in curbing water demand in Kelowna. Whereas restricting the proportion of turf in landscapes to levels below 50% turf (i.e. to 25% turf) may not be as favourable for residents. Further research on the effects of restrictions would provide further insight as to whether respondents' indicated preference for smaller proportions of lawns in their total home landscape holds under lawn restrictions.

Lawn variety also affects residents' choices considerably with the sample population more likely to choose water conserving lawns over their current, traditional lawn scenarios (Figure 4.12). For example, over 60% of both residents with medium and large lawns chose to switch to water conserving 'new lawn' alternatives while residents with small lawns were relatively split between choosing the new lawn and staying with their status quo. Conversely, residents' with smaller and larger proportions of turf in their yard tended to favour their status quo over artificial lawns. The negative part worth utility estimate for very green lawn reduced the percentage of residents' willing to switch to artificial lawns[a]. This result could be attributed to a problem with interactions within the model as artificial lawns were only shown as ‘very green’ in the CE. Therefore, artificial lawn preferences could be worth exploring in future studies.

Compared to lawn variety and the proportion of turf in yard, lawn appearance affects residents’ choices less, but the parameter estimates are still significant (Figure 4.13). The majority of detached homeowners in each proportion of turf group chose to stay with their status quo instead of moving to a new lawn alternative with different lawn appearance attributes than their status quo. Only the 50% turf group displayed choice uncertainty when asked to choose between their status quo and a new lawn with mostly green grass (55% chose the new lawn). When shown ‘new lawns’ with either ‘very green’ or ‘more brown than green’ appearances, a majority of residents in each proportion of turf segment chose to stay with their status quo. According to the choice model, this trend is due to detached homeowners’ negative view of ‘very green’ and ‘more brown than green’ lawns. This trend could indicate that respondents exhibit a predisposition to conserve water up until the point where their lawn turns brown.

Not shown in the DST, property size trends indicate that detached homeowners with larger property sizes (above an average urban lot) favour smaller proportions of turf. This trend is likely due to higher watering costs being associated with bigger lawns on larger properties. Also, as property size increases, subsidy has less effect on residents’ choices likely because subsidy levels are not high enough to impact higher water costs of large urban and rural properties.

Next, to inform decision makers about appropriate lawn management restrictions, I used the DST to explore residents’ support for extreme water conserving scenarios. Using the same methodology described above, I used the same status quo groups to play through DST scenarios where multiple attributes were manipulated, but this time they represented likely management scenarios (Figure 4.14). I limited alternative attributes to levels requiring the least amount of water to maintain. For comparison and contrast, I also investigated residents’ choices for a water intensive lawn scenario. For the water intensive scenario, I set alternative attributes to levels requiring the most water

[a] In the CE design, all artificial lawns were shown as ‘very green’ in appearance.

to maintain and set the proportion of turf in yard to the level that gave residents the highest utility (50% lawn). Three alternative scenarios were created:

1. Extreme Water Conserving: A ‘new lawn’ with 25% turf of a water conserving variety kept ‘more brown than green’ during the peak of summer with a $125 subsidy.

2. Extreme Artificial: A ‘new lawn’ with 25% turf of an artificial variety kept ‘more brown than green’ during the peak of summer with a $125 subsidy.

3. Water Intensive: A ‘new lawn’ with 50% turf of a traditional variety kept ‘very green’ during the peak of summer with a $125 subsidy.

Figure 4.14. Scenario analysis for residents' lawn management: Effects of water conserving and water intensive scenarios.

Extreme Water Conserving Lawn Scenario

Lawn Features:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
Size***	**25% Turf**	**SQ25**	**25% Turf**	**SQ50**	**25% Turf**	**SQ75**
Variety***	**Water Conserving**		**Water Conserving**		**Water Conserving**	
Appearance***	**More Brown than Green**		**More Brown than Green**		**More Brown than Green**	
Subsidy***	$125		$125		$125	
Summer water use**	31.60m^3		31.60m^3		31.60m^3	
Summer watering cost**	$30.00		$30.00		$30.00	

	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
Choice Shares:	**26%**	**74%**	**56%**	**44%**	**80%**	**20%**

Extreme Artificial Lawn Scenario

Lawn Features:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
Size***	**25% Turf**	**SQ25**	**25% Turf**	**SQ50**	**25% Turf**	**SQ75**
Variety***	**Artificial**		**Artificial**		**Artificial**	
Appearance***	**Very Green**		**Very Green**		**Very Green**	
Subsidy***	$125		$125		$125	
Summer water use**	N/A		N/A		N/A	
Summer watering cost**	N/A		N/A		N/A	

	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
Choice Shares:	**11%**	**89%**	**30%**	**70%**	**58%**	**42%**

Figure 4.14. Scenario analysis for residents' lawn management: Effects of water conserving and water intensive scenarios (continued).

Water Intensive Lawn Scenario

Lawn Features:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
Size***	**25% Turf**	**SQ25**	**25% Turf**	**SQ50**	**25% Turf**	**SQ75**
Variety***	**Traditional**		**Traditional**		**Traditional**	
Appearance***	**Very Green**		**Very Green**		**Very Green**	
Subsidy***	$125		$125		$125	
Summer water use**	44.75m^3		44.75m^3		44.75m^3	
Summer watering cost**	$70.00		$70.00		$70.00	

Choice Shares:	New Lawn	Status Quo	New Lawn	Status Quo	New Lawn	Status Quo
	10%	**90%**	**30%**	**70%**	**57%**	**43%**

The DST indicates that residents with larger lawns (75% turf) are generally in support of more extreme water conserving scenarios (80% chose the smaller, water conserving lawn over their status quo). Residents with medium lawns (50% turf) displayed uncertainty about their lawn choices between a new, water conserving scenario and their status quo. As seen in previous DST analysis, residents with small lawns (25% turf) tended to choose their status quo regardless of the ‘new lawn’ alternative offered to them. Support for the water conserving ‘new lawn’ scenario with artificial turf decreased for all proportion of turf groups. Increasing subsidy levels had minimal affect on residents’ support for ‘new lawn’ scenarios with subsidies of $250 and $375 only increasing ‘new lawn’ selection by 1-3% over $125 subsidy for the two extreme water conserving scenarios.

Compared to water conserving scenarios, DST choice shares for the Water Intensive Lawn Scenario most resembled choice shares for the Extreme Artificial Lawn Scenario. A large majority of respondents in the 25% turf and 50% turf groups chose to stay with their status quo instead of moving to a new, water intensive lawn scenario. However, respondents in the 75% turf group slightly favoured the ‘new lawn’ alternative. These choice share trends are likely due to the strong effect of percentages of turf in landscape on detached homeowners’ choices. For detached homeowners’ with larger status quo percentages of turf in landscape, water cost savings increase if they choose to reduce their lawn size to smaller, alternative lawns. Cost savings are less for homeowners with smaller status quo lawn proportions. This interaction seems to be the main driver of respondents’ choices and this trend permeates throughout my DST analysis. Therefore, planners and water managers should focus on considering guidelines on the percentage of turf residents use in their landscapes as a feasible strategy to encourage water conservation in residents’ yards.

5. Discussion

The driest region in Canada (OWSC 2008), the Okanagan Basin has the lowest per capita availability of freshwater in the country (Hrasko et al. 2008) and, therefore, water management should be a priority for planners and water managers in the region. With challenges caused by population growth, urbanization, and climate change facing the local area, managing water resources sustainably is vital to maintaining local residents' wellbeing as well as minimizing negative environmental impacts of water demand. Residential water demand is increasing as population growth continues in the Okanagan and its largest city, Kelowna. Outdoor uses such as landscaping irrigation account for the majority of residential water use in Kelowna and the larger Okanagan Valley. . To reduce outdoor water consumption, water use planning can incorporate strategies to minimize water use in residents' lawns and yards such as bylaws that restrict the percentage of turf in yards (Hurd and Smith 2005; Vickers 2007), turfgrass variety (Addink 2005, Hurd and Smith 2005, Vickers 2007), and lawn appearance during peak summer months (Gordon, Chapman, and Blarney 2000; Spinti, St. Hilaire, and Vanleeuwen 2004; Hurd and Smith 2005) and subsidies to compensate residents for landscaping alterations (Sovocool and Rosales 2001; Driver 2002; Addink 2005).

To ensure new planning guidelines and bylaws are supported by Kelowna and other communities in the Okanagan, management should consider water users' preferences. My study investigated the lawn preferences of home owners in detached dwellings, who are the single largest group of outdoor water users in the community. The results could be used by managers to determine what tools and strategies are most feasible to reduce residential water demand by that user group. Water managers in the Okanagan are interested in reducing outdoor water consumption through a variety of hypothetical strategies such as bylaws to limit the proportion of turf, turf variety, and lawn appearance during hot summer months. Different households in Kelowna vary in how they manage and maintain their lawns. Determining whether or not residents' current situation affects their water management choices, is important when developing policies or guidelines to curb water demand. Understanding how these residents trade off between the various lawn features is valuable for creating new polices to manage outdoor water use. Furthermore, when decision-makers are determining if new policies are appropriate for a community, identifying public support for hypothetical landscaping management polices is important.

To inform water planning and help curb water demand in Kelowna, my research examined detached homeowners' preferences for various lawn characteristics that affect household outdoor water use. My research is part of a larger Okanagan Water Study in which Steve Conrad explores residential and agricultural water consumption and demand. My study is complementary to Steve Conrad's research and focuses on studying detached homeowner's preferences and preferences for managing water in their yards. My research also provides decision makers with a quantitative decision support tool (DST) to inform them about detached homeowner's lawn choices. The knowledge gained from the DST could help managers to integrate residents' preferences and opinions about water use into water resource planning and decision-making processes. This discussion section speaks to my aforementioned research objectives:

1. What are detached homeowners' preferences for lawn characteristics in the City of Kelowna?
2. Do detached homeowners' socio-demographic and current house and property conditions affect their water conservation attitudes and lawn preference?

To address my research objectives I measured detached homeowners' preferences for lawn features and assessed their views about neighbourhood changes and lawn management restrictions. Along with my research partners, I conducted a choice experiment to obtain utility estimates for the selected lawn attributes. To account for characteristics of individuals and determine if people's socio-demographic and current property conditions are associated with their water management choices, we created a personalized status quo option for each respondent based on 'current lawn' data that they supplied in the survey. This personalized status quo method is a relatively novel approach to CEs examining water resources and allowed me to explore the relationship between individuals' current situation and their stated choice behaviour.

5.1. General Characteristics of Detached Homeowners

My study focused on a sample population of detached homeowners in Kelowna, B.C. The typical respondent was between the age of 35 and 65; the sample was slightly older than Kelowna census data. Detached homeowners were relatively evenly split between male and female respondents and a large portion of them were retired. The average income of respondents was almost double that of the average Kelowna resident in the census data. However, the census data accounts for younger individuals not included in the survey who most likely have lower than average incomes. Most respondents completed high school and over half of them had some form of post-secondary education (i.e. university, trades school, or non-university certificate/diploma).

Most respondents lived on an average urban lot with either 75% turf or 50% turf in their yard, while one quarter had 25% turf. Virtually no homeowners owned a property containing 100% turf. The vast majority of lawn varieties within respondents' yards were of a traditional variety. Few detached homeowners maintained lawns with water conserving grass and no respondents had artificial lawn in their yard. During the peak of summer, most respondents kept their lawns either mostly green or more green than brown.

Our survey explored respondents' attitudes toward personal landscaping alterations and water conservation. Further, the current percentage of turf existing in their properties was suspected to be an important variable in the context of household water management and, therefore, respondents were split into three segments for my analysis (25%, 50%, and 75% and 100% existing turf). Within the larger community of detached homeowners, opinions about and attitudes toward water conservation issues vary. However, with respect to percentage of turf in landscape segments, opinions were fairly homogenous. When attitudinal heterogeneity occurred, it was usually between the smaller turf segment and the medium and larger turf segments. For example, detached homeowners with smaller percentages of turf in their yard were more likely to be content with their current landscaping, believed they were doing all they could to conserve water, and felt that they used less water than their neighbours, while those with medium and larger percentages of turf in their landscape were more interested in reducing their lawn size. Though they were more willing to reduce outdoor water consumption, respondents with medium and larger percentages of turf felt that time and money were barriers for them making retrofits. This result may be due to some landscaping alterations being less feasible for detached homeowners with larger proportions of turf in their yard. Therefore, a ‘one-size-fits-all’ solution to managing landscaping issues is likely not appropriate for detached homeowners.

Interestingly, the majority of respondents were personally concerned about water conservation issues, which could indicate that more water conscious detached homeowners are more likely to respond to this type of survey. This could be an indication of response bias toward water conservation in the data.

Generally, detached homeowners were interested in learning more about landscaping water requirements before deciding on any changes and indicated that they would like to eventually select more drought tolerant varieties of plants for their yards. The majority of respondents believed that climate change is occurring and that water shortages have increased. Also, they believed that, compared to other uses, water available for the natural environment has decreased over the last 10 years.

The majority of respondents believed that water for agriculture, wildlife, and the natural environment are the most important uses for fresh water while water for municipal landscape irrigation and private landscape irrigation are the least important uses. These results may have huge management implications as they imply that detached homeowners may be willing to reduce water consumption in their yards in favour of more important uses for agriculture and the environment. As a foundation for this argument, respondents also felt that restricting water use on private and public lawns and yards was an acceptable management practice and were willing to reduce various household water uses (e.g. lawn watering, showering, toilet flushing) by at least one-third. Further, allowing local lakes and reservoirs to drain as well as reducing water availability for wildlife and fish habitats was considered unacceptable.

Interestingly, respondents tended to rate water for agriculture and the environment as more important than water for household indoor use. The survey did not ask respondents to rate the importance of drinking water for humans though one could assume this would be included under indoor water use. If respondents included drinking water for humans under the household indoor use category, then these results are surprising because I would assume that people would tend to rate drinking water as the most important water use. However, I cannot assume that respondents thought about drinking water for humans when considering this question and respondents may not have factored this in when ranking the importance of different water uses. Also, respondents were asked to rank each water use on a separate Likert scale and were not asked to rank the water uses against each other. By rating each water use separately, respondents may not have compared the different water uses to each other and, therefore, this question may not fully represent respondents' views of important water uses. Further, the standard deviations for important water use categories were fairly high indicating that respondents' opinions vary wildly about the importance of each water use.

To explore user preferences, the Multinomial Logit (MNL) with Predictors model was selected for statistical analysis as it accommodates the variables that were used to personalize the CE. The results of the predictor model imply that the proportion of turf in one's yard was the most influential parameter on detached homeowners' preferences about lawn characteristics followed by lawn variety and lawn appearance. The overall sample population prefer 50% turf in their yard, and, in general, detached homeowners' favour smaller lawns over larger lawns. Based on my DST sensitivity analysis in section 4.6, detached homeowners' with medium to larger lawns were more willing to choose landscaping alterations that conserve water compared to people with smaller lawns. Generally, detached homeowners who have smaller lawns were less likely to choose to alter their yard regardless of the new lawn's features. One explanation for this result could be that, compared to retrofitting yards containing greater turf areas, altering smaller turf areas results in less overall water use savings and, in turn, less cost savings to the user. While detached homeowners' with larger lawns were willing to choose new, water conserving lawns, time and financial constraints seemed to be a barrier for these residents improving their yard's water efficiency.

The summary above provides an overview of my study's findings. In the following sections, I compare my results to the water management literature, discuss my DST analysis, consider planning implications of my study, and explore the limitations of my research.

5.2. Comparison with the Literature

This paper seeks to inform planners' and policymakers' decisions by understanding detached homeowners` preferences and choices for resident water management scenarios. Specifically, we created a CE to estimate part worth utilities for residential lawn management attributes and used this model to build a DST to visualize detached homeowners support for different lawns. To examine the context specific nature of users' choices, we incorporated an individualized status quo choice in the CE for each respondent (a novel approach in water resource studies). Due to model complexity caused by individualized status quos, I settled on a MNL Model with Predictors using predictor variables to represent individuals' 'current lawn' attributes. My analysis of this choice model is presented below as well as a comparison of my results with the water management literature.

Analysis of the MNL Model with Predictors revealed that the proportion of turf in one's yard influences detached homeowners' lawn choices more than any other lawn characteristic. Generally, detached homeowners preferred smaller proportions of lawn over larger ones, within the range offered. Residents received the highest utility from landscaping consisting of 50% turf followed relatively closely by 25% turf. Conversely, larger turf proportions of 75% and 100% turf were less preferred. The aforementioned results are consistent with the literature (Hurd 2006; Yabiku, Casagrande, and Farley-Metzger 2008). For example, Hurd (2006) found a large majority of homeowners in arid cities in New Mexico prefer landscaping containing smaller plots of grass. In Kelowna, detached homeowners' preference for smaller proportions of turf in their yards implies lawn size restrictions could be a reasonable policy target for local and regional water conservation strategies. The predictor estimates allowed me to include information about individuals' current lawn features in the MNL model. These estimates indicated that residents with larger proportions of current lawn (75% and 100% turf) preferred the 'new lawn' alternatives over their 'current lawn' while residents with smaller (25% turf) and medium proportions of lawn (50% turf) prefer their 'current lawn' over other alternatives. This evidence suggests that owners with larger proportions of turf in their yards may be willing to make water conserving landscaping retrofits. However, as mentioned above, respondents who are more water conscious are more likely to respond to this kind of survey and, therefore, could have skewed the results. Further research should explore if this is a bias in the data or representative of the larger community.

Also examined in the MNL Model with Predictors were lawn variety preferences. Residents preferred water conserving varieties of lawn over traditional and artificial varieties. Predictor estimates indicated residents with traditional turfgrass varieties in their 'current lawn' preferred CE alternatives over their 'current lawn' while residents with water conserving lawns preferred their current situation over alternatives. Therefore, residents may be willing to switch to water conserving turfgrass in the future. Similar to the proportion of turf in one's yard, preferences for water conserving turfgrass varieties over traditional varieties are consistent with findings in other settings discussed in the literature (Hurd, Hilaire, and White 2006).

The water management literature indicates that residents living in drier climates find xeriscaping acceptable (Spinti, Hilaire, and Vanleeuwen 2004). However, people prefer "high-water-use landscapes over dry landscapes for their own yards" (Yabiku, Casagrande, and Farley-Metzger 2008, p. 382) and, therefore, adoption of xeriscaping lterations is relatively low (Spinti, Hilaire, and Vanleeuwen 2004). Similarly, my MNL Model with Predictors demonstrated that residents preferred lawns kept 'mostly green' or containing only some brown grass over 'very green' lawns. However, detached homeowners did not like 'more brown than green' lawns. During dry months, an individual's lawn appearance is related to the amount of water used to irrigate the grass; the lusher a lawn looks, the more likely a larger volume of water has been used to maintain its appearance compared to a brown lawn. The fact that respondents did not prefer 'very green' lawns seems counterintuitive as one would expect people to prefer healthier looking yards, but can be explained by some sensitivity to and awareness of water conservation issues. Also, after the study one expert indicated that respondents may have viewed the reference to 'very green' lawns as meaning unnaturally green (i.e. heavily fertilized, etc.) and, therefore, reacted negatively towards lawns that appeared this way.

Described in section 3.2.6., the attributes above were used to estimate watering cost for individual lawn scenarios and, therefore, water cost is proportional to the proportion of turf in one's yard, variety, and appearance. As expected, the MNL with Predictors revealed that residents preferred lower watering costs over higher costs. The rather flat cost curve (Figure 4.8) indicates that research should explore how increasing watering costs further impact water demand. However, similar to the literature, watering cost seems to be relatively price inelastic at these relatively low prices (Worthington and Hoffman 2008; Barrett 2004; Sebri 2014). Interestingly, while watering cost was significant, the price increase of water over the next five years (30%, 60% and 90% increases) was not significant and, therefore, parameter estimates for price increase were not shown in the model (however, it is a factor of watering cost). One explanation may be that while the price increase was applied consistently to all alternative in a choice set, watering cost varied for each alternative. Therefore, respondents were able to compare the watering costs of different lawn alternatives to each other to inform their choices but did not make similar comparisons for different price increases between choice sets.

In areas such as drier regions of the United States, turfgrass rebate programs have been used to successfully incentivise residents to alter their landscaping to increase water efficiency and reduce consumption (Sovocool and Rosales 2001; Driver 2002; Addink 2005). However, parameter estimates from the MNL Model with Predictors indicated that residents gained relatively little utility from subsidy levels shown in the CE. Further, residents preferred the highest subsidy level ($500) less than other levels which could indicate that respondents did not believe the $500 subsidy was an obtainable or realistic option.

While the choice model results indicate which attributes detached homeowners' derive the most utility from while controlling for all other attributes, they do not show what happens when attributes are combined into different lawn scenarios. This complexity increases even further when one attempts to account for segments of homeowners with different proportions of lawn in their own yards. This complexity is best investigated in a sensitivity analysis of the DST. The DST can also be used for its own type of 'scenario planning' to explore public support for certain types of possible lawn management outcomes.

5.3. DST Implications

The DST explores preferences about the outcomes of water management mechanisms (i.e. tools) that planners can use to curb water demand, but it does not examine these tools directly. Sensitivity analysis allowed me to explore the effects of individual lawn attributes on detached homeowners' lawn choices. Further, the DST allowed me to explore respondents' reactions to water conserving and water intensive lawn scenarios. By taking a scenario planning approach to landscaping and water management, planners and water managers can reduce uncertainty about users' lawn preference behaviour.

The DST sensitivity analysis indicated that if given the opportunity to choose, a majority of these detached homeowners in Kelowna are willing to switch to smaller proportions of turf. Described in the results chapter, columns in tables Figure 4.11 to Figure 4.14 compare the three proportion of turf in yard segments which are driven by the predictor variables. Yards with 50% turf seem to be the most acceptable for residents but a majority of residents with larger turf proportions (75% turf) supported switching to 25% turf. However, from survey question 10, when segmented by current proportion of turf, a large portion of residents with medium and large lawns believed that they do not have the time to retrofit their yard to increase water efficiency. Further, funding also seems to be a barrier to landscaping retrofits. Water conserving retrofits would most likely be more expensive and time consuming for residents with larger lawns than for those with smaller lawns. Therefore, decision makers should explore ways of ensuring that water efficient landscaping alterations are feasible for these members of the community. Also, the vast majority of detached homeowners with smaller proportions of turf in their yard were less likely to alter their lawns regardless of any landscaping changes that were offered. Therefore, when designing turf-oriented conservation programs, planners and water managers should focus on those programs that target residents with larger lawns versus smaller lawns as these groups are more willing to make landscape retrofits.

The sensitivity analysis also revealed that, if given a choice, a large percentage of detached homeowners preferred water conserving varieties of grass regardless of their current proportion of turf. Similar to other attribute effects, respondents with medium and larger proportions of turf were more willing to switch to water conserving lawns, possibly because water cost savings are higher for these groups. Mentioned before, the sample population displayed a predisposition for water conservation and, therefore, may not be representative of the larger population of Kelowna. Therefore, research should explore whether the broader population is willing to switch from traditional varieties of turf to water conserving varieties.

Compared to lawn variety and the proportion of turf, lawn appearance had a smaller effect on respondents' lawn choices. Regardless of the proportion of turf group they belonged to, the majority of respondents consistently chose the status quo over a 'new lawn' that differed only in lawn appearance. In terms of water use planning, the simplest water conservation measure for the city to instigate would be to have residents reduce their watering allowing their grass to turn brown or almost brown. Figure 4.11 (above) tested this scenario and the DST analysis revealed that the vast majority of respondents from each turf group would choose their status quo over a brown lawn. Therefore, managers should consider other water conservation measures and should investigate whether an education program could influence attitudes about brown lawns and restrictions on outdoor irrigation.

The last run of the DST (Figure 4.14) is an example of scenario planning where I examine users' lawn choices under scenarios that 1) minimize water consumption and 2) maximize water consumption for a yard consisting of 25% turf. Consistent with the choice trends discussed above, the 75% turf group are the most likely to switch to new, water conserving lawn scenarios followed by the 50% turf group. Respondents significantly favour water conserving lawns over artificial varieties and are more likely to choose the status quo over a water intensive lawn. Again, these preferences toward conservation could be indicative of the respondents' bias toward water conservation issues.

My analysis above indicates that the DST appears to be a useful tool for predicting detached homeowners' lawn choices. Not only does it allow managers to test the effects of individual attributes on users' choices, but it also allows managers to test users' choices under a variety of lawn scenarios. Further, by segmenting the sample population by proportions of turf in respondents' yards, managers can identify which user groups may be most likely to make conservation changes.

5.4. Implications for Water Use Planning in Kelowna

In British Columbia, planning and policy documents at the provincial, regional, and municipal levels promote water conservation and sustainable management of water resources. For example, in *Living Water Smart: British Columbia's Water Plan* the provincial government asserts that, by 2020, "fifty percent of new municipal water needs will be acquired through conservation" (BCME 2008, p. 75). Also, at the municipal level, cities such as Kelowna have implemented bylaws to reduce landscaping irrigation. My study accounts for one type of uncertainty that is usually not considered by technical water demand models: users' preferences and behaviour. The information gathered from detached homeowners can inform water use planning in Kelowna, B.C.

To effectively manage outdoor residential water demand, managers need to understand user preferences. The MNL model with Predictors and DST revealed that lawn size and lawn variety influence detached homeowners lawn choices more than any other lawn attribute. Generally, users prefer smaller proportions of turf over larger ones with 50% turf being the most preferred proportion of turf. As previously mentioned, this suggests that lawn size restrictions or incentives to reduce the proportion of turf in people's yards could be an effective measure to promote water conservation in Kelowna. However, users also generally prefer water conserving varieties of turf over traditional and artificial types. As such, designing programs that encourage detached homeowners to retrofit traditional lawns with water conserving varieties (such as lawn reseeding programs) could also help curb water demand. Unlike the proportion of turf in yard and lawn variety, lawn appearance seems to have little effect on detached homeowners' lawn choices. Though it would be relatively easy for the city to enforce outdoor water use restrictions, the DST revealed that users would not be in favour of letting their lawns turn brown.

The argument I present in this paper is more sophisticated than just talking about detached homeowners' preferences in Kelowna because the three status quo segments react quite differently toward lawn choices. Therefore, planning should target specific users based on the proportion of turf present in their yard. The DST revealed that people with small proportions of turf in their yard already think they are doing enough to conserve water and are not willing to switch from their current lawn situation. Conversely, respondents with 75% turf may be more willing to consider switching to smaller, water conserving lawns and should become a focus for water conservation measures. For example, based on the water use calculation in the DST (see section 3.2.6), if a household with a lawn configuration of 75% turf of a traditional variety kept more green than brown during the summer, reduced the proportion of turf in their yard to 50%, they would decrease water use by 25%. For an average sized property (between 0.15 and 0.25 acres), over a 7 month period from April to October, this would result in water savings of approximately 133,200 litres. Furthermore, if the proportion of turf in the yard was reduced from 75% to 25%, water consumption in the lawn would be reduced by 50% resulting in water savings of 266,500 litres. Almost 40% of detached homeowners surveyed had 75% turf in their yard and, therefore, targeting this group for conservation could have major implications for water conservation. The choice variation between status quo segments – illustrated in this paper – indicates that future studies should also consider how respondents' current situation and current landscaping features influence their choices.

Individual's current lawn situation may not be the only factor influencing their lawn choices. One's income and education could also affect their conservation behaviour. For example, detached homeowner's who can afford to make retrofits may be more willing to do so compared to those who cannot afford to alter their landscaping. Also, detached homeowners who are more informed about water conservation issues may be more willing to make landscaping alterations to conserve water compared to those whom are less educated. Both education and income were not significant in my model and, therefore, not used as predictors in the final choice model. This may have been due to the sample population generally earning higher incomes and being more educated than the census population. Respondents' age could also affect their choices but age was not significant in my model.

The City of Kelowna has already implemented some strategies to reduce outdoor water consumption. For example, the city has an irrigation approval bylaw to help control retrofits by managing how residents water their yards. To be approved by the city, residents' landscaping has to meet a certain level of efficiency. When installing an automatic irrigation system, Kelowna city bylaws require residents to submit a water conservation report and landscaping design plan to the city for approval. For example, schedule 4 of Bylaw 7900 (2012) includes design standards for landscaping and irrigation systems and recommends landscaping designs to minimize mown turf areas. The bylaw states that residents should strive for 25% turfgrass in their yards and consider a maximum of 50% turfgrass. However, without incentives or mandatory regulation, larger lawn sizes are still possible. The bylaw also recommends maximizing the percentage of unirrigated yard area as well as maximizing low-water use vegetation present in yards.

Landscaping alterations can be expensive and may not be feasible for all users. From survey question 10, when segmented by current proportion of turf, a large portion of residents with medium and larger proportions of turf in their yards believed that they do not have the time to retrofit their yard to increase water efficiency. Further, these groups also believed that they do not have the money for water efficient landscaping alterations. Water conserving retrofits would most like be more expensive and time consuming for residents with larger lawns than for those with smaller lawns. Therefore, decision makers should ensure water efficient landscaping alterations are feasible for these members of the community.

Subsidies to incentivise landscaping modifications may help residents afford retrofits and rebate-based turf removal programs have been successful in many cities in the U.S. located in the drier regions of California (City of Pasadena 2013; City of Roseville 2013 and Arizona (City of Glendale; City of Scottsdale 2013). However, my findings illustrate that the subsidy levels offered in the CE may not have been high enough to entice residents to make landscaping renovations. Exploring higher subsidy rates (above $500) for water conserving retrofits could determine if financial incentives would encourage more residents to consider landscaping alterations.

However, if higher subsidy levels are not feasible for the City of Kelowna, alternative top-down and bottom-up strategies to encourage residents to retrofit their yards should be considered. One top-down solution is creating legislation to restrict the proportion of turf in residents' yards. The DST demonstrated that detached homeowners in my study preferred smaller proportions of lawn in their yard over larger proportions and were willing to preferred downsizing their current lawn. These results may support an argument toward lawn restrictions. However, when exploring lawn restrictions, managers should consider how feasible retrofits are because few homeowners may spend the time and money to alter their lawns. Another top-down solution is summer lawn watering restrictions. From survey question 17, a majority of respondents disagreed that water restrictions should be voluntary rather than mandated by the government. Further, from survey question 20, detached homeowners found water restrictions on private yards to be acceptable. However, these detached homeowners did not like brown lawns but, if the water conservation benefits are communicated clearly, education programs may be able to alter people's perceptions of brown turf. Together, these results indicate that legislation may be an appropriate means to mandate water conservation and incentivise a larger majority of residents to make water conserving outdoor retrofits. Also, though price increase seemed to have little effect on respondents' lawn choices, future research should explore the effects of higher prices on water demand to determine if this is an appropriate strategy to promote landscaping retrofits. This is especially relevant because past research has found that outdoor residential water demand is more price elastic than indoor residential water demand and that summer demand is more elastic than winter demand (Mitchell and Chesnutt 2009). Also, from the water demand literature, "residential customer demand for water is more responsive to price over the long-term than over the short-term" (Mitchell and Chesnutt 2009, p. 3). Therefore, managers should consider that it may take time for price changes to influence residential water demand because it may take a while for people to make water conserving alterations to their household such as landscaping retrofits.

From a bottom-up perspective, the city could partner with a third party landscaping company and offer discounts on lawn removal and replacement. However, this would rely on collaboration between the city and the landscaping company and may be hard to achieve. To inform collaborative water conservation rebate and incentive programs, water managers can look to examples from the energy sector. For example, through its PowerSense program, Fortis BC offers 50 percent rebates on ENERGY STAR® LED bulbs purchased at participating stores (Fortis BC 2013). I suggest that the city and Okanagan Basin Water Board could partner with local lawn and garden stores in Kelowna and the Okanagan to market native and drought tolerant plants to locals by offering rebates and discounts for purchasing these products. Further, this grassroots approach could encourage local business owners to educate customers about cost-effective, water efficient landscaping retrofits and management strategies.

Providing education on how to increase the water efficiency of larger lawns (i.e. by reducing lawn size or altering lawn variety) may be another effective approach to conserve water. In our focus group testing, many people were surprised to learn how much water the average Canadian consumes annually and could not remember roughly how much their annual water bill costs. This trend emphasizes the need for water managers to increase the water literacy of consumers and increase awareness of water conservation issues. In drought susceptible areas such as Kelowna, planners can look to examples from Australia to increase Canadian water literacy. Communicating about drought risks and reservoir levels may be a strategy to amplify the general public's awareness about fresh water resources (Belzille 2011). Also, from survey question 10, detached homeowners are interested in learning about how to increase their yard's water efficiency. However, focus groups conducted for our studies revealed individuals did not understand some possible landscaping management strategies such as augmenting topsoil or retrofitting yards with unwatered features such as organic mulch.

Therefore, the city should consider implementing education programs to increase individuals' awareness about how to feasibly make water efficient retrofits to the landscaping. For example, the city and/or Okanagan Basin Water Board could create an education program to teach residents about the benefits of top soil augmentation as well as methods available for installing this retrofit. The city and Okanagan Basin Water Board should ensure information about water conservation is made readily available for all citizens and is easily accessible (i.e. through the city's website and other resources). Currently, conservation information located on the city's website is sparse and does not include specific examples of landscaping retrofits and their associated costs as well as local businesses that can help residents implement alterations (City of Kelowna 2009d). I suggest the city should make such information available to the community and market it as a valuable resource for residents to reduce outdoor irrigation costs. By educating consumers about diverse water efficient landscaping retrofits with a range of associated costs and benefits, planners and water managers can encourage residents with varying financial backgrounds to make feasible landscaping alterations.

The information gained from this study provides a view of detached homeowners preferences and intended behaviour toward water conservation in Kelowna, B.C. Results from this study as well as the DST can be used to facilitate discussion amongst water managers at the municipal and regional scale. Water management is very technical and, therefore, it can be challenging to involve more stakeholders in participatory decision-making. However, experts have stressed the importance of incorporating public knowledge and preferences into natural resource management (Kimmins 2007; Jaccard 2009; Smith et al. 2012). Planners and water managers can use the knowledge gathered from detached homeowners in this study to inform top-down planning processes. By accounting for preferences of users as a whole and segmenting by proportions of turf in yards, managers can reduce uncertainty and create more effective policies and plans for the future.

However, this study only involved current residential developments. To enhance and inform neighbourhood and land-use planning, future research should compare residents' preferences for current landscaping retrofits with new development landscaping designs.

Similar to Kelowna, many cities are built around a suburban sprawl model and, because of this, are not sustainable (Roseland 2012). As planners guide communities toward denser neighbourhood developments, policies should be implemented to increase resource use efficiency of suburban areas. By applying the CE methodology used in this study to other communities in Canada, planners can gather context and place specific information about communities' lawn preferences and choices. Engaging with communities allows planners to make better informed decisions and recommendations to increase social wellbeing while protecting the environment through cost effective solutions. Coupled with anti-sprawl urban planning approaches such as Smart Growth (Roseland 2012), information gleaned from our CE design can help ensure Canadian suburbs are more sustainable in the future. Water efficient landscaping retrofitting is one facet of managing a community's water resources more sustainably.

5.5. Limitations and Future Research

Noted in my discussion, our study focused on the lawn within residents' yards and did not consider larger landscaping features. From focus groups, residents lacked knowledge and comprehension about more complex water conservation strategies such as topsoil augmentation and xeriscaping. Therefore, we chose to focus specifically on lawn alternatives to allow respondents to make tangible tradeoffs between landscaping features they understood. While turf management can account for a large portion of water used in one's yard, other features – such as non-native plant species (e.g. cedar hedges) – can require large volumes of water to maintain. Conversely, xeriscaping and increasing the size of unirrigated features (e.g. rock gardens and organic mulch) can increase a yard's water efficiency. More comprehensive studies should examine a complete yard picture. A comprehensive study could provide more insight into residents' preferences for landscaping management features and provide more complete data about how people view residential outdoor water management and conservation.

Another issue with the scope of this study was the focus on single family detached homes without consideration of multi-unit dwellings that also include turf on their property. Consistent with the survey demographics, the majority of Kelowna residents live in single family homes. However, to capture a larger picture of the community, considering other dwelling types is important especially when applying our CE methodology to other Canadian cities and regions.

Researchers should exercise caution when extrapolating results of my study to other cities and regions in Canada because the water issues and attitudes revealed may be specific to Kelowna. For example, Kelowna is a relatively unique Canadian city because it is located in the driest region in Canada and more prone to drought than other areas. Therefore, transferring results to other communities is limited because of inherent dependency on local context. Local context could even limit how much Kelowna residents' attitudes toward water issues transfer throughout the Okanagan. Therefore, I recommend studies be undertaken in other cities in the Okanagan (e.g. Vernon and Penticton) for comparison and to gain insight about the larger Basin-wide community. Though my model findings were consistent with other published studies on landscaping management (Hurd 2006; Hurd, Hilaire, and White 2006; Yabiku, Casagrande, and Farley-Metzger 2008), those studies focused on arid communities as well. Thus, similar studies should be repeated in Canadian cities located in more water rich areas to provide insight about communities' outdoor water conservation preferences throughout Canada.

Mentioned in my discussion, subsidy levels may not have been high enough to encourage residents to alter their current yards. Exploring higher levels would be important to determine whether subsidies can affect people's choices. Also, price increase was not significant in any model analysed in my study. To determine appropriate pricing models, future studies should explore price effects more widely by including steeper price increases.

Another limitation to this study was the focus on retrofits of existing homes without considering new developments. One could argue that if the public supports decreasing the proportion of turf in their yards for existing homes, residents might also express this preference when purchasing new homes containing smaller lawns. However, people's willingness to alter landscaping versus buying a new house with water efficient landscaping may differ especially since prospective buyers may not be current residents of Kelowna. Therefore, I recommend future research to explore people's preferences for landscaping features in new developments and compare results to current landscaping retrofits.

By individualizing respondents' status quo option, I was able to explore the relationship between people's current situation and their stated choice behaviour. The status quo information provided to each individual allowed respondents to make tradeoffs between new lawn alternatives and their current situation providing context to their decision making. The use of a reference alternative (i.e. the status quo) allowed respondents to evaluate the losses and gains of choosing a new lawn alternative over their status quo (Kahneman and Tversky 1979; Rose et al. 2008). For example, reducing the proportion of turf in one's yard could be perceived as a loss but the water cost savings my outweigh this loss incentivising respondents to choose smaller lawn alternatives over their status quo. While this information is powerful to inform context specific planning, many complex interactions within the dataset exist compared to traditional, opt-out status quo options found in many choice experiments. Since this individualized status quo methodology is relatively novel in water resource management research, there may be some interactions left unaccounted for. Future research should explore the effects of individualizing respondents' status quo compared to using generalized status quo options within choice experiments.

My study used a DST to estimated detached homeowners' stated choice behavior for different lawn scenarios. While the choice model explores people's intentions to conserve water in their lawns it does not estimate people's actual behaviour. To determine if my findings represent actual behaviour, research could incorporate detached homeowners' revealed preferences into a similar study examining landscaping retrofits.

6. Conclusion

Fresh water is among the most important resources on the planet and, therefore, as decision makers plan for the present and the future, they need to ensure that this resource is managed sustainably. At the residential level, water users (i.e. residents) ultimately determine the quantity and allocation of water use within a household. Consequently, planners and water managers should utilize information about residents' preferences and behaviour to inform water use planning and conservation strategies.

Decision makers can employ policies and guidelines to help curb residential water demand. By understanding and incorporating public preferences into water resource planning, governing bodies can ensure that new policies are appropriate and acceptable for a given community. As part of a larger Okanagan Water Study examining residential and agricultural water consumption and demand, I explored detached homeowners' preferences and intended behaviour for managing their lawns within their private property in Kelowna, B.C. Through the use of a choice experiment (CE) and a decision support tool (DST), I was able to estimate public support for different lawn management scenarios and evaluate what percent of residents would choose to alter their landscaping versus staying with their current situation.

My results were framed through a context specific lens accounting for individuals' current landscaping features. As such, I was able to account for heterogeneity within my dataset and demonstrate that respondent's present lawn configuration affects their preferences for alternative lawn scenarios. My results suggest that the proportion of turf in a yard is the strongest contributor to residents' lawn management choices with residents generally preferring smaller to medium sized lawns or larger ones. Lawn variety also factors into residents' choice behaviour with a majority of residents preferring water conserving lawns to traditional and artificial varieties. Considering ones' current lawn scenario, my results suggest that residents with larger lawns are more willing to choose smaller, water conserving alternatives. Conversely, residents with smaller proportions of turf in their yard are less willing to choose water conserving options. Decision makers should consider to implement policies that encourage detached homeowners with larger lawns to make landscaping retrofits to 50% turf or less, as well as consider to introduce water conserving varieties of turf into their yard. While the levels of subsidy examined in this study did not have a significant effect on residents landscaping choice, governing bodies should consider providing education programs to teach residents about water conservation measures they can incorporate into their landscaping.

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Appendices

Appendix A.

Complete Survey Example

Investing in Okanagan's Water:
What is important to you?

In collaboration with the **City of Kelowna, the South East Kelowna Irrigation District**, The Okanagan Basin Water Board, and other partners, Simon Fraser University is currently conducting a study on residential water use in the Okanagan. The survey will give you the chance to provide input on what is important to you, as your water provider plans for the future.

Your water provider will use the survey results to help them decide on future water polices and management strategies for its customers water researchers, policymakers and consumers; therefore we would truly appreciate your support.

As a **token of appreciation** for a completed survey, we will add your name to a prize draw. See page 15 for more information.

By filling out this questionnaire, you are consenting to participate. Your participation in this survey is voluntary, and you may choose not to respond to any question or terminate the survey at any time. All information that you provide in this survey will be kept strictly confidential in accordance with Simon Fraser University's research ethics guidelines. Any personal identifying information you provide will be used only to contact you in the event that you win one of the prizes. Your response will be stored offline in a secure password-controlled cache. Individual records will be identified using a code for data analysis and all records will be destroyed once the data analysis is complete. Your responses will be analyzed in aggregate and will not be identifiable in any publications.

Contact Information
(See page 15)

Privacy Policy
(See page 15)

Okanagan Basin WATER BOARD | City of Kelowna | Pacific Institute for Climate Solutions Knowledge. Insight. Action. | BRITISH COLUMBIA | Agriculture and Agri-Food Canada

Overview

This survey discusses water use in the Okanagan basin, which extends from Armstrong in the north to the US border in the south.

The region is known for its dry sunny climate however the Okanagan basin also has the lowest level of precipitation of all of Canada. Each year the available amount of water is determined by seasonal fluctuations in rain and snowfall, and the storage capacity of reservoirs and aquifers.

HOUSEHOLD WATER USE:

In this survey we encourage you to consider your full household. Your "household" includes you and possibly other people you live with and who use water in your residence.

1. To begin, please tell us about your home – your primary residence

1.1 Who is your current water provider?
Please select one response only.

- City of Kelowna ☐
- Southeast Kelowna Irrigation District ☐
- Black Mountain Irrigation District ☐
- Glenmore-Ellison Improvement District ☐
- Rutland Waterworks District ☐
- Private Well ☐
- Do not Know ☐
- Other ____________________

1.2 How would you describe your residence?
Please select one response only.

- Detached house ☐
- Multi-family house (multiple suites in a single home) ☐
- Attached house (townhouse, duplex, triplex, etc.) ☐
- Apartment/condominium ☐
- Mobile home ☐

1.3 How many people live in your residence?
Please enter the number of individuals living in your household, including yourself.

____

1.4 When was your current residence built?
Please select one response only.

- 1970 and before ☐
- 1971-1980 ☐
- 1981-1990 ☐
- 1991-2000 ☐
- 2001-2012 ☐
- Don’t know ☐

1.5 Have any of the following rooms been renovated in your residence since it was built?
Please select all that apply.

- Bathroom(s) ☐
- Kitchen ☐
- Laundry Room ☐

1.6 Do you own or rent your residence?
Please select one response only.

- Own ☐
- Rent ☐

1.7 When did you first take up residence in the Okanagan?
Please select one response only.

- 1970 and before ☐
- 1970-1980 ☐
- 1981-1990 ☐
- 1991-2000 ☐
- 2001-2012 ☐
- Don’t know ☐

1.8 Are you a seasonal or part time resident?
Please select one response only.

- Yes ☐
- No ☐

1.9 Do you expect to be residing in the Okanagan in 5 years?
Please select one response only.

- Yes ☐
- No ☐

2. Approximately how large is your property?
Please select one response only.

A condominium or apartment with no yard
☐ **SKIP to 11**

A small urban lot or townhouse (~60 x 100 feet or 0.15 acre)
☐

An average urban lot (between 0.15 acre and ¼ acre)
☐

A large urban lot (between ¼ acre and 1 acre)
☐

A larger than average urban lot or rural property (between ½ to ¾ acres)
☐

A very large urban lot or a rural property (between ¾ to 1 acres)
☐

From 1 to 5 acres
☐

From 5 to 10 acres
☐

Over 10 acres
☐

If you answered "A condominium or apartment with no yard," skip to question 11.

3. How would you describe your property's landscape?
Please indicate which of the following features are present in your landscape.

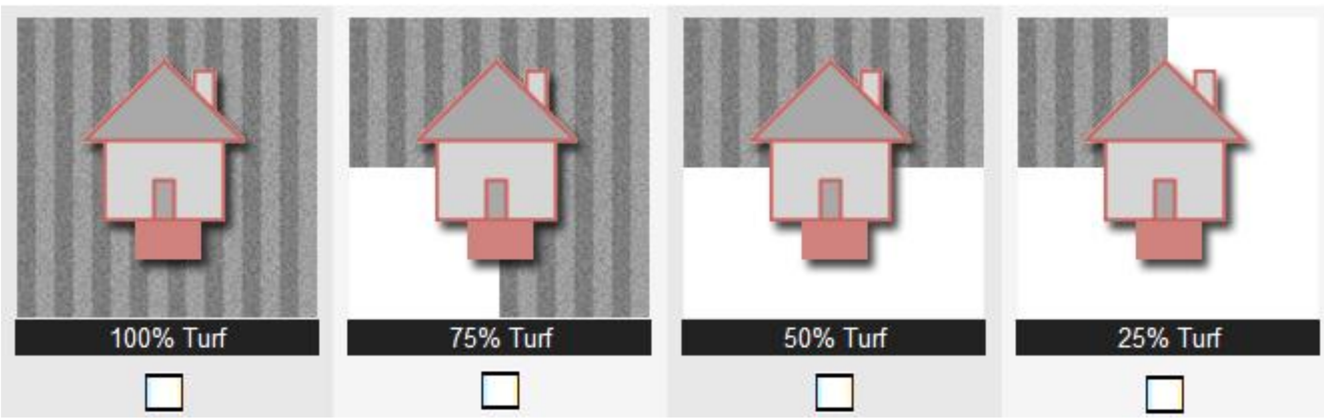
Turf or lawn ☐
Traditional variety of trees, shrubs, hedges ☐
Flowers and vegetable gardens ☐
Water-conserving variety of trees, shrubs ☐
Native or natural landscape ☐
Rocks, gravel, and bare soil ☐
Other features ____________________

If you landscape does not include a "Turf or lawn," skip to question 10.

4. Do you hire a professional when making alterations to your landscape?
Please select one response only.

Yes, I routinely hire a landscape professional ☐
Yes, I have before but I also make many changes myself ☐
No, I make all changes myself ☐
N/A, I have not made any changes to my landscape ☐

5. Considering the yard *surrounding* your home, driveway, and patios, what percentage is covered by turf of lawn?
Please select the option that is closest to your lawn size.



6. What is the majority type of turf used in your lawn?
Please select one response only.

Traditional variety of turf (Kentucky Blue Grass, Ryegrass) ☐
Water-conserving variety of turf (eco-Smart Blend, Sheep Fescue, Chewings Fescue) ☐
Artificial or synthetic turf ☐

7. On average, how often is your lawn watered during the peak summer months (July, August)?
Please select one response only.

1-2 times per week ☐
3-4 times per week ☐
5 times per week or more ☐
Almost never ☐

8. When your lawn is watered, how is your lawn usually watered?
Please select one response only.

- Manually, using a hose sprayer ☐
- Manually, using a hose and sprinkler ☐
- Manually, using an irrigation system ☐
- Automatically, using an irrigation system with timer ☐
- My lawn is not watered ☐
- Other ____________________________

9. During the peak of summer, how green or brown is your lawn?
Please select one response only.

- Very Green ☐
- Mostly Green ☐
- More Green than Brown ☐
- More Brown than Green ☐

10. To what extent do you agree or disagree with each of the following statements about your landscape's appearance?

For each statement, please select one option.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
I am content with my present landscape.	☐	☐	☐	☐	☐
I would like to reduce the amount of lawn in my yard.	☐	☐	☐	☐	☐
I would like to learn more about landscape water requirements before deciding on any changes.	☐	☐	☐	☐	☐
I would like to eventually select more drought tolerant varieties of plants.	☐	☐	☐	☐	☐
I do not think my neighbours would accept changes in my landscape that reduce the amount of lawn.	☐	☐	☐	☐	☐
I would like to reduce the amount of lawn on my property, but I do not have the ***time*** to make changes.	☐	☐	☐	☐	☐
I would like to reduce the amount of water my landscape uses but I do not have the ***money*** to make changes.	☐	☐	☐	☐	☐
	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree

11. Which of the following home improvements has your household taken to reduce water use in and around your residence?
Please select all that apply.

- Use a low water use dishwasher ☐
- Use a low water use clothes washer ☐
- Use low flush toilets ☐
- Use low flow shower fixtures ☐
- Use an automatic irrigation timer ☐
- Use rainwater basins for outdoor irrigation ☐
- Use native or low water use vegetation in outdoor landscapes ☐
- Use a layer of heavy topsoil to improve soil water retention ☐
- Use the results of an irrigation efficiency audit to improve landscape irrigation ☐
- Reduced the amount of lawn in my yard ☐
- Replaced my lawn with a water conserving variety ☐
- Other ______________________________ ☐

12. How confident are you in your ability…

Please rate your confidence on a scale from (1 = cannot identify at all) to (5 = can identify with certainty).

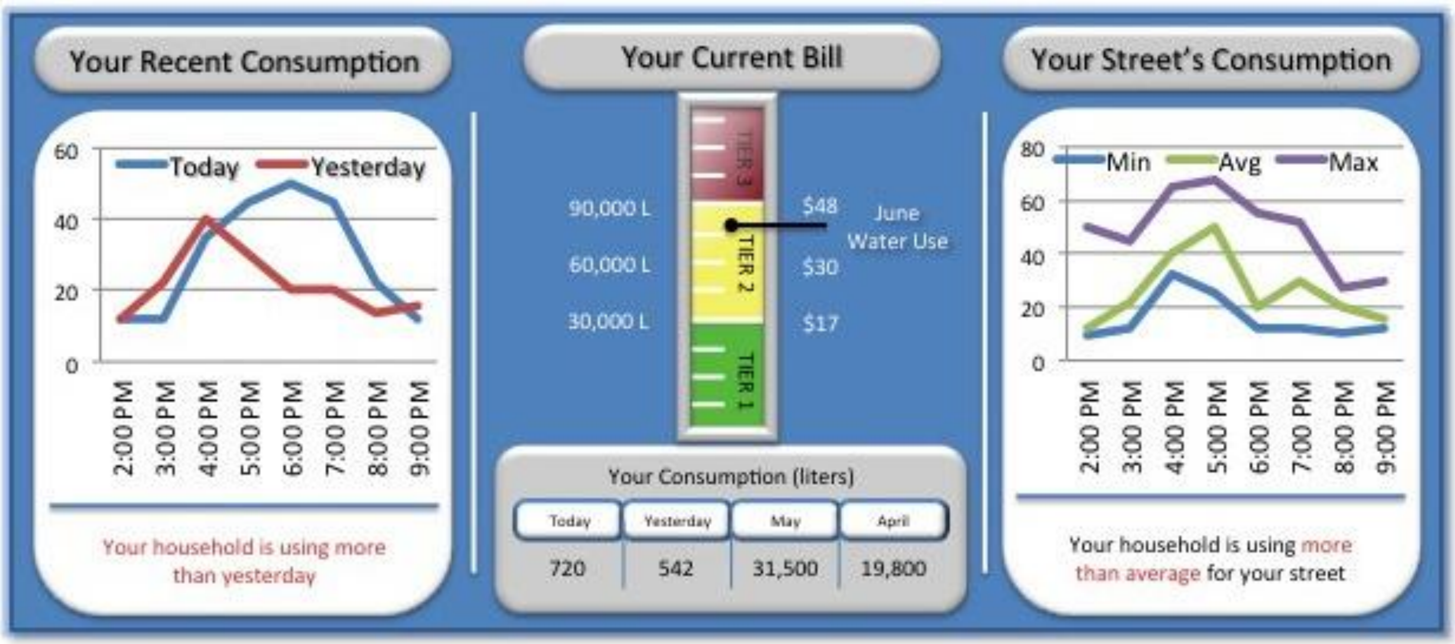
	I cannot identify at all				I can identify with certainty
...to identify how much water is used by your household?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
...to identify how to reduce indoor water use by your household?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐
...to identify how to reduce outdoor water use by your household?	1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

13. Which sources of information about water and water related issues in the Okanagan do you find most trustworthy?

Please select up to three options below.

Friends and family ☐
Neighbours ☐
Local news source ☐
My water provider ☐
Regional water board ☐
Provincial government ☐
Other ______________ ☐

It is now possible to provide each household with very detailed and up-to-date information about their water consumption. The figure below shows the possible information that could be made available to you on a frequent basis.



14. If the above information was made available to you <u>on an in-home display</u>, to what extent do you agree or disagree with the following statements?

For each statement, please select one option.

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
I would check the accuracy of my water bill more frequently	☐	☐	☐	☐	☐
I would check my outdoor watering more frequently and think about adjustments	☐	☐	☐	☐	☐
I would purchase more water efficient appliances	☐	☐	☐	☐	☐
I would investigate and repair any water leaks I discover	☐	☐	☐	☐	☐
	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

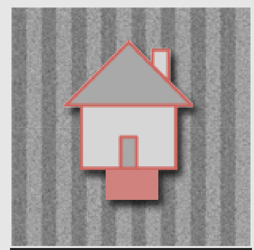
Choose your preferred landscaping - Instructions

In the next section of this survey, you will be presented with ***six different sets*** *of lawns to consider for your future landscape with rising water prices. Each set will consist of* ***two possible lawns and your current lawn*** *as described by you earlier.*

Your task is to ***pick the lawn you most prefer*** *after considering the features in each set. There are no right or wrong answers to these questions but it is important to regard them as real-world situations, in which you must make a personal investment choice.*

Below is ***an example*** *of what you will be asked to consider.*

At any point during the survey you may familiarize yourself with the features of the lawn by clicking on the info buttons.

Lawn Features	Lawn A	Lawn B	Your Current Lawn
Price of water in 5 years	**30% more than today**		
% of total landscape	 25% Turf	 50% Turf	 100% Turf
***Variety** of turf*	Water Conserving	Traditional	Traditional
***Appearance** during peak of summer*	Very Green	Mostly Green	More Brown than Green
*One time **Subsidy** to reduce or replace*	$125 maximum	$250 maximum	$0
***Water use** over 5 years*	100 m^3/year	240 m^3/year	350 m^3/year
***Watering cost** over 5 years*	$50/year	$120/year	$200/year

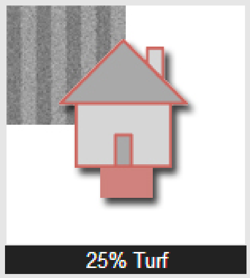
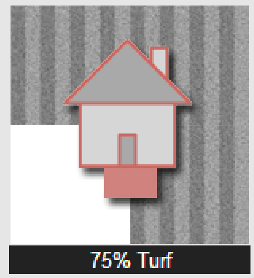
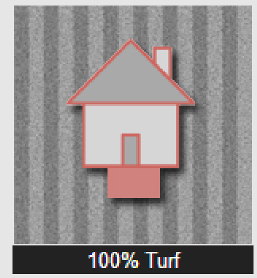
Your Opinion on Water Use in the Okanagan

Selecting a Lawn - 1 of 6

- **If the following were the only lawn options available to you, which one would you choose?** *

Please make your choice by clicking on one of the profiles.

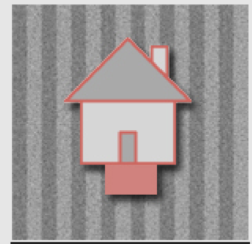
Price of water in 5 years: **30% more than today**

Lawn Features	Lawn A	Lawn B	Your Current Lawn
% of total landscape			
***Variety** of turf*	Water Conserving	Water Conserving	Traditional
***Appearance** during peak of summer*	More Brown than Green	Very Green	More Brown than Green
*One time **Subsidy** to reduce or replace*	$250 maximum	$125 maximum	$0
***Water use** over five years*	70 m^3/year	300 m^3/year	350 m^3/year
***Watering cost** over 5 years*	$30/year	$170/year	$200/year
I would choose →	○	○	○

Selecting a Lawn - 2 of 6

- **If the following were the only lawn options available to you, which one would you choose?** *

Please make your choice by clicking on one of the profiles.

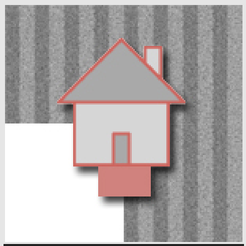
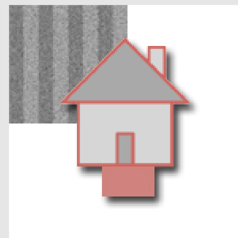
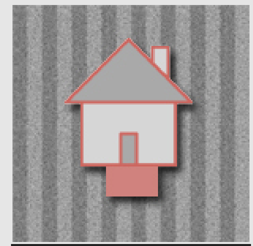
Lawn Features	Lawn A	Lawn B	Your Current Lawn
Price of water in 5 years	**60% more than today**		
% of total landscape	 25% Turf	 50% Turf	 100% Turf
***Variety** of turf*	Water Conserving	Traditional	Traditional
***Appearance** during peak of summer*	Mostly Green	More Brown than Green	More Brown than Green
*One time **Subsidy** to reduce or replace*	$125 maximum	$500 maximum	$0
***Water use** over five years*	90 m^3/year	180 m^3/year	350 m^3/year
***Watering cost** over 5 years*	$50/year	$110/year	$240/year
I would choose ➔	○	○	○

Selecting a Lawn - 3 of 6

- **If the following were the only lawn options available to you, which one would you choose?** *

Please make your choice by clicking on one of the profiles.

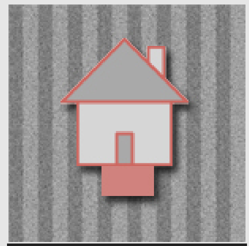
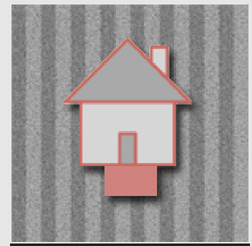
Price of water in 5 years: **90% more than today**

Lawn Features	Lawn A	Lawn B	Your Current Lawn
% of total landscape	 75% Turf	 25% Turf	 100% Turf
***Variety** of turf*	Water Conserving	Traditional	Traditional
***Appearance** during peak of summer*	Very Green	Mostly Green	More Brown than Green
*One time **Subsidy** to reduce or replace*	$250 maximum	$500 maximum	$0
***Water use** over five years*	300 m^3/year	120 m^3/year	350 m^3/year
***Watering cost** over 5 years*	$240/year	$80/year	$290/year
I would choose ➔	○	○	○

Selecting a Lawn - 4 of 6

- **If the following were the only lawn options available to you, which one would you choose?** *

Please make your choice by clicking on one of the profiles.

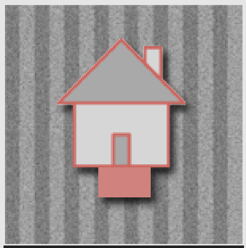
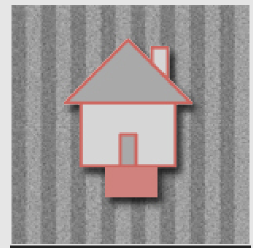
Price of water in 5 years	**60% more than today**		
Lawn Features	**Lawn A**	**Lawn B**	**Your Current Lawn**
% of total landscape	 50% Turf	 100% Turf	 100% Turf
***Variety** of turf*	Traditional	Traditional	Traditional
***Appearance** during peak of summer*	More Brown than Green	Mostly Green	More Brown than Green
*One time **Subsidy** to reduce or replace*	$375 maximum	$250 maximum	$0
***Water use** over five years*	180 m^3/year	470 m^3/year	350 m^3/year
***Watering cost** over 5 years*	$110/year	$350/year	$240/year
I would choose →	○	○	○

Selecting a Lawn - 5 of 6

- **If the following were the only lawn options available to you, which one would you choose?** *

Please make your choice by clicking on one of the profiles.

Price of water in 5 years: **60% more than today**

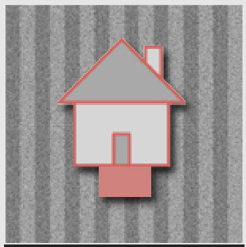
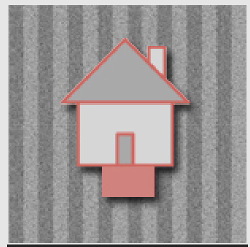
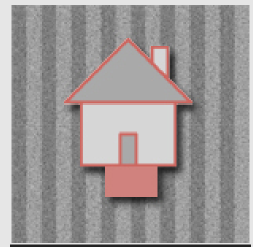
Lawn Features	Lawn A	Lawn B	Your Current Lawn
% of total landscape	 100% Turf	 50% Turf	 100% Turf
***Variety** of turf*	Traditional	Water Conserving	Traditional
***Appearance** during peak of summer*	Mostly Green	More Green than Brown	More Brown than Green
*One time **Subsidy** to reduce or replace*	$500 maximum	$250 maximum	$0
***Water use** over five years*	470 m^3/year	150 m^3/year	350 m^3/year
***Watering cost** over 5 years*	$350/year	$90/year	$240/year
I would choose ➔	○	○	○

Selecting a Lawn - 6 of 6

- **If the following were the only lawn options available to you, which one would you choose?** *

Please make your choice by clicking on one of the profiles.

Price of water in 5 years: **90% more than today**

Lawn Features	Lawn A	Lawn B	Your Current Lawn
% of total landscape	 100% Turf	 100% Turf	 100% Turf
***Variety** of turf*	Artificial	Artificial	Traditional
***Appearance** during peak of summer*	Very Green	Very Green	More Brown than Green
*One time **Subsidy** to reduce or replace*	$125 maximum	$375 maximum	$0
***Water use** over five years*	0 m^3/year	0 m^3/year	350 m^3/year
***Watering cost** over 5 years*	$0/year	$0/year	$290/year
I would choose ➔	○	○	○

15. In your opinion, how have each of the following water uses <u>changed</u> in the Okanagan region over the last 10 years?

For each category of water use, please select one option.

	Increased	Not Changed	Decreased	Do not know
Water used by residents	☐	☐	☐	☐
Water used by agriculture	☐	☐	☐	☐
Water used by businesses	☐	☐	☐	☐
Water used by parks	☐	☐	☐	☐
Water used by golf courses	☐	☐	☐	☐
Water available for the natural environment	☐	☐	☐	☐

16. To what extent do you personally agree or disagree with each of the following statements about <u>water use</u> in the Okanagan Basin?

For each statement, please select one option.

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree	No Opinion
I am doing all I can to conserve water	☐	☐	☐	☐	☐	☐
My neighbours currently use more water than I do	☐	☐	☐	☐	☐	☐
Water conservation is an issue I am personally concerned about	☐	☐	☐	☐	☐	☐
Water conservation programs should include options for changing water users' behaviour	☐	☐	☐	☐	☐	☐
Using technology is the only way we will permanently reduce the amount of water we use	☐	☐	☐	☐	☐	☐
	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree	No Opinion

17. To what extent do you personally agree or disagree with each of the following statements about <u>managing</u> Okanagan's water resources?

For each statement, please select one box.

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree	No Opinion
Water restrictions should be voluntary rather than mandated by the government	☐	☐	☐	☐	☐	☐
Regional land use and water planning is needed to manage water scarcity	☐	☐	☐	☐	☐	☐
Growth of cities should be limited to manage water scarcity	☐	☐	☐	☐	☐	☐
Public money should be used to develop or acquire new water resources	☐	☐	☐	☐	☐	☐
I am satisfied with the current system of water management	☐	☐	☐	☐	☐	☐
Water policymakers understand my priorities for water use	☐	☐	☐	☐	☐	☐
	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree	No Opinion

18. Which of the following statements most accurately reflects your opinion about climate change in the Okanagan the closest?

Please select one response only

Yes, climate change will happen, but its indications will only become apparent later	☐
Yes, climate change is happening; first indications are apparent already	☐
The statements about climate change are too uncertain. It is too early to have an opinion about it	☐
No, I do not believe in climate change	☐
Other opinion ____	☐

19. Have you noticed any <u>changes</u> to the following climate events in the Okanagan?

For each statement, please select one option.

	Increased	Not Changed	Decreased	Don't Know
The amount of rainfall during the summer...	☐	☐	☐	☐
The severity of winters has...	☐	☐	☐	☐
The frequency of water shortages has...	☐	☐	☐	☐

20. During short-term water scarcity events, how acceptable would each of the following water management programs be to you?

Please rate your acceptance of each management program on a scale from (1 = very unacceptable) to (5 = very acceptable).

	Very unacceptable 1	2	3	4	Very acceptable 5
Restricting the amount of water that can be used on private lawns and landscapes	☐	☐	☐	☐	☐
Restricting the amount of water that can be used on public landscapes	☐	☐	☐	☐	☐
Temporarily paying farmers to reduce water	☐	☐	☐	☐	☐
Restricting the amount of water that can be use by industry and businesses	☐	☐	☐	☐	☐
Allowing local lakes and reservoirs to drain	☐	☐	☐	☐	☐
Reducing the amount of water available for wildlife and fish habitats	☐	☐	☐	☐	☐

Imagine that in the not too distant future, you receive a notice from your water provider that spring snowpack levels are low, and that the seasonal outlook calls for a dry and hot summer, with ***the Okanagan expected to receive 35% less rainfall than average.***

21. During the resulting summer, how much would you be willing to reduce your household's water consumption in each of the following categories?
For each statement, please select one option.

	No reduction 0%	10	20	30	40	50	60	70	80	90	Stop this activity 100%
Summer lawn watering	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Length of showering or bathing	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Frequency of flushing toilets	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Frequency of using a dishwasher	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Frequency of using a clothes washer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

22. Now consider the appearance of your community during the same summer. How disturbing would it be to you if public green spaces turned brown?
Please select one response only.

- Very disturbing ☐
- Slightly disturbing ☐
- Neither disturbing nor not disturbing ☐
- Not disturbing ☐
- Not at all disturbing ☐

23. During the same summer, how disturbing would it be to you if private green spaces turned brown?
Please select one response only.

- Very disturbing ☐
- Slightly disturbing ☐
- Neither disturbing nor not disturbing ☐
- Not disturbing ☐
- Not at all disturbing ☐

Some future scenarios suggest that due to climate change the Okanagan Region could ***continually receive about 20% less precipitation during the summer months.*** *In such a situation, there may not be enough water for all water uses and policymakers may consider prioritizing the types of uses of water.*

24. For each of the following water uses, please indicate how <u>important</u> each is for the Okanagan basin in times of water scarcity?

Please rate how beneficial each use of water is on a scale from (1 = Not very important) to (5 = Very important).

	Not very important 1	2	3	4	Very important 5
Water for Agriculture (e.g., food or feed crop production, livestock)	☐	☐	☐	☐	☐
Water for Municipal landscape Irrigation (e.g., community parks, municipal golf courses)	☐	☐	☐	☐	☐
Water for Recreation (e.g., rafting, fishing, boating, swimming, skiing, scenic viewing)	☐	☐	☐	☐	☐
Water for Wildlife and the Natural Environment (e.g., as part of fish and wildlife habitat, forest health, in-stream management, and other natural uses)	☐	☐	☐	☐	☐
Water for Household Indoor Use (e.g., drinking, cooking, shower, laundry, dishwashing, toilets)	☐	☐	☐	☐	☐
Water for Private landscape irrigation (e.g., lawns and gardens for private homes and business)	☐	☐	☐	☐	☐
Water for Commercial and Industrial Use (e.g., commercial manufacturing, mining, and private golf courses)	☐	☐	☐	☐	☐

Demographics

25. Are you responsible for paying your water utility bill?
Please select one response only.

Yes ☐
No ☐
I do not receive a water utility bill ☐

26. What is the nearest street intersection to your residence?
Please enter the two cross streets of the nearest intersection to your residence
____________________________ and______________ ______________

27. What is your gender?
Please select one response only.

Female ☐
Male ☐

28. Which of the following age categories describes you?
Please select one response only.

Under 20 ☐
20 to 24 ☐
25 to 34 ☐
35 to 44 ☐
45 to 54 ☐
55 to 65 ☐
65 or over ☐

29. What is the highest level of education that you have completed?
Please select one response only.

- Less than high school ☐
- Completed high school ☐
- Some post secondary education (post secondary not completed) ☐
- Trades or non-university certificate or diploma ☐
- Completed university ☐
- Post graduate degree ☐

30. Which of the following categories best describes your pre-tax annual household income?
Please check the box that corresponds with your answer.

- $19,999 or less ☐
- $20,000 to $39,999 ☐
- $40,000 to $59,999 ☐
- $60,000 to $79,999 ☐
- $80,000 to $99,999 ☐
- $100,000 to $125,999 ☐
- $130,000 to 149,999 ☐
- $200,000 to $249,999 ☐
- $250,000 or more ☐

31. Are you retired?

Please select one response only

- Yes ☐
- No ☐

Last Words

1. If you have any suggestions or additional comments regarding this survey, we would appreciate to know about it.

2. ____
____
____
____
____
____

Thank you for completing this survey. As a token and as a token of appreciation for completing the survey you qualify to enter your name into a prize draw to win a $250 gift card to Home Depot or 1 of 3 $50 cash card prizes.

To be considered for the draw, please provide your contact information. Any personal identifying information you provide will be used only to contact you in the event that you win one of the prizes and will not be associated with your answers.

Name: _________________________________

Address: ____

____

Postal Code: _______________

3. Draw Prizes

Upon returning this survey, you be given the opportunity to enter your name into a drawing to win one of the following prizes.

- One GRAND prize of a $250 gift card to Home Depot
- One of three $50 cash card prizes

Winners will be drawn on May 30 and congratulatory emails will be sent out on the same day. If there is no response to these emails within 7 days, new winners will be drawn until a winner is contacted.

4. Contact Information

Contact Information

If you have any questions, concerns, or comments, please contact the project investigator, Steve Conrad at:

steve.conrad@sfu.ca

School for Resource and Environmental Management
Simon Fraser University
8888 University Drive
Burnaby, BC V5A 1S6
Telephone: 604-649-6746
Fax: 778-782-4986

5. Privacy Policy

This project (2011s0575) has received ethics approval by the Research Ethics Board at Simon Fraser University.

By filling out this questionnaire, you are consenting to participate. Your participation in this survey is voluntary, and you may choose not to respond to any question or terminate the survey at any time. All information that you provide in this survey will be kept strictly confidential in accordance with Simon Fraser University's research ethics guidelines.

Any personal identifying information you provide will be used only to inform you when the survey is ready and to contact you in the event that you win one of the prizes. Your response will be stored offline in a secure password-controlled cache. Individual records will be identified using a code for data analysis and all records will be destroyed once the data analysis is complete. Your responses will be analyzed in aggregate and will not be identifiable in any publications.

Your may address any concerns or complaints about this research to Dr. Wolfgang Haider, the project supervisor, at wolfgang_haider@sfu.ca or 778-782-3066 .

Alternatively, if Dr. Haider is unreachable, you may contact Dr. Hal Weinberg, Director, Office of Research Ethics at: hal_weinberg@sfu.ca or 778-782-6593 with reference to File #: 2011s0575.