Increasing environmental knowledge and effecting change in lawn maintenance behavior among homeowners

A Thesis

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Abstract

The management of private property in urban areas can greatly influence the amount of fertilizer, soil, and water runoff into surrounding watersheds, increasing nitrogen and phosphorus pollution and creating eutrophic conditions in water bodies. Lawns are a prominent component of managed landscapes, and as such can play a role in water pollution levels over time. Encouraging beneficial maintenance behaviors has the potential to reduce nutrient runoff from turfgrass areas and increase the ecosystem services they provide. However, there are complex reasons why private property owners make lawn and yard care decisions. In addition, members of the public often do not understand the path water travels when it leaves their property. Therefore, the objectives of this study thesis are to assess whether or not an individual's possession of inaccurate water pathway knowledge is related to their lawn and yard maintenance behavior, as well as to determine the effectiveness of video and written educational interventions in changing the behavior and intent to behave of individuals. Surveys of Twin Cities Metro Area, MN residents were conducted 2014 and 2015. Based on their answers, respondents were divided into two groups; those who had obvious misconceptions about runoff water pathways and those who did not. Approximately 32% of survey participants had misconceptions about runoff water pathways. In addition, there were significant differences between the two groups regarding knowledge of the effects of maintenance activities, as well as the

frequency that participants watered their lawns, mowed, and used fertilizer. A follow-up survey of the June, 2014 respondents did not indicate much change in maintenance behavior after viewing the educational video. However within the 2015 survey a comparison between video and written educational methods found that written educational materials were more effective than video on influencing an individual's intent to behave. By providing information on what types of educational materials are most effective in changing intent to behave, this research will help inform and direct public outreach and education efforts to help improve local water quality in urban areas.

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List of Abbreviations

BES	Baltimore Ecosystem Study
BMP	Best Management Practice
DC	District of Columbia
DRP	Dissolved Reactive Phosphorus
EPA	Environmental Protection Agency
HGTV	Home & Gardens Television
HOA	Homeowners' Association
MPCA	Minnesota Pollution Control Agency
MSPMA	Minneapolis-St. Paul Metropolitan Area
N	Nitrogen
NO_2	Nitrogen Dioxide
NO_3	Nitrate
NO_x	Nitric Oxides
NEP	New Environmental Paradigm
NWQAP	National Water Quality Assessment Program
P	Phosphorus
TCMR	Twin Cities-Mississippi River
TPB	Theory of Planned Behavior

Chapter 1

Introduction

Water quality in urban areas is a topic of increasing concern on both an international and local level, particularly when nutrient pollution caused by human activity contributes to the eutrophication of rivers, lakes, and streams (Kemp, et. al, 2005). Yard and lawn management practices used on public and private property can increase the amount of nitrogen and phosphorus leaching from or running off of these landscapes, causing water bodies to become unsuitable for aquatic life and reducing their ability to support recreational activities (Carey, et. al, 2013). Changes in lawn maintenance practices can reduce nutrient losses from managed landscapes (Bell and Moss, 2008), but individual preferences regarding turf appearance and function as well as social norms and values make it difficult to influence homeowner behavior on a broad scale. Knowledge about environmental issues can influence individual behavior and some studies have shown that individuals in certain metropolitan areas lack an understanding of the relationship between water movement from their property and water quality in nearby lakes, rivers, or streams (Nielson and Smith, 2005 and Martini, et. al, 2013). Therefore, a need exists to determine if environmental knowledge is related to homeowner property management behavior and if so, to compare methods for educating urban property owners on water pollution issues

and their relationship to landscape management practices. The effectiveness of different methods in educating homeowners to change or intend to change their behavior will help inform further research.

Urban Water Quality

Aquatic ecosystems around the world face major environmental challenges related to human activity. Currently, two of the most pressing issues are algae blooms and related eutrophication, which are both fueled by excess nitrogen and phosphorus running off and leaching from land into rivers, lakes, and oceans (Conley, et. al, 2009 and Howarth, et. al, 2002). Algal blooms are made up of elevated numbers of phytoplankton that can increase turbidity and reduce oxygen levels in bodies of water, creating situations that are harmful to indigenous plant and animal life as well as reducing recreational and economic opportunities for people (van den Bergh, et. al., 2002). In particular, native game fish and supporting plant populations lose competitive advantages when the trophic status of their habitats change, thus providing opportunities for invasive species to infiltrate and dominate these systems. Non-native species, such as the widespread curly-leaf pondweed (*Potamogeton crispus*), are often able to thrive in water with lower levels of sunlight, where native plant species cannot survive (Johnson, et. al, 2012). In addition, some algae blooms are composed of

cyanobacteria species, especially when phosphorus levels are within a range of about 20 ug L^{-1} to 100 ug L^{-1} (Carvahlo, et. al, 2013). Algal blooms can produce toxins that are harmful when they come into contact with or are ingested by people and animals (Backer, et. al, 2010).

While a comprehensive worldwide assessment of water bodies impaired by nutrient pollution does not exist, the Clean Water Act of the United States mandates that individual state governments provide surface water quality information to the Environmental Protection Agency (EPA) on a biannual basis (USEPA, 2009). Data from the EPA and the National Water Quality Assessment Program (NWQAP) have been used by multiple researchers, who have concluded that urban water quality has been reduced due to nutrient loading. One study in particular, conducted in urban and rural regions of the south central United States, found positive correlations between algal assemblages and NO_2 and NO_3 concentrations in streams within the study area, as well as a decrease in the diversity of invertebrate populations over the same time period (Miller, et. al, 2012). Overall, phosphorus and nitrogen concentrations in the majority of surface water throughout the United States remained the same or increased between 1993 and 2003 (USGS, 2008). A 2013 report published by the Minnesota Pollution Control Agency (MPCA) concluded that a significant proportion of lakes for which data was available did not support aquatic recreation because of elevated nutrient levels (2013).

Sources of Nutrient Pollution in Urban Waterways

Nutrient loading of waterways within the United States can originate from many places. Point sources such as industrial discharges are relatively easy to track, while non-point sources such as runoff from agricultural and urban land are more difficult. Quantifying the amount of nutrients that originate from agricultural and urban land can be challenging, but it is important to do this when attempting to control nutrient loading. A report by the National Research Council (2009) characterizes storm-water runoff from the built environment, a non-point source, as a principal contributor to water body impairment nationally. Researchers analyzed data from urban and nonurban watersheds in the Twin Cities region and concluded that the most highly urbanized watershed, the Twin-Cities Mississippi Watershed, contributed a significant proportion of total phosphorus and total nitrogen in downriver areas. Additionally, medium-density urban land use was positively correlated with runoff water quantity and total nitrogen concentrations in the watershed (Kloiber, 2005). Other estimates have put typical nutrient concentrations in urban storm water across the United States at 2.0 mg L^{-1} total nitrogen and .26 mg L^{-1} total phosphorus (Schueler, 2003). These amounts are higher than the 0.04-0.10 mg L^{-1} total phosphorus standards set in Minnesota and the 0.60 mg L^{-1} total nitrogen limits set by Ohio; both standards are similar to limits set by other states across the country (EPA, 2015).

Urban spaces are particularly prone to an increased rate of nutrient transport via water flow predominately because natural hydrologic cycles are disrupted by the amount of impervious surfaces and artificial storm-water drainage systems in these areas (Steele, et. al, 2010 and Carey, et. al, 2013). An illustration of this point is provided by Sahoo, et. al (2013) on the sources of nutrient loading to Lake Tahoe in the United States. They concluded that urban areas contributed 67% of fine particle loading (an indicator of water clarity) to the lake while non-urban areas contributed 16%, despite the fact that urban areas were responsible for only 6% of the average annual total water flow into the lake. Additionally, urban areas contributed 18% of total phosphorus inputs into the lake, leading the authors to conclude that controlling runoff from these areas would be the most effective way to reduce fine particle and phosphorus loading into the lake (Sahoo, et. al, 2013). Similarly, research conducted as part of the Baltimore Ecosystem Study (BES) showed that urban watersheds consistently have higher nitrate concentrations than forested but lower than agricultural watersheds (Pickett, et. al, 2007). Another article published by those involved with the BES found that watersheds with high impervious surface coverage, and where urban areas were the dominant land use, had the highest soluble reactive phosphorus and total phosphorus (24.5-83.7 kg^{-1} km^{-1} yr^{-1}) when compared with forested and low-density residential land watersheds (2.8-3.1 kg^{-1} km^{-1} yr^{-1}) (Duan, et. al, 2012). There is ample evidence that urban areas contribute large amounts of nutrient loading to our nation's waterways. However, because urban

areas are uniquely made up of many thousands of relatively small, individually owned parcels of land, discovering the particular landscape characteristics that cause the largest amount of nutrient runoff is difficult.

The Contribution of Residential Lawns to Nutrient Pollution in Urban Watersheds

Lawns are a prominent component of residential outdoor spaces and an integral part of urban and suburban areas in the United States. From 1945 to 2002, the amount of urban land has increased from 15 million acres to 60 million acres (Lubowski, et al, 2002). Along with this increase has come an expansion of the amount of space covered by turfgrass, which Robbins and Bikenholz (2003) have put at nearly a quarter of urban land cover. More recently, Milesi et. al, (2005) found that turfgrass occupies 164,000 square kilometers of land in the United States, or three times the amount of any other irrigated crop.

Turfgrass areas serve many purposes, and are valued for their recreational, functional, and aesthetic qualities. They provide numerous ecosystem services, including erosion control, improved water infiltration, soil building, and heat and noise abatement (Beard and Green, 1994, Murphy and Murphy, 2001). To maintain lawns at a level necessary for these functions, inputs such as water, labor, fertilizer, and pesticides may be required (Carey, et. al, 2012, Carey, et. al,

2013). Over time, concern has developed that managed turfgrass areas contribute significantly to pollution issues, including nutrient loading, because of their tendency to be high input landscaping choices. Fissore, et. al (2012) found that nitrogen inputs to lawns exceeded what was required by the ecosystem by 51%. Large fertilizer applications can result in phosphorus and nitrogen runoff and leaching from landscapes dominated by turf areas. King et. al, (2007) and Rice and Horgan, 2013 found that nearby water bodies that drained golf courses had phosphorus levels that exceeded water quality guidelines, but nitrate levels lower than Environmental Protection Agency (EPA) proposed standards. Higher levels of phosphorus applications have been found to be associated with large P inputs resulting in higher total phosphorus amounts in runoff water, averaging as much as 2.54 mg L^{-1} in frozen soil and 3.17 mg L^{-1} in non-frozen soil (Bierman, et. al, 2010). In its second year of data collection, this same study found lower levels of total phosphorus runoff in grass that was fertilized with nitrogen and potassium but no phosphorus when compared to grass to which no fertilizer was applied. The results demonstrated that turfgrass fertilized with nitrogen and potassium but no phosphorus had improved density when compared to turfgrass that was not fertilized at all. This implies that plots with greater amounts of exposed soil were more susceptible to soil erosion and therefore phosphorus runoff, as phosphorus adheres to soil particles. These conclusions agree with another article, which found that turfgrass' ability to reduce runoff and leachate was related to shoot density (Easton and Petrovic, 2004).

The issue is more complex than assuming that turfgrass is always the biggest culprit regarding nitrogen and phosphorus loading in watersheds, as the quantities of these nutrients originating from any individual space can be site, species, and temporally dependent. Comparisons between multiple species of turfgrass have not been conducted, but many studies have looked at the differences in runoff amounts between perennial residential landscapes and turf areas. Some have found that managed turfgrass actually results in less nutrient leaching or runoff than herbaceous or woody perennial areas. For instance, in Florida in 2012, Loper, et. al observed that during the establishment period higher cumulative leachate volume, inorganic nitrogen and DRP loads, and mean NO_3, NO_2, and DRP concentrations were found originating from mixed ornamental areas rather than St. Augustinegrass turf areas. The authors attributed these differences to greater shoot density in the turf areas, which aligns with the research discussed previously in this section. Erickson, et. al, 2001 found similar results, showing that when planted in sandy soils newly established St. Augustinegrass sod leached 4.1 kg N ha^{-1} compared to a mixed species landscape, which leached 48.3 kg N ha^{-1} . In contrast, Qin et al. (2014) reported that landscapes planted with 90% turfgrass and 10% woody ornamentals leached significantly greater concentrations of total kjeldahl nitrogen, NO_x and dissolved reactive phosphorus than landscapes planted with lower turfgrass to ornamental ratios. The difference between to these two studies is that in the former the plantings were newly established, while in the latter data was not collected until

plants were fully established, showing that in addition to site characteristics and species, the age of a landscape may also affect nutrient loss quantities. Overall, nutrient losses from managed outdoor spaces seem to be related primarily to appropriate fertilization practices, plant density, and time of the year, rather than the type of plants that dominate an area. Indeed, most maintenance practices known to help reduce nutrient losses from turfgrass areas can also be easily applied to non-turf areas, such as reducing water, maintain density, and keeping organic material out of street gutters (Bell and Moss, 2008).

Drivers of Landscape Management Behavior

To reduce nutrient losses from managed landscapes, behavior change among the general public must occur, but individual behaviors regarding environmental issues are influenced by many different factors. Approaches to assessing these factors have varied considerably over time and often have produced disparate results. Dunlap's New Environmental Paradigm (NEP) Scale has been widely used to measure pro-environmental orientation (Dunlap, et. al, 2000). The same authors revised this methodology in 2000 as the New Ecological Paradigm Scale to update outmoded terminology and include a broader range of views (Dunlap, et. al, 2000). One study drawing on the NEP concept, conducted in Phoenix, Arizona, found that anthropocentric worldviews were related to a

preference for grass-based as opposed to mesic landscapes (Yabiku, et. al, 2008). Using a more comprehensive and comparative approach, Larson, et. al. (2010) found that anthropocentric worldviews resulted in more herbicide use and preferences for oasis as opposed to mesic landscapes. However, researchers using additional types of assessments have produced varied results, finding that membership to environmental organizations is associated with higher levels of fertilizer applications, (Templeton, et. al, 1999) and increased environmental awareness is related to more frequent pesticide applications (Robbins, et. al, 2001). Individual behaviors do not always parallel environmental views; the reality tends to be much more complex. For example, Wolf, et. al. (2013) conducted qualitative interviews of stewardship managers in the Puget Sound region of Washington state and found that motivations for stewardship were very diverse, ranging from practical to conceptual reasons.

A different approach utilizes a concept known as the theory of planned behavior (TPB), which moves away from considering behavior predominantly through the lens of an individual's location on a pro-environmental scale and towards a more holistic methodology. TPB can help to better sort out reasons why an individual may choose to make certain landscape management decisions by breaking down the determinants of behavior into three categories of beliefs: behavioral, normative, and control beliefs. These beliefs respectively represent a person's expectations about the consequences of their behavior, the approval or disapproval of others about a behavior, and the perception of impediments or

factors that will assist a person in performing a behavior (Ajzen, 1991). In 2010, Hughes, et. al. used this framework to determine why a river water quality educational campaign in Perth, Australia had been met with limited success. It was discovered that members of the public were aware of the links between their yard fertilization practices and water quality, but were prevented from using less harmful products by a lack knowledge about these products as well as concerns about their effectiveness and cost. The implication of this study was that the educational campaign had positively influenced the general public's behavioral and normative beliefs, but not their control beliefs, and therefore saw limited success.

Other research has been conducted that does not specifically draw on the theories articulated by Ajzen (1991), but supports the concept that many yard management decisions are made based on a combination of the different motivational belief systems posited by TPB. For instance, a demographic study conducted in the Baltimore, Maryland area found that lifestyle characteristics are better predictors of high grass cover, while past demographics from the 1960's are better predictors of trees, indicating that over time many residents of that area have come to value lawns more highly in their landscapes than trees (Boone, et. al, 2009). A related study surveyed current residents of the Baltimore area and found that many expressed negative views of trees related to management, health, and pest concerns (Battaglia, et. al, 2014).

The results presented in this section clearly indicate that being considered an environmentalist or having pro-environmental beliefs does not necessarily translate into behavior that results in positive environmental outcomes. As well, education alone may also not effect behavior change, as there are other perceived barriers that influence the actions of individuals. However, outreach is the first step in discovering whether or not barriers to change exist; to effectively educate the public determining what environmental knowledge gaps exist in the target population is crucial.

Lack of Environmental Knowledge Regarding Local Water Quality Issues

Very little research has been undertaken to determine what knowledge the general public does or does not possess regarding water quality issues in their local area. As previously discussed, densely populated urban areas often contribute significantly to local and national water pollution. In a number of urban areas, storm sewer systems drain directly into local lakes, stream, or rivers, but residents of these areas may not be aware of this fact. A survey conducted in communities the Twin Cities Metro area examined influences on residential turfgrass fertilization and found that only 44% of respondents were able to correctly answer that storm water in their area was not treated (Martini, et. al, 2013). A focus group study of other Twin Cities area communities noted that

respondents only infrequently mentioned connections between their yards and local waterways via the storm sewer system when asked to discuss the relationship between their property and the urban ecosystem. In other geographical regions, similar or even more notable results have emerged; in the Tualatin Watershed near Portland, Oregon, only 15% of participants surveyed were able to accurately state that water going into the storm sewer system goes directly into a nearby stream (Nielson and Smith, 2005).

Educational Methods for Imparting Environmental Knowledge

Environmental education programs generally improve environmental knowledge, attitudes, and behaviors (Hostetler et. al, 2008), but public outreach campaigns must take into account many factors when trying to determine the best methodology to use. As previously noted while discussing the Hughes, et al., article (2010), it is important to first understand existing knowledge gaps so that the type of information disseminated can be focused and not superfluous. It is also essential to determine what demographic or lifestyle characteristic groups those with a lack of knowledge belong to, as well as with what method they might best be reached. Often, the communities where urban environmental programs are the most successful are ones with the least need, as discovered by Locke and Grove (2014). They found that a reduced cost tree-planting program in Washington, DC

and Baltimore, Maryland was most effective in affluent neighborhoods with existing tree canopy. Finally, education alone is not particularly helpful in improving environmental issues, such as nutrient pollution, if individual behavior change does not actually occur, as shown in the study conducted by Hughes, et. al, (2010).

As homeowners who apply large amounts of inputs to their lawns or undertake other harmful management practices likely have a disproportionally negative effect on the environment, it makes sense to focus on these groups of people when conducting outreach (Baker, et. al, 2008). Therefore, demographic characterization of homeowners who have disproportionately negative environmental impacts is an important step, and some research has been done that specifically addresses this issue. For instance, income and education are often positively associated with higher lawn care inputs such as fertilizers and chemicals (Robbins, et. al, 2001, and Osmond and Hardy, 2004). Additionally, higher lawn care expenditures are significantly predicted by socioeconomic status and lifestyle factors such as median house value and house age (Zhou, et. al, 2009). Blaine et. al, (2010) surveyed homeowners in Ohio, and found that higher income and living in urban and suburban areas were predictors of whether or not an individual applied chemicals to their lawns. A study conducted in Baltimore, Maryland found that belonging to a homeowner's association (HOA) was related to higher fertilizer application rates (Fraser, et. al, 2013). Generally, the available data seems to show that those with higher input lawns tend to have a higher

socioeconomic status, be better educated, have newer homes, and may belong to a HOA.

The dissemination of information to the public is a complex endeavor that can have variable results, in both the amount of information that the target audience receives, as well as whether or not they actually change their behavior upon receiving education. There seems to be general agreement that one of the best ways to actually see behavior change is through adult educational programs (such as Master Gardener training programs) that promote and provide information best management practices (BPMs) (Borisova, et. al, 2012, Herringshaw, et. al, 2010, Martin, et. al, 2011). Specifically in regard to water quality BPMs, it has been found that knowledge of the BPMs themselves is the best predictor of their use (Brehm, et. al, 2012). Other successful educational efforts have included the use of neighborhood associations, local government entities, environmental organizations, and news outlets (Martin, et. al, 2011, Monroe, et. al, 2013). As a complementary aspect to these programs, information also disseminates in a less intentional manner, as individuals pass knowledge to friends, family, or neighbors through unstructured conversations. Martini, et. al, (2014) found that 34% of surveyed residents in the Minneapolis-St. Paul metropolitan area shared information with their neighbors. Any environmental outreach effort should take into account the fact that "teaching the teachers" is an effective strategy to use, considering that individuals who participate in

educational programs will not only be more likely to change their own behavior, but also to pass on information to their neighbors, family, and friends.

Conclusion

Nutrient pollution in urban watersheds, including the Minneapolis-St. Paul Metropolitan area, is a serious problem that will not be solved until homeowners recognize the effect of their yard and lawn maintenance practices have on the broader environment and change behavior accordingly. As there are diverse sets of factors that influence environmental decision-making, this will be a challenging endeavor, but not an impossible one. Using the large breadth of research already available on this topic, it is possible to educate the public by discovering what knowledge gaps exist in a specific region, and then disseminating the correct information in various educational formats to determine what will ultimately change behavior. This step alone may not encourage behavior change among all members of the target audience, but it will open the door to further research efforts to discover the barriers to change among those whose behaviors remain the same despite education.

Chapter 2

The relationship between lawn maintenance practices and water pathway perceptions among residents of the Minneapolis-St. Paul Metropolitan area

Summary

Phosphorus and nitrogen pollution of water bodies in urban areas is a widespread problem in the United States, caused partially by an increase in impervious surfaces and a simultaneous reduction in vegetative cover. Landscape management practices undertaken by residential homeowners in urban environments also contribute to water pollution, but certain beneficial actions can be taken to reduce nutrient losses from these spaces. While many different factors affect environmental decision-making, public education on local environmental issues and best yard management practices may be able to help create behavioral change. The objectives of this study were to conduct surveys in 2014 and 2015 among residents of the Minneapolis-St. Paul Metropolitan area to discover urban water pathway knowledge gaps and assess the effectiveness of educational methods on behavior change. Of those surveyed, 31.8% of participants who had

misconceptions about water pathways were likely to do some detrimental lawn and yard maintenance practices more often than those without misconceptions. The 2014 survey found that educational video was effective in encouraging some participants to sweep grass clippings, search for fine fescue seed, and reduce watering. Furthermore, the 2015 survey found that reading information rather than watching a video was more effective in influencing an individual's intent to undertake beneficial yard maintenance behaviors. These results show that public education on local water pathways can be an important component of any successful future water quality improvement campaign in the Minneapolis-St. Paul Metropolitan area.

Introduction

Urban landscapes can have significant negative impacts on the surrounding watershed, particularly from nutrient pollution. Large amounts of impervious surfaces and a reduction in vegetative groundcover can decrease soil infiltration and increase storm water flow volumes (Paul and Meyer, 2001, Wissmar, et. al, 2004, and Sahoo et. al, 2013), creating urban hydrological systems that are very different from their natural counterparts (Steele, et. al, 2010). A study conducted in the Twin Cities Metropolitan area found that percent impervious surface cover was the factor most positively correlated with runoff

water volume, after taking into account rainfall totals and geographical area. This is due to the fact that impervious surfaces do not allow water to infiltrate directly into the soil; rather it runs directly into storm sewer systems (Brezonik and Stadelmann, 2001). Greater quantities of runoff water can transport higher amounts of phosphorus and nitrogen from land (Groffman, et. al, 2004, Bell and Moss, 2008, and Carey, et. al, 2012), and estimates have put typical nutrient concentrations in urban storm water in the United States at 2.0 mg L^{-1} total nitrogen and .26 mg L^{-1} total phosphorus (Schueler, 2003). A recent study conducted of the Twin Cities-Mississippi River (TCMR) watershed and other nearby watersheds showed that 28% (90,718.5 kilograms per year) of total phosphorus and 33% (531,610 kilograms per year) of total nitrogen in the lower Mississippi River came from the TCMR watershed (Kloiber, 2006). High levels of nutrient loading can result in eutrophication in nearby water bodies (Conley, et. al, 2009) as well as coastal regions far from the original source of pollution (Howarth, et. al, 2002). Algae blooms often caused by eutrophication can produce toxins, increase turbidity, and reduce oxygen levels creating poor water quality that can be harmful to indigenous plant and animal life as well as reduce recreational and economic opportunities for people (van den Bergh, et. al, 2002 and Backer, et. al, 2010).

Factors other than impervious surfaces contribute to phosphorus and nitrogen transport from residential landscapes (Fissore, et. al, 2011). Management practices used on lawns, gardens, and other vegetative cover can result in

fertilizer, organic matter, and soil washing out of yards and into storm sewer systems, which in the Twin Cities run directly into local bodies of water (Carey, et. al, 2010). As lawns are a prominent component of managed landscapes and often thought of as high-input landscaping choices, they are frequently viewed as the main culprit in residential contributions to nutrient pollution (Robbins and Birkenholtz, 2003). However, multiple studies have shown that perennial woody and herbaceous plantings often have similar or more nutrient losses as compared to turfgrass areas (Erickson, et. al, 2001, Erickson, et. al, 2005, Erickson et. al, 2008, Steinke et. al, 2009, and Pannkuk, et. al, 2011, Spence, et. al, 2012). Annual plantings, such as vegetable gardens and green roofs have also been shown to have high phosphorus and nitrogen losses (Predotova, 2011, Malcolm, et. al, 2014, Whittinghill et. al, 2014). In addition, inappropriate grass species use can require high inputs of fertilizer, pesticides, and water in situations where low input turfgrass species are appropriate; for example, planting non-saline tolerant grasses in soils with high salinity levels or shade-intolerant grasses in shady areas. Therefore, when attempting to reduce runoff from managed landscapes, it is important to look at specific site conditions and management practices used, such as fertilizer or watering frequency, rather than focus on a particular type of vegetative cover.

Certain maintenance practices, such as correct fertilizer applications, reducing irrigation, and appropriate species selection will help prevent excess nutrient losses from yards and gardens (Bell and Moss, 2008, Carey, et. al, 2010).

Multiple studies have shown that using grass species not suited for a particular area can result in stands of turf that have less shoot density and leave more bare soil exposed (Watkins, et. al, 2010, Friell, et. al, 2012, Gardener and Goss, 2013). Bierman et. al (2010), found that applying nitrogen fertilizer without phosphorus fertilizer resulted in less phosphorus losses from Kentucky bluegrass turf areas than applying no fertilizer at all, implying that nitrogen fertilizer encourages dense turf and thus reduces soil erosion. In addition, Easton and Petrovic (2004) found that a reduction in volume of water runoff from turf areas is related to shoot density. These conclusions are worth applying to non-turf perennial plantings, especially considering the results from previously discussed studies showing high nutrient losses from these areas. However, homeowners do not always chose to perform beneficial management practices, and those who manage their landscapes inappropriately may have a disproportionally negative environmental impact (Baker, et. al, 2008).

The concept of disproportionality illustrates the need to encourage behavior change among homeowners, but convincing individuals to alter their lawn and yard maintenance practices can be difficult. Environmental decision-making is influenced by numerous factors. Both the New Environmental Paradigm scale and the New Ecological Paradigm scale have been used over time to measure an individual's pro-environmental orientation (Dunlap, et. al, 2000). Studies utilizing this and other methodology have had variable results, with some

determining that anthropocentric worldviews were related to a preference for higher-input landscaping (Yabiku et. al, 2008 and Larson et. al, 2010) while others have concluded that pro-environmental characteristics are actually associated with more frequent applications of inputs (Templeton et. al, 1999, Robbins et. al, 2001). More frequent applications of inputs is not necessarily a harmful management practice, as it is sometimes beneficial to apply certain inputs in smaller amounts more often each season (Christians, 2011). For example, applying smaller quantities of fertilizer multiple times a season could potentially reduce nutrient runoff.

Lack of knowledge regarding local hydrological pathways may also contribute to detrimental environmental decision-making. Two studies conducted in the TCMA, MN and Tualatin, OR found that a majority of residents surveyed could not correctly identify where water went after entering the storm sewer system; in both communities storm water goes directly into nearby waterways without first going to a treatment plant (Nielson and Smith, 2005 and Martini, et. al, 2013). Recent research has shown that the likelihood a homeowner would do water quality best management practices (BMPs) was most strongly correlated with their knowledge of the BMPs (Brehm, et. al, 2013). Further studies have found that environmental education programs generally improve environmental knowledge, attitudes, and behaviors (Hostetler et. al, 2008). Education may therefore be necessary in changing environmental behavior, but public outreach attempts are not always successful. Hughes, et. al. (2010) conducted research in

Sydney, Australia that used the theory of planned behavior (Azjen, 1991) to discover why residents of the area were not responding positively to a water quality outreach campaign. In this study, it was determined that the public had successfully been educated about water quality issues, but had not been given information about which products they could purchase that would be effective in helping them reduce water pollution. In this case, education successfully changed some beliefs but did not address others, creating a barrier to behavior change.

In an attempt to move towards a reduction of non-point source nutrient pollution in the Twin Cities, the first objective of this study was to assess the relationship between water pathway knowledge and frequency of lawn maintenance practices among residents of the Minneapolis-St. Paul Metropolitan area. The second objective was to assess whether or not a video or written educational method would result in behavior change or intent to change behavior among survey participants.

Materials and Methods

Between 2013 and 2015, multiple surveys were conducted. The objective of the first survey was to learn about the habits of consumers of turfgrass products

and also about how they would like to receive their information (needs assessment survey). The goals of the 2014 and 2015 lawn and yard maintenance surveys were to assess the effectiveness of either video or written educational methods on the frequency of lawn and yard maintenance practices, and determine if a relationship exists between an individual's urban water pathway knowledge and their frequency of maintenance practices.

Needs Assessment Survey

In 2013 a needs assessment survey was conducted using the survey tool Qualtrics. The survey was accessed between January 1st and March 31st, 2013. Twenty two questions were developed to determine the habits of consumers of turfgrass products and how they like to receive information. A link advertising the survey was posted on the University of Minnesota's Turfgrass Extension website (turf.umn.edu), and in the March edition of the University of Minnesota Extension's online blog *Yard and Garden News*. Further, email advertising was sent out to all members of the University of Minnesota Alumni Association. As an incentive, those who completed the survey were entered into drawings for two iPad Minis.

2014 Lawn Maintenance Survey

An online survey was conducted in 2014 using the survey tool Qualtrics. A total of 26 survey questions were chosen and formatted (Appendix A). An educational video was created and included in the survey to inform participants about the effect their lawn maintenance practices have on water quality in the Twin Cities Metropolitan Area (TCMA). The choice to use an educational video in an online format was made because of information garnered from the needs assessment survey (Table 1).

Participants were then recruited through websites and Facebook pages of city governments in the TCMA, neighborhood associations with an online presence in the cities of Minneapolis and St. Paul, as well as through general advertisement via the website Craigslist.com. The same recruitment statement was used in every advertisement and included a direct link to the survey. Those who clicked on the survey link were first directed to an introductory page where their informed consent was obtained. Participants were able to access the survey online between June 22nd, 2014 and July 25th, 2014. Upon answering all survey questions participants were able to indicate whether or not they would be willing to participate in a follow-up survey. Additionally, at this point participants could voluntarily provide their email addresses in order to be entered into a drawing for one of three $50 gift cards.

Follow-up Lawn Maintenance Survey

For participants in the initial lawn maintenance survey and following consent, a three question follow-up survey was conducted online exactly two weeks after their completion of the first survey using the survey tool Qualtrics (Appendix B). Participants were able to access the follow-up survey website between July 14th, 2014 and August 18th, 2014. Upon completion of this survey, participants could again provide their email addresses in order to be entered for a second time into a $50 gift card drawing. Participants were specifically asked how often they usually did six different beneficial lawn maintenance practices. These answers were then compared to the responses of participants in the first Lawn Maintenance Survey.

2015 Yard Maintenance Survey

Using the online survey tool Qualtrics, as survey was conducted between March 20th and April 28, 2015 of residents of five different postal routes in the city of Minneapolis. The postal routes were selected based on their proximity to Lake Harriet (44°55′17″N 93°18′19″W) or Lake Nokomis (44°54′34″N 93°14′32″W) in order to compare responses from two different neighborhoods that included a major body of water, as well as to allow accurate calculation of a response rate. In mid-March of 2015, invitation letters were mailed to each residence within the postal route. Half of the invitation letters directed respondents to an online survey with an educational video on best yard

maintenance practices (Appendix C), and the other half directed respondents to an online survey with a pamphlet containing the same information in written form (Appendix D). These letters were randomized by hand before being delivered to the post office. Two weeks after the invitations were mailed, door hangers with a survey reminder message printed on them were hand-delivered to each residence within the five selected postal routes.

The survey was comprised of 26 questions that were chosen with the assistance of horticulture extension professionals and environmental sociologists at the University of Minnesota, and were formatted in accordance with best survey design practices. The questions fell into five categories: pre-education yard maintenance behaviors, water pathway knowledge, effect of yard maintenance on others, post-education intent to do yard maintenance behaviors, and demographics. Before answering the questions, prospective survey respondents gave their consent to participate.

Statistical Analysis

Analysis for all four surveys was performed using the software programs "R" and "Excel". The data from the Needs Assessment Survey question was analyzed using a two-sample test for differences in proportion with continuity correction, as well as Tukey's honest significant difference test. Quantitative data from the 2014 and 2015 surveys was also analyzed using a two-sample test for significant differences in proportions with continuity correction as well as a one-

sample t-test, and qualitative data was analyzed using Chi-squared goodness of fit tests. The data for qualitative questions was grouped in order to find the point at which the greatest significant differences among answers occurred between the two groups being compared.

Results and Discussion

Needs Assessment Survey

One question from this survey was picked for analysis based on its particular relevance to how consumers prefer to receive information on turfgrass, and 1,086 respondents chose to answer this question. Each participant was asked: "If you wanted to learn more information about a lawn care/ turfgrass topic, how would you prefer to learn about it? Rank the top 5 with 1 being your top choice." The possible answers were: social media, a 3-5 minute video, watching a demonstration, completing an online course, taking part in a webinar, listening to an expert lecture, working on a hands-on activity in a small group, reading, browsing a website, watching or listening to a podcast, talking to a friend or neighbor, and watching HGTV or a yard and gardening television show.

Respondents most often placed the website, lecture, reading, video, and demonstration answers in their top five choices. Website fell into the top five a significantly great proportion of the time. Further analysis found that of the most

common top-five answers, website was ranked significantly higher than all options except reading. Lecture, 3-5 minute video, and reading were not significantly different than each other, but all ranked higher than demonstration (Table 1).

Table 1: The frequency of appearance and the average ranking of the top five most preferred ways to receive information about turfgrass or lawn care.

Answer	Number of appearances in respondents top five choices	Average ranking within respondents top five choices
Website	756	3.51a
Reading	686	3.70ab
Lecture	696	3.74bc
Video	654	3.84bc

Demonstration	609	4.18

Significant differences within columns are the $\alpha = 0.05$ confidence level. N = 1,086. Numbers followed by the same letter indicate no significant differences between average rankings. In the "average ranking" column, 1 corresponds to the respondent's first choice, 2 to their second choice, 3 to their third choice, 4 to their fourth choice and 5 to their fifth choice.

Based on these results, participants in this survey would most often prefer to go to a website when trying to learn more about turfgrass or lawn care. To have the greatest appeal to website visitors, information would ideally be presented in the form of reading material, a 3-5 minute video, an expert lecture, or a format that incorporated all three of these options.

2014 Lawn Maintenance Survey

This survey had 359 completed responses, 303 of which were by individuals that identified themselves as primary home lawn caretakers. Those who did not identify as such were not included in the results, as their knowledge of the management practices used on their lawns was likely to be incomplete. The response rate for this survey could not be calculated, as participants were recruited from websites with an unknown number of visitors, rather than from a quantifiable population.

Demographically, the survey respondents differed in certain ways from the overall population of the Minneapolis-St. Paul Metropolitan area (Austrian, et. al, 2011). Survey respondents were more likely to be Caucasian, have a higher household income, and be better educated than average Minneapolis-St. Paul Metropolitan area residents. These differences may mean that the results of this survey will not be able to be generalized to a larger population.

Each participant was asked to categorize and rank five possible locations for water to travel after leaving their yards, and there were three possible ways in which this question could be answered incorrectly. Of the 303 primary home lawn caretakers who completed the survey, 31.8% fell into Group N, which is characterized by having one of three misconceptions about where water goes when it leaves the yard of the respondent. The remainder, 68.2%, did not have one of these misconceptions (Group Y). Of Group N, 45% thought that runoff water enters the storm sewer system and never reaches a treatment plant or local waterway, 22% thought runoff water reaches a treatment plant and never a local waterway, and 33% thought runoff water reaches a treatment plant before a local waterway. In the TCMA, if runoff water enters a storm sewer system it will reach a local waterway before a water treatment plant.

Participants were asked about the frequency of their lawn maintenance practices, specifically regarding frequency of mowing, watering, fertilizing, and the application of pesticides. Members of Group N performed all four lawn

maintenance practices more often than Members of Group Y. These differences were most significant when considering the frequency of mowing, pesticide use, and watering (Table 2).

Table 2: A comparison of the frequency of maintenance practices reported by respondents with accurate or inaccurate perceptions of water pathways

Maintenance practice	Group N (Inaccurate)	Group Y (Accurate)	P-Value
Mowing	Once per week or more	Every two weeks	0.012**
Fertilizing	Two times per	One time per year	0.049**

	year or more	or less	
Watering	Every other week or more	Never or when necessary	0.028**
Pesticide Use	Less than one time per year	Never	0.026**

P values denoted by ** correspond to $\alpha = 0.05$. N = 303. P values indicate differences between Group Y and Group N in frequency of the corresponding maintenance practice

Members of Group N and Group Y also had significantly different beliefs when asked to choose whether or not their lawn maintenance activities affected external areas or groups. When compared with Group Y, members of Group N less often answered affirmatively when asked if their activities affected the quality of water in local lakes, streams, or rivers. They also answered affirmatively more often when asked the same question about "the environment" and "myself or my family", but these differences were significant only at the $\alpha = 0.10$ level (Table 3).

Table 3: A comparison of beliefs between respondents with inaccurate or accurate perceptions of water pathways regarding the effects of their lawn maintenance practices.

Affected area or	Percentage of	Percentage of	P-value

group	affirmative answers in Group N (Inaccurate)	affirmative answers in Group Y (Accurate)	
My neighbors	81.3	83	0.597
The environment	82.4	89.2	0.066*
Myself and/or my family	90.1	94.3	0.093*
The local drinking water supply	57.1	62.7	0.311
Water in a nearby lake or stream	46.2	83.5	2.863-e11***

P values denoted by *, ** and *** correspond to $\alpha = 0.1$, 0.05 and 0.01, respectively. N=303

Overall, approximately 32% of survey respondents do not have an accurate perception of where water goes when it leaves their yards. Furthermore, many members of the misconception group do not believe that their maintenance activities affect water in nearby lakes or streams, but they perform all lawn maintenance activities more often than the group of respondents that have accurate water pathway perceptions. This could result in members of Group N having a disproportionally negative effect on local water quality. This makes

Group N an important target audience for an outreach campaign regarding the true route of water through their communities and the contribution lawn care practices to nutrient pollution.

Follow-Up Lawn Maintenance Survey

The follow-up survey had a total of 191 completed responses, all of which were primary home lawn caretakers. The participants were asked six questions regarding how often they had done certain beneficial lawn maintenance practices over the past three weeks, and these were compared directly to the answers of the same respondent during the first survey. Among those who initially said they did not do a particular beneficial practice, 18.6% had swept grass clippings, 30.6% had looked for fine fescue seed, and 39.4% had reduced watering during the three weeks previous to completing the follow-up survey. The other three practices saw no or little change among respondents. One reason for this could be that some lawn maintenance practices are not typically done during the middle of the summer. For instance, homeowners often only fertilize their lawns during the spring and fall. Therefore, this may have limited the number of individuals who were able to say they had done a practice during the three-week period, even though they may have intended to do it in the future.

2015 Yard Maintenance Survey

A total of 1550 survey invitation letters were delivered to residents of single family homes or small multi-unit buildings within the five postal routes specified in the previous section. Residents of large apartment complexes or assisted living facilities were not included in the count of letters delivered as they could not be expected to be familiar with the grounds keeping practices of their buildings. In the neighborhoods closer to Lake Nokomis, 115 people completed surveys, whereas in the neighborhoods closer to Lake Harriet, 169 people completed surveys. The remaining 19 chose to not specify what neighborhood they resided in. Since the total number of completed surveys was 303, the response rate was calculated as 19.5%.

In the first section of the survey, participants were asked questions about the frequency with which they did common yard maintenance practices, including mowing, watering, fertilizing, pesticide application, and how much time they generally spent per week on these activities. In the second section, participants were given five options for where water could go after running out of their yard and asked to rank in order the places they thought water would go. Based on their response to this question, each respondent was placed into one of two groups: those with and without accurate perceptions of water pathways. The group with inaccurate perceptions was comprised of 96 respondents, or 31.7%, and the group with accurate perceptions made up the remaining 68.3% of respondents, or 207 people. As illustrated in Table 4, using Chi-Squared Goodness of Fit tests it was found that the frequency of mowing and fertilizer applications were significantly

different between the two groups, with Group N (inaccurate perceptions) mowing and fertilizing more frequently that Group Y (accurate perceptions). Neither the frequency of watering or pesticide applications was significantly different between the two groups. There were no statistical differences across the two groups related to demographics, this includes information about age, gender, race, income, education, neighborhood of residence, and distance of residence from a body of water.

Table 4: A comparison of the frequency of maintenance practices reported by respondents with inaccurate or accurate perceptions of water pathways

Maintenance practice	Group N (Inaccurate)	Group Y (Accurate)	P-value
Mowing	Once per week or more	Every two weeks or less	0.09*
Fertilizing	Three times per year or more	Two times per year or less	0.031**
Watering	Once per week or more	Every other week or less	0.208
Pesticides	Once time per year or more	Every other year or less	0.34

P values denoted by *, and ** correspond to $\alpha = 0.1$ and 0.05, respectively. N = 303. P values indicate differences between Group Y and Group N in frequency of the corresponding maintenance practice

The third section of the survey asked respondents to choose from a list what or whom they thought their yard maintenance activities affected. Group N members were significantly less likely than members of Group Y to believe that their maintenance activities affected themselves, others, aspects of the surrounding environment. This was particularly noticeable in regard to water in a nearby lake or stream (Table 5).

Table 5: A comparison of beliefs between respondents with accurate or inaccurate perceptions of water pathways regarding the effects of their lawn maintenance practices.

Affected area or group	Percentage of affirmative answers among Group N (Inaccurate)	Percentage of affirmative answers among Group Y (Accurate)	P-value
My neighbors	53.2	75.8	0.00015***
The environment	87	94	0.066*
Myself and/or my family	79.7	93	0.0011***
The local drinking water supply	47.8	63.2	0.017**
Water in a nearby lake or stream	58.5	89.3	1.77-e09***

P values denoted by *, ** and *** correspond to $\alpha = 0.1$, 0.05, and 0.01, respectively. N = 303

Finally, participants were asked to indicate how often they did certain beneficial yard maintenance practices before watching an educational video or reading a pamphlet with the same information as the video. Both interventions described current issues with nutrient pollution in the Minneapolis-St. Paul

Metropolitan area, how yard maintenance practices contribute to water pollution problems, and five ways in which homeowners can change their behavior to help reduce these problems. After participating in the educational intervention, respondents were asked how often they intended to do beneficial yard maintenance practices in the future. They had the option of giving the following responses for each practice: always, most of the time, half the time, sometimes, or never.

Each intervention group consisted of 142 individuals as some respondents did not answer enough of the before or after questions to be included in the data analysis for this section. Using a student's t-test it was shown that both groups responded to either intervention by indicating that they planned to do the specific behavior more often than they had in the past (Table 6). The exception to this was that after the intervention, the reading group was significantly less likely to say they would reduce watering. However, this change is not particularly concerning, as both groups said that they almost always reduced watering in response to rainfall even before the educational intervention. In terms of which group responded more positively to watching the video or reading, the intervention was significantly more effective on the reading group than it was on the video group. Following directions on fertilizer bags was the only behavior where the change between the two groups was not significantly different. There were no significant differences between Group N and Group Y in terms intent to change behavior. The limitations of measuring intent to behave rather than actual behavior change

is that it is not possible to draw conclusions about whether or not study participants will follow through with making their intended changes.

Table 6: A comparison of the average change in intent to behave between the video and reading intervention groups.

Behavior	Video Group Average[+]			Reading Group Average[+]			Difference in Change
	Before	After	Dif.	Before	After	Dif.	
Sweep fertilizer	2.76	1.85	0.90***	2.91	1.26	1.65***	0.001***
Follow directions	1.63	1.16	0.46***	1.73	1.32	0.42***	NS
Fill in bare soil	1.88	1.38	0.50***	1.85	1.08	.77***	0.029**
Reduce watering	1.25	1.09	0.15***	1.16	1.31	-0.15**	0.0004***
Keep organic material out of street	1.55	1.13	0.41***	1.64	1.00	0.64***	0.009***

P values denoted by *, ** and *** correspond to $\alpha = 0.1$, 0.05, and 0.01, respectively. N = 303.

[+] To indicate scale, the answer "always" corresponds to the number 1 and the answer "never" corresponds to the number 5.

WWhile using both an educational video and a written pamphlet will help change an individual's intent to behave regarding their yard maintenance practices, we conclude that providing the information in written form may be more effective. We can hypothesize that a document gives the reader the opportunity to go back and re-read the information multiple times, whereas an individual watching a video to revisit a section they wanted to view again is not as easy. However, previous studies have concluded that written brochures are not always effective at communicating information about environmental issues (George and Crooks, 2006, Oxarart and Monroe, 2012). Indeed, the previously discussed Needs Assessment Survey found that participants preferred to receive their information about lawn care via video. Additionally, other studies indicate that environmental education information is most effectively disseminated via multiple strategies (Monroe, et. al, 2013) and using two-way, interactive methods (Toman, et. al, 2006). Therefore, the decision about what types of educational tools to use as part of a broad public outreach campaign must be based on a multitude of factors, as different people will be variously receptive to different information dissemination methodologies.

Conclusion

Large areas of impervious surfaces and a loss of vegetative groundcover create unique hydrological systems in urban watersheds that increase the amount of storm water runoff into local bodies of water. Landscape maintenance practices on private property can contribute to nutrient pollution, but many homeowners are not aware of the connection between their yards and local water systems. This study found that a large proportion of TCMA residents had inaccurate perceptions of urban water pathways and did some landscape maintenance practices more frequently than those who had accurate perceptions. While environmental decision-making is influenced by many different factors, education may encourage the public to do beneficial yard maintenance behaviors more often. In particular, surveys conducted in 2014 showed that this might be somewhat effective in regard to a reduction in watering and an effort to utilize fine fescue, a low-maintenance turfgrass species. Additionally, surveys conducted in 2015 found that education via a written pamphlet was more effective at changing intent to behave among participants than an educational video. However, in order to design the most effective outreach campaign, future research must determine what type of information dissemination methods best cause actual behavior change.

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Appendix A: Lawn Maintenance Survey

Thank you for agreeing to complete this survey!
You are being invited to participate in this study because you are a resident of the Twin Cities Metro area. If you do decide to participate, please click the "Continue" button at the bottom of the page when you have finished reading this section.

Purpose
This study is being conducted as part of graduate student thesis work and its purpose is to collect information about lawn maintenance practices used by residents in the Twin Cities Metro area. The results of this study will be used to help inform the direction of lawn care outreach and education efforts.

Survey Structure
It should take approximately 10 minutes to answer all of the following survey questions and watch a short educational video. In addition, if you agree, you will be contacted in three weeks via email to complete a 1-2 minute follow-up survey.

Risks
There are no risks associated with participating in this study

Confidentiality
Every effort will be made to keep any information collected confidential. In order to keep information about you safe, all names and other identifying information will be stored on a private and secure University of Minnesota drive. Only project investigators will have access to this drive. This information will not be included in the final thesis that results from this research project.

Payment
Participants will not be paid upon completion of this survey. However, each person will have the opportunity provide their name and contact information to be included in a drawing for one of three possible $50.00 gift cards.

Your Rights as a Research Participant
Participating in this study is entirely voluntary at all times. You can choose to not participate at all or to leave the study at any point. If you decide that you no longer want to take part in the study, the information already obtained through

your participation will not be included in the data analysis and final thesis for this study.

Questions or Concerns?
If you have questions about this study you may contact Madeline Leslie at lesl0034@umn.edu. You may also contact the researcher's faculty advisor, Dr. Brian Horgan, at bphorgan@umn.edu.

Q1 Are you the primary caretaker of your home lawn?

- ❍ Yes
- ❍ No

Q2 If you answered no to the previous question, who is the primary caretaker of your lawn?

- ❍ Other family member
- ❍ A lawn service company
- ❍ A neighborhood association
- ❍ Other _____

Q3 In a professional or volunteer capacity, do you advise others on caring for their home lawn?

- ❍ Yes
- ❍ No

Q4 If you answered yes to the previous question, in what capacity do you advise others?

- ❍ As a Master Gardener
- ❍ An employee of a lawn service or landscaping company
- ❍ A garden center or nursery employee
- ❍ Other (please write your answer in the text box) _____

Q5 What type of grass do you currently have in your home lawn? (check all that apply)

- ❑ Kentucky bluegrass
- ❑ Perennial ryegrass
- ❑ Fine fescue
- ❑ Tall fescue
- ❑ Shade mix
- ❑ Sun mix
- ❑ Other _____
- ❑ I do not know

Q6 My lawn is approximately:

- ❍ Less than 1/8 acre
- ❍ City lot (1/8 acre)
- ❍ 1/4 acre
- ❍ 1/2 acre
- ❍ 1 acre
- ❍ More than 1 acre
- ❍ I do not know

Q7 On average, how often do you mow your lawn?

- ❍ More than once per week
- ❍ Once per week
- ❍ Once every two weeks
- ❍ Once a month
- ❍ Less than once a month
- ❍ When it is needed (please estimate how many times per year this is) _____
- ❍ Never

Q8 What type of equipment do you most often use to mow your lawn?

- ❍ Gas-powered mower
- ❍ Electric mower
- ❍ Non-gas push mower
- ❍ I do not mow my lawn

Q9 On average, how often do you fertilize your lawn per year?

- ❍ Never
- ❍ Less than one time per year
- ❍ 1 time per year
- ❍ 2 times per year
- ❍ 3 times per year
- ❍ 4 times per year
- ❍ 5 times per year
- ❍ Less than 5 times per year

Q10 On average, how often do you water your lawn?

- ❍ Never
- ❍ When it looks stressed
- ❍ Less than every other week
- ❍ Every other week
- ❍ Once per week
- ❍ Twice per week
- ❍ Three times a week
- ❍ Every day

Q11 On average, how often do you apply pesticides (for weed, insect, or disease control) to your lawn?

- ❍ Never
- ❍ Less than one time per year
- ❍ 1 time per year
- ❍ 2 times per year
- ❍ 3 times per year
- ❍ 4 times per year
- ❍ 5 times per year
- ❍ More than 5 times per year

Q12 Do you consider your lawn a low-input lawn?

- ❍ Yes
- ❍ No

Q13 Please drag and drop into the boxes on the right, the places that water goes after it runs off your lawn, in order from first to last.

Where water goes after running of your lawn	Water does not go here after running off my lawn
_____ To a water treatment plant	_____ To a water treatment plant
_____ Into the street	_____ Into the street
_____ Into a local lake, stream, or river	_____ Into a local lake, stream, or river
_____ Underground	_____ Underground
_____ Into a storm sewer	_____ Into a storm sewer

Q14 My lawn maintenance activities affect (check all that apply):

- ❑ My neighbors
- ❑ The environment
- ❑ Myself and/or my family
- ❑ The local drinking water supply
- ❑ Water in a nearby lake or stream

Q15 Indicate how much you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Agree	Strongly Agree
I am concerned about the water quality of lakes and streams in my community	❍	❍	❍	❍	❍	❍	❍
The way I maintain my lawn positively affects the environment	❍	❍	❍	❍	❍	❍	❍
Maintaining my lawn helps to cause algae blooms in nearby lakes	❍	❍	❍	❍	❍	❍	❍
Organic fertilizer is better for the environment	❍	❍	❍	❍	❍	❍	❍
It is legal to apply fertilizer with phosphorus in it to my lawn under all circumstances.	❍	❍	❍	❍	❍	❍	❍

Q16 When maintaining your lawn, indicate how often you do the following things:

	All of the time	Most of the time	Half the time	Sometimes	Never	No need to undertake this activity
Sweep excess fertilizer off sidewalks and driveways.	❍	❍	❍	❍	❍	❍
Follow directions on fertlizer bags	❍	❍	❍	❍	❍	❍
Repair bare patches in lawn by seeding or other method	❍	❍	❍	❍	❍	❍
Reduce or eliminate watering when rain has fallen	❍	❍	❍	❍	❍	❍
Look for low-input or fine fescue grasses when purchasing seed	❍	❍	❍	❍	❍	❍
Prevent your grass clippings from	❍	❍	❍	❍	❍	❍

getting in the street						

Q17 Please watch the following video. It is very important that you watch the entire video.

Q18 Were you able to watch this video?

- ❍ Yes
- ❍ No

Q19 What was the main topic being addressed in the video?

- ❍ The best time of year to seed a new lawn
- ❍ The best lakes for fishing in the Twin Cities
- ❍ The ways in which lawns can contribute to water pollution in the Twin Cities
- ❍ The history of water pollution in the Twin Cities

Q20 Please indicate how many lawn care tips in total were provided in the video:

- ❍ 3
- ❍ 4
- ❍ 5
- ❍ There were no lawn care tips provided

Q21 Please provide the following demographic information

Q21a Do you consider yourself
- ❍ Caucasian
- ❍ Hispanic
- ❍ African American
- ❍ Asian or Pacific Islander
- ❍ Native American
- ❍ Other _____

Q21b What is your age?

Q21c What is your total household income?
- ❍ Less than $30,000
- ❍ $30,000 - $49,000
- ❍ $50,000 - $69,000
- ❍ $70,000 - $99,999
- ❍ $100,000 - $149,000
- ❍ $150,000 or more

Q21d Please indicate your gender:

Q21e What is your highest level of education? Please select one.
- ❍ High school diploma
- ❍ Some College
- ❍ Associate's Degree
- ❍ Bachelor's Degree
- ❍ Master's Degree
- ❍ Doctoral Degree

Q21f Please enter the zip code that your home is located in:

Q22 Please enter your email address and phone number in order to be entered into a drawing for a $50 gift card to Amazon.com or Target. Winners of this drawing will be notified by email and/or phone by August 15st, 2014. Your information will not be shared with any other party.

Email address

Phone number

Q23

- ❑ Do not contact me for a one minute follow-up questionnaire in two to three weeks (participation in the follow-up questionnaire will result in a second entry of your name in the gift card drawing)

Q24 Do you have any additional comments?

Appendix B

Lawn Follow-up Survey

Thank you for agreeing to complete this short follow-up survey! You are being invited to participate in this follow-up survey because you completed a previous survey on lawn maintenance activities. To participate, please click the "Continue" button at the bottom of the page when you have finished reading this section.

Purpose
This study is being conducted as part of graduate student thesis work and its purpose is to collect information about lawn maintenance practices used by residents in the Twin Cities Metro area. The results of this study will be used to help inform the direction of lawn care outreach and education efforts.

Survey Structure
It should take approximately 1-2 minutes to answer the following survey questions.

Risks
There are no risks associated with participating in this study.

Confidentiality
Every effort will be made to keep any information collected confidential. In order to keep information about you safe, all names and other identifying information will be stored on a private and secure University of Minnesota drive. Only project investigators will have access to this drive. This identifying information will not be included in the final thesis that results from this research project.

Payment
Participants will not be paid upon completion of this survey. However, each person will have the opportunity provide their name and contact information to be included a second time in a drawing for one of three possible $50.00 gift cards.

Your Rights as a Research Participant
Participating in this study is entirely voluntary at all times. You can choose to not participate at all or to leave the study at any point. If you decide that you no longer want to take part in the study, the information already obtained through your participation will not be included in the data analysis and final thesis for this study.

Questions or Concerns?
If you have questions about this study you may contact Madeline Leslie at lesl0034@umn.edu. You may also contact the researcher's faculty advisor, Dr. Brian Horgan, at bphorgan@umn.edu.

Q1 During the past three weeks, have you done any of the following while maintaining your lawn?

	I have done this activity	I have not done this activity	It was not necessary to do this activity (i.e. you did not fertilize, mow your lawn, etc)
Swept excess fertilizer off sidewalks and driveways.	❍	❍	❍
Followed directions on fertilizer bags.	❍	❍	❍
Repaired bare patches in your lawn by seeding or another method.	❍	❍	❍
Reduced or eliminated watering after rain has fallen.	❍	❍	❍
Looked for low-input or fine fescue grasses when purchasing seed.	❍	❍	❍
Prevented your grass clippings from getting in the street.	❍	❍	❍

Q2 Please provide the same email address you did in the first survey. This is make sure we accurately track demographic information and are also able to enter your name a second time in the gift card drawing.

Q3 Do you have any additional comments?

Appendix C

Yard Care Video Survey

Thank you for agreeing to complete this survey

You are being invited to participate in this study because you are a resident of the city of Minneapolis. If you do decide to participate, please click the "Continue" button at the bottom of the page when you have finished reading this section.

Purpose
This study is being conducted as part of graduate student thesis work and its purpose is to collect information about yard maintenance practices used by residents in the Twin Cities Metro area. The results of this study will be used to help inform the direction of landscaping outreach and education efforts.

Survey Structure
It should take approximately 10-15 minutes to answer all of the following survey questions and watch a short educational video. Before watching the video, you will be able to go back and re-answer any question. After the video, you will not be able to go back and answer any questions.

Risks
There are no risks associated with participating in this study

Confidentiality
Every effort will be made to keep any information collected confidential. In order to keep information about you safe, all names and other identifying information will be stored on a private and secure University of Minnesota drive. Only project investigators will have access to this drive. This information will not be included in the final thesis that results from this research project.

Payment
Participants will not be paid upon completion of this survey.

Your Rights as a Research Participant
Participating in this study is entirely voluntary at all times. You can choose to not participate at all or to leave the study at any point. If you decide that you no longer want to take part in the study, the information already obtained through your participation will not be included in the data analysis and final thesis project for this study.

Questions or Concerns?

If you have questions about this study you may contact Madeline Leslie at lesl0034@umn.edu. You may also contact the researcher's faculty advisor, Dr. Brian Horgan, at bphorgan@umn.edu.

Q2 Are you one of the primary decision makers about yard maintenance choices in your yard? Consider "yard" to be any outdoor space on the property you reside at.

- ❍ Yes
- ❍ No

Q3 The property I reside at is approximately:

- ❍ Less than 1/8 acre
- ❍ City lot (1/8 acre)
- ❍ 1/4 acre
- ❍ 1/2 acre
- ❍ 1 acre
- ❍ More than 1 acre

Q4 Do you have any of the following landscaping features in your yard?

	Yes	No
Lawn	❍	❍
Trees or bushes	❍	❍
Perennial plants (plants die back in the winter, but return the following spring)	❍	❍
Annual plants (plants die back in the winter and do not return the following spring)	❍	❍
Areas that are dominated by plants commonly considered weeds	❍	❍
Areas that are mainly bare dirt with few or no plants	❍	❍
Hardscaping areas, such as brick patios, sidewalks, gravel, etc.	❍	❍
Ponds or other water features	❍	❍

Q5 How far away is the property you reside at from the closest lake, stream, or river?

- ❍ I live directly on a lake, stream, or river
- ❍ Within approximately 1/4 mile
- ❍ Within approximately 1/2 mile
- ❍ Within approximately 1 mile
- ❍ Within approximately 2 miles
- ❍ Greater than approximately 2 miles

Q6 On average, how often do you mow your lawn or other parts of your yard?

- ❍ Never
- ❍ Less than once every two monhts
- ❍ Once every two months
- ❍ Once per month
- ❍ Once every two weeks
- ❍ Once a week
- ❍ More than once a week

Q7 On average, how often do you water any area of your yard?

- ❍ Never
- ❍ Less than every other week
- ❍ Every other week
- ❍ Once per week
- ❍ Twice per week
- ❍ Three times a week
- ❍ Every day

Q8 On average, how many times per year do you apply fertilizer to any area in your yard?

- ❍ Never
- ❍ Every other year or less frequently
- ❍ 1 time per year
- ❍ 2 times per year
- ❍ 3 times per year
- ❍ 4 times per year
- ❍ 5 times per year
- ❍ More than 5 times per year

Q9 On average, how many times per year do you apply pesticides (for weed, insect, or disease control) to any area in your yard?

- ❍ Never
- ❍ Every other year or less frequently
- ❍ 1 time per year
- ❍ 2 times per year
- ❍ 3 times per year
- ❍ 4 times per year
- ❍ 5 times per year
- ❍ More than 5 times per year

Q10 On average, how much time per week do you or another member of your household spend on yard maintenance activities? Consider "activities" to mean any time spent in your yard doing anything similar to the following: mowing, weeding, watering, applying fertilizer or pesticides, pruning, raking, removing plants, putting in new plants, installing any type of hardscaping, etc.

- ❍ No time at all
- ❍ Less than 1 hour
- ❍ 1-2 hours
- ❍ More than 2 hours but less than 5 hours
- ❍ More than 5 hours

Q11 Do you consider your yard to be low-input? Consider inputs to be any of the following: water, fertilizer, pesticides, and time/labor spent on maintenance.

- ❍ Yes
- ❍ No

Q12 Please drag and drop into the boxes on the right, the places that water goes after it runs out of your yard, in order from first to last. If you are not sure where water goes after running out of your yard, please make your best guesses.

Where water goes after running out of your yard	Water does not go here after running out of your yard
_____ To a water treatment plant	_____ To a water treatment plant
_____ Into the street	_____ Into the street
_____ Into a local lake, stream, or river	_____ Into a local lake, stream, or river
_____ Soaks into the ground	_____ Soaks into the ground
_____ Into a storm sewer	_____ Into a storm sewer

Q13 Do your yard maintenance choices affect or not affect any of the following?

	Affect	Do not affect
Your neighbors	❍	❍
The environment	❍	❍
Yourself and/or your family	❍	❍
Your drinking water supply	❍	❍
Water in a nearby lake, stream, or river	❍	❍

Q14 Indicate how much you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Agree	Strongly Agree
I care about the water quality of lakes, streams, and rivers in my community	❍	❍	❍	❍	❍	❍	❍
The way I maintain my yard affects the environment in a positive way	❍	❍	❍	❍	❍	❍	❍
Maintaining my yard helps to cause algae blooms in nearby lakes	❍	❍	❍	❍	❍	❍	❍
Organic fertilizer is better for the environment	❍	❍	❍	❍	❍	❍	❍
It is legal to apply fertilizer with phosphorus in it to my lawn under all circumstances.	❍	❍	❍	❍	❍	❍	❍

Q15 When maintaining your yard, indicate how frequently or infrequently you did the following activities over the past two years: If the statement does not apply to you, do not mark any option.

	Always	Most of the time	Half the time	Sometimes	Never
Sweep fertilizer or compost off sidewalks and driveways.	❍	❍	❍	❍	❍
Follow directions on fertilizer bags.	❍	❍	❍	❍	❍
Fill in bare soil areas with grass, other plants, or mulch/woodchips.	❍	❍	❍	❍	❍
Reduce or eliminate watering when rain has fallen.	❍	❍	❍	❍	❍
Prevent your grass clippings, leaves, or other plant material from getting in the street.	❍	❍	❍	❍	❍

Video
Please watch the following video. Make sure you watch the entire video.

Q16 Were you able to watch this video?

- ❍ Yes
- ❍ No

Q17 What was the main topic being addressed in the video?

- ❍ The best time of year to seed a new lawn
- ❍ The best lakes for fishing in the Twin Cities
- ❍ The relationship between yard maintenance activities and water pollution in the Twin Cities
- ❍ The history of water pollution in the Twin Cities

Q18 When maintaining your yard, indicate how frequently or infrequently you plan to do the following activities in the future: If the statement does not apply to you, do not mark any option.

	Always	Most of the time	Half the time	Sometimes	Never
Sweep fertilizer or compost off sidewalks and driveways.	❍	❍	❍	❍	❍
Follow directions on fertilizer bags.	❍	❍	❍	❍	❍
Fill in bare soil areas with grass, other plants, or woodchips.	❍	❍	❍	❍	❍
Reduce watering when rain has fallen.	❍	❍	❍	❍	❍
Prevent your grass clippings, leaves, or other plant material from getting in the street.	❍	❍	❍	❍	❍

Q19 Please provide the following demographic information:

Q20 Do you consider yourself: Check all that apply.

- ❑ Caucasian
- ❑ Hispanic
- ❑ African American
- ❑ Asian or Pacific Islander
- ❑ Native American
- ❑ Other _____

Q21 What is your age?

Q22 What is your total household income?

- ❍ Less than $30,000
- ❍ $30,000 - $49,000
- ❍ $50,000 - $69,000
- ❍ $70,000 - $99,999
- ❍ $100,000 - $149,000
- ❍ $150,000 or more

Q23 Please indicate your gender:

Q24 What is your highest level of education?

- ❍ High school diploma
- ❍ Some College
- ❍ Associate's Degree
- ❍ Bachelor's Degree
- ❍ Master's Degree
- ❍ Doctoral Degree

Q25 Which of the following two neighborhoods is your place of residence located in or nearest to?

- ❍ Nokomis
- ❍ Linden Hills

Q26 Do you have any additional comments?

Appendix D

Yard Care Reading Survey

Thank you for agreeing to complete this survey

You are being invited to participate in this study because you are a resident of the city of Minneapolis. If you do decide to participate, please click the "Continue" button at the bottom of the page when you have finished reading this section.

Purpose
This study is being conducted as part of graduate student thesis work and its purpose is to collect information about yard maintenance practices used by residents in the Twin Cities Metro area. The results of this study will be used to help inform the direction of landscaping outreach and education efforts.

Survey Structure
It should take approximately 10-15 minutes to answer all of the following survey questions and watch a short educational video. Before watching the video, you will be able to go back and re-answer any question. After the video, you will not be able to go back and answer any questions.

Risks
There are no risks associated with participating in this study

Confidentiality
Every effort will be made to keep any information collected confidential. In order to keep information about you safe, all names and other identifying information will be stored on a private and secure University of Minnesota drive. Only project investigators will have access to this drive. This information will not be included in the final thesis that results from this research project.

Payment
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Questions or Concerns?
If you have questions about this study you may contact Madeline Leslie at lesl0034@umn.edu. You may also contact the researcher's faculty advisor, Dr. Brian Horgan, at bphorgan@umn.edu.

Q2 Are you one of the primary decision makers about yard maintenance choices in your yard? Consider "yard" to be any outdoor space on the property you reside at.

- ❍ Yes
- ❍ No

Q3 The property I reside at is approximately:

- ❍ Less than 1/8 acre
- ❍ City lot (1/8 acre)
- ❍ 1/4 acre
- ❍ 1/2 acre
- ❍ 1 acre
- ❍ More than 1 acre

Q4 Do you have any of the following landscaping features in your yard?

	Yes	No
Lawn	❍	❍
Trees or bushes	❍	❍
Perennial plants (plants die back in the winter, but return the following spring)	❍	❍
Annual plants (plants die back in the winter and do not return the following spring)	❍	❍
Areas that are dominated by plants commonly considered weeds	❍	❍
Areas that are mainly bare dirt with few or no plants	❍	❍
Hardscaping areas, such as brick patios, sidewalks, gravel, etc.	❍	❍
Ponds or other water features	❍	❍

Q5 How far away is the property you reside at from the closest lake, stream, or river?

- ❍ I live directly on a lake, stream, or river
- ❍ Within approximately 1/4 mile
- ❍ Within approximately 1/2 mile
- ❍ Within approximately 1 mile
- ❍ Within approximately 2 miles
- ❍ Greater than approximately 2 miles

Q6 On average, how often do you mow your lawn or other parts of your yard?

- ❍ Never
- ❍ Less than once every two monhts
- ❍ Once every two months
- ❍ Once per month
- ❍ Once every two weeks
- ❍ Once a week
- ❍ More than once a week

Q7 On average, how often do you water any area of your yard?

- ❍ Never
- ❍ Less than every other week
- ❍ Every other week
- ❍ Once per week
- ❍ Twice per week
- ❍ Three times a week
- ❍ Every day

Q8 On average, how many times per year do you apply fertilizer to any area in your yard?

- ❍ Never
- ❍ Every other year or less frequently
- ❍ 1 time per year
- ❍ 2 times per year
- ❍ 3 times per year
- ❍ 4 times per year
- ❍ 5 times per year
- ❍ More than 5 times per year

Q9 On average, how many times per year do you apply pesticides (for weed, insect, or disease control) to any area in your yard?

- ❍ Never
- ❍ Every other year or less frequently
- ❍ 1 time per year
- ❍ 2 times per year
- ❍ 3 times per year
- ❍ 4 times per year
- ❍ 5 times per year
- ❍ More than 5 times per year

Q10 On average, how much time per week do you or another member of your household spend on yard maintenance activities? Consider "activities" to mean any time spent in your yard doing anything similar to the following: mowing, weeding, watering, applying fertilizer or pesticides, pruning, raking, removing plants, putting in new plants, installing any type of hardscaping, etc.

- ❍ No time at all
- ❍ Less than 1 hour
- ❍ 1-2 hours
- ❍ More than 2 hours but less than 5 hours
- ❍ More than 5 hours

Q11 Do you consider your yard to be low-input? Consider inputs to be any of the following: water, fertilizer, pesticides, and time/labor spent on maintenance.

- ❍ Yes
- ❍ No

Q12 Please drag and drop into the boxes on the right, the places that water goes after it runs out of your yard, in order from first to last. If you are not sure where water goes after running out of your yard, please make your best guesses.

Where water goes after running out of your yard	Water does not go here after running out of your yard
_____ To a water treatment plant	_____ To a water treatment plant
_____ Into the street	_____ Into the street
_____ Into a local lake, stream, or river	_____ Into a local lake, stream, or river
_____ Soaks into the ground	_____ Soaks into the ground
_____ Into a storm sewer	_____ Into a storm sewer

Q13 Do your yard maintenance choices affect or not affect any of the following?

	Affect	Do not affect
Your neighbors	❍	❍
The environment	❍	❍
Yourself and/or your family	❍	❍
Your drinking water supply	❍	❍
Water in a nearby lake, stream, or river	❍	❍

Q14 Indicate how much you agree or disagree with the following statements:

	Strongly Disagree	Disagree	Somewhat Disagree	Neither agree nor disagree	Somewhat Agree	Agree	Strongly Agree
I care about the water quality of lakes, streams, and rivers in my community	❍	❍	❍	❍	❍	❍	❍
The way I maintain my yard affects the environment in a positive way	❍	❍	❍	❍	❍	❍	❍
Maintaining my yard helps to cause algae blooms in nearby lakes	❍	❍	❍	❍	❍	❍	❍
Organic fertilizer is better for the environment	❍	❍	❍	❍	❍	❍	❍
It is legal to apply fertilizer with phosphorus in it to my lawn under all circumstances.	❍	❍	❍	❍	❍	❍	❍

Q15 When maintaining your yard, indicate how frequently or infrequently you did the following activities over the past two years: If the statement does not apply to you, do not mark any option.

	Always	Most of the time	Half the time	Sometimes	Never
Sweep fertilizer or compost off sidewalks and driveways.	❍	❍	❍	❍	❍
Follow directions on fertilizer bags.	❍	❍	❍	❍	❍
Fill in bare soil areas with grass, other plants, or mulch/woodchips.	❍	❍	❍	❍	❍
Reduce or eliminate watering when rain has fallen.	❍	❍	❍	❍	❍
Prevent your grass clippings, leaves, or other plant material from getting in the street.	❍	❍	❍	❍	❍

Information

Please carefully read through all of the following information:

Lawns and Gardens: Their effects on water quality in the Twin Cities

In the Twin Cities, many of our lakes and streams are designated as impaired by the Minnesota Pollution Control Agency. This means that they are either not suitable for aquatic recreation, such as swimming, or do not support healthy levels of aquatic plants and animals.

Why are our local water bodies impaired?
One major reason for this is nutrient pollution, which occurs when nitrogen and phosphorus run off landscapes during rain or watering events, travel into the street, through the storm sewer system, and into a local body of water.

What is the effect of nutrient pollution on lakes, streams, and rivers?
While nitrogen and phosphorus occur naturally in the environment and are essential to plant growth, they can cause algae blooms to proliferate in local water bodies. These blooms can make swimming and boating unpleasant or even dangerous, as the algae can sometime produce harmful toxins which they release into the water. In addition, the algae blooms also lower the dissolved oxygen levels in the water, which can damage aquatic plant and animal life, and in particular can cause large fish kills.

How can individual property owners help prevent nutrient pollution?
Maintenance practices you use in your yard may contribute to the pollution of local bodies of water. This is because nitrogen and phosphorus are present in lawn and garden fertilizer, grass clippings and leaves, soil, and pet waste. If any of these things enter the storm sewer system, they will increase nutrient levels in lakes, streams, and river, potentially causing harmful algae blooms.

Here are a simple few things everyone can do to help prevent nutrient pollution:

Quick Tips
Remove grass clippings, leaves, and fertilizer from sidewalks, driveways, and street gutters.
Prevent loose soil from leaving your yard by repairing bare patches in your lawn and refrain from establishing annual gardens in sloped areas.
Follow directions on fertilizer bags and consider converting to a low-input fine fescue lawn. This type of grass requires fewer inputs in the form of water, mowing, and fertilizing.
Install rain gardens on your property in order to reduce runoff and increase the amount of water that stays in your yard and infiltrates into the soil.

Make sure to promptly clean up all pet waste.

Every person who makes these small changes to their yard maintenance practices can help improve water quality and preserve our local resources for current and future generations.

Q17 What was the main topic being addressed in the information you just read?

- ❍ The best time of year to seed a new lawn
- ❍ The best lakes for fishing in the Twin Cities
- ❍ The relationship between yard maintenance activities and water pollution in the Twin Cities
- ❍ The history of water pollution in the Twin Cities

Q18 When maintaining your yard, indicate how frequently or infrequently you plan to do the following activities in the future: If the statement does not apply to you, do not mark any option.

	Always	Most of the time	Half the time	Sometimes	Never
Sweep fertilizer or compost off sidewalks and driveways.	❍	❍	❍	❍	❍
Follow directions on fertilizer bags.	❍	❍	❍	❍	❍
Fill in bare soil areas with grass, other plants, or woodchips.	❍	❍	❍	❍	❍
Reduce watering when rain has fallen.	❍	❍	❍	❍	❍
Prevent your grass clippings, leaves, or other plant material from getting in the street.	❍	❍	❍	❍	❍

Q19 Please provide the following demographic information:

Q20 Do you consider yourself: Check all that apply.
- ❑ Caucasian
- ❑ Hispanic
- ❑ African American
- ❑ Asian or Pacific Islander
- ❑ Native American
- ❑ Other _____

Q21 What is your age?

Q22 What is your total household income?
- ❍ Less than $30,000
- ❍ $30,000 - $49,000
- ❍ $50,000 - $69,000
- ❍ $70,000 - $99,999
- ❍ $100,000 - $149,000
- ❍ $150,000 or more

Q23 Please indicate your gender:

Q24 What is your highest level of education?
- ❍ High school diploma
- ❍ Some College
- ❍ Associate's Degree
- ❍ Bachelor's Degree
- ❍ Master's Degree
- ❍ Doctoral Degree

Q25 Which of the following two neighborhoods is your place of residence located in or nearest to?
- ❍ Nokomis
- ❍ Linden Hills

Q26 Do you have any additional comments?