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Landscaping Perceptions And Behaviors: Socio-ecological Drivers Of Nitrogen In The Residential Landscape

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LANDSCAPING PERCEPTIONS AND BEHAVIORS: SOCIO-ECOLOGICAL DRIVERS OF NITROGEN IN THE RESIDENTIAL LANDSCAPE

by

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ABSTRACT

Driven by individual influences such as beliefs, attitudes, personal norms, and abilities, as well as by social influences like community norms, mandates, and the market, suburban homeowners are motivated to select and maintain a turf grass landscape. In many areas of Florida, effective suburban lawn maintenance requires regular inputs of nitrogenous fertilizer, some of which is lost to the environment, contributing to water quality degradation and ecosystem dysfunction. Reducing nitrogen inputs to aquatic systems requires a better understanding of the links between residential landscape management and the potential for fertilizer loss. This dissertation examines the linkages between the human behaviors contributing nitrogen to the suburban landscape and the resulting environmental impacts. Framed in socio-psychological theory and social marketing research, the outcomes of this dissertation contribute much needed information to the growing realm of interdisciplinary science that expands integrative theory, develops mixed methods, utilizes spatial and temporal analyses, and conducts actionable research. Using a suite of research tools, this dissertation examines relevant urban ecology questions:

- What behavioral and socio-demographic variables most strongly influence individual residential landscape design and management practices?
- What types of communities are more likely to contribute more nitrogen inputs?
- What social constraints prevent homeowners from implementing a more sustainable residential landscape?

- What outcome measures can be used to evaluate the environmental impact associated with landscape maintenance behaviors?

Social and environmental data were collected over five years from three distinct projects to advise environmental marketing strategies and targeted communications. The research questions provided important information for water quality stakeholders and environmental marketers to prioritize strategies and target audiences based on the power of forces that are influencing landscaping behaviors. The research drew on the methods of urban ecology to understand nutrient dynamics by spatially integrating social and environmental data. It used social-psychology theory to define influences that can motivate or deter landscape management behaviors and preferences. It applied the methods of social marketing to advise implementation strategies.

Completing this research involved ethnographic, social survey, and environmental quality data collection. Suburban homeowners were recruited as research participants to collect important qualitative information about individual and social forces of suburban landscape management and the perceptions of environmentally-friendly landscaping. Questions were developed to operationalize the dimensions of individual and social influences and quantitative data were collected at two different scales, regional and statewide. Homeowners were defined in terms of their polluting potential, influences and mandates as well as their potential for adopting a more sustainable landscape. The research mapped behavioral and environmental data to understand human-ecosystem linkages and recommended environmental quality indicators to continue building future outcomes. This dissertation research was conducted in three distinct projects.

The Landscape Exchange project collected telephone survey data, interview data, and ethnographic information from project participants for three years in a subdivision in southwest Florida.

In the Wekiva Basin of Central Florida, the Land-water Connection (LWC) project studied sources of nitrogen by examining the linkages between human behaviors, community land use patterns, and environmental quality. In the LWC project, patch dynamics of a suburbanizing watershed were mapped to link residential fertilizer frequency with water resource impacts. By collecting socio-economic information key to understanding the households and neighborhoods within the watershed, LWC attempted to better understand and characterize polluting potential and impact. This investigation of the human-ecosystem connection provided valuable insight to the potential source contributed by residential landscape management while demonstrating a tool for visualizing human-environment interactions. Integrating data and understanding processes that are being carried out at different spatial and temporal scales requires research that crosses interdisciplinary boundaries and extends beyond simple models to understand complex causal relationships (Young *et al* 2006). The LWC project integrated socio-demographic data like housing age and property values, household and lifestyle behaviors, and individual application rates with environmental data such as soil nutrients and groundwater NO_3^- concentrations. Results demonstrated that significant relationships existed between structural features like Homeowners Associations (HOA) and golf courses and high fertilizer frequency, but that these areas did not consistently show patterns of elevated nitrogen concentrations in ground and surface water.

Confounding geophysical features, limited data availability, and a temporal lag between land-based fertilizer activity and groundwater nitrogen concentrations are likely.

In the Predicting Maintenance Intensity (PMI) project, I collected statewide survey data from Florida homeowners and used multivariate analyses to determine if the same variables that predicted landscape maintenance intensity also influenced the odds of adopting an environmentally-friendly landscape (EFL). The purpose was to see how landscape maintenance and EFL adoption related and which human psychological or socio-economic variables predicted them. I used the framework of the Theory of Planned Behavior and Normative Action Theory to measure the extent that individual beliefs or community influences predicted landscape maintenance intensity. Although most of the alternative hypotheses that I posed in the research were significantly related to landscape maintenance intensity and EFL adoption in the predicted direction, the findings were somewhat unexpected. This was particularly the case when comparing household's position on environmentally-friendly landscaping (EFL) adoption and landscape maintenance intensity. I found that those who adopted EFL practices had similar landscape maintenance intensity scores as those who did not intend to ever change their landscape practices and that those who intended to do more EFL had the highest landscape maintenance intensity score. This indicated that landscape maintenance intensity was a useful measure of product inputs but did little to explain individual attitudes about EFL adoption.

Similar to the findings of the Land-Water Connection in Wekiva referenced previously, the statewide PMI project also found that community norms, living in a HOA governed community and household income were significant positive predictors of high landscape maintenance and that environmental consciousness, awareness of consequences, and house age were significant negative predictors. Environmental consciousness and enjoying gardening significantly increased the odds of currently practicing or intending to practice EFL relative to never changing their landscape, but community norms only significantly influenced the likelihood to intend to do more EFL.

Another interesting finding of this dissertation was the differences of predictive powers of variables over scales. For example, the individual scale versus the community scale of influence. EFL Adoption was related more to individual characteristics such as personal norms, attitudes about the garden, and awareness of consequences while landscape maintenance intensity was more influenced by structural differences like who was responsible for maintenance and socio-demographics like house age and income were strongly significant and community norms. The findings of this dissertation supported the concept of lawn anxiety described by Robbins (2007), regarding those who are aware of the environmental consequences, but still applied lawn care products. It would be interesting to explore the relationships further to understand why those who are environmentally aware are motivated to high maintenance regardless. From these results, it appears they are influenced by their community norms and HOA mandates.

More investigation of the human dimensions of the suburban landscape is warranted. Further research on human life-history measures, perceived behavioral controls and normative influences of those who adopt alternative landscapes would help guide communications. Understanding more specifically what mechanisms are needed to enable a societal change to a sustainable landscape requires further exploration of the motives and barriers that will prevent it from happening.

Further research is also needed to better understand suburban nitrogen system dynamics. Studies that focus at the community scale should be conducted to apply and trace residential fertilizes from the yard to the street and into aquatic systems. The use of labeled nitrogen fertilizer can be used identify fertilizer from background nitrogen.

Lastly, land use planning and development must seek to rebalance the scale that promotes both environmental protection and economic growth back toward environmental protection. It has been too long tipped in favor of development pressure and short-term economic growth to the demise of our aquatic systems.

This dissertation is dedicated to Brent K. Marshall,

my friend, teacher, and colleague who departed far too early,

but has been with me all along.

Thank you for the vision of interdisciplinary research,

the skills that would allow me to do it,

and the inspiration to get it done.

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LIST OF ACRONYMS/ABBREVIATIONS

DTW - Depth to ground Water

EFL - Environmentally-friendly Landscaping

FDEP - Florida Department of Environmental Protection

FFL - Florida-friendly Landscaping

HOA - Homeowners Association

HLM - Homeowner Landscape Manager

IRB - Institutional Review Board

LEP - Landscape Exchange Project

LMI - Landscape Maintenance Intensity

LWC - Land Water Connection Project

N - Nitrogen

NH_3 - Ammonia

NH_4^+ - Ammonium

NO_3^- - Nitrate

NO_X - Total nitrate and nitrite

NAT - Normative Action Theory

P&B - Perceptions and Behaviors

PBC - Perceived Behavioral Controls

PLM - Professional Landscape Manager

PMI - Predicting Landscape Maintenance Intensity

TKN - Total Kjeldahl Nitrogen

TMDL - Total Maximum Daily Loads

TN - Total Nitrogen includes Sum of TKN and NO_X

TPB - Theory of Planned Behavior

US EPA - United States Environmental Protection Agency

GENERAL INTRODUCTION

> "Humans drive urban biogeochemical cycles with their actions, which are based in culture, attitudes and beliefs and are constrained by institutional and socioeconomic factors. Landscape design and management choices such as species composition and lawn fertilization and irrigation regimes can alter vegetation and nutrients as drivers of urban biogeochemical cycles,"
>
> (Kaye *et al* 2006).

Feeding the world's growing population is a primary goal of world leaders. Historically, food production was limited by available plant nutrients in the soil such as reactive nitrogen and phosphorus. This limitation was overcome in 1913 by the Haber-Bosch process which enabled the manufacturing of nitrogenous fertilizers by fixing ammonia (NH_3) from the limitless pool of available atmospheric N_2 gas. It is the most widespread industrial method to produce N fertilizers, producing 500 million tons annually (Smil 2001). Heralded as one of the most important inventions of the twentieth century, the Haber-Bosch process fed starving populations, resulting in exponential population growth from 1.6 billion in 1900 to over 7 billion people today. Mankind created a machine that could feed the starving by fixing nitrogen from the air and putting it in the ground. In doing so they also altered nutrient dynamics and nitrogen cycles worldwide.

Feeding people is a good thing, but mankind's ability to transform the nitrogen cycle has had serious unintended consequences. These increased nitrogen inputs have contributed to air quality degradation, acidification of soil and surface water, disruption of ecosystem processes, and eutrophication of receiving waters (Galloway *et al* 2008).

Although 40% of the world's population depends on artificial fertilizers to grow crops, the impact that excess nitrogen is having on receiving systems must be remedied to sustain water quality and ecological health.

Sustainability requires changes in current human actions to enable future generations to live in a healthy environment (Rayner 1998). Large scale system dynamics take a long time to respond and changes addressed now may well take generations before an improvement is noticeable. Society must stop deferring the environmental consequences of current practices to future generations, because eventually a point will be reached where reparations are too late (Agyeman 2002; Erikson 1994, pg 224). Before sustainable strategies can be identified, a thorough understanding is needed of the behaviors that caused the crisis in the first place (Viederman 1993). Fertilizers for food crops are necessary to feed our growing population and present enough of a challenge to remedy. Suburban lawn fertilizers are applied for aesthetic reasons and to sustain an acceptable ground cover. The suburban landscape reliance on this additional, unnecessary nitrogen input will be challenging to change but is an imperative to address.

The suburban turf-grass residential landscape is a non-sustainable human development standard that contributes excess nitrogen to an already overburdened nutrient system, and there is reason to believe that impacts will increase. Turf grass is the dominant land cover in urban environments, covering about 18 million hectares in the U.S. (Professional Lawn Care Association of America 2012). Projections suggest that fertilizer impacts will continue to increase as agricultural lands are converted to suburban lawn-covered lots (Robbins *et al* 2001; Robbins and Birkenholtz 2003) and that impacts will be most severe in states experiencing rapid urban growth along the coast such as Florida, Georgia, Texas, and California (Alig *et al* 2004). Suburban growth can have serious implications for non-point source pollution management.

According to U.S. Fish and Wildlife Service, homeowners use 10 times more chemicals on their lawns than farmers use on crops (USFWS 2000), with more homeowners applying fertilizer (84%) than pesticides (64%) (National Gardening Association, 2000). There is little doubt that residential fertilizer is a significant source of excessive nitrogen (Driscoll *et al* 2003, Boyer *et al* 2002, Law *et al* 2004, Zhu *et al* 2004) with measures estimating it contributes as much as 25% of nitrogen loads to aquatic systems in the Northeast U.S. (Howarth *et al* 1996). Florida studies showed varying estimates, suggesting fertilizer contributed 20% of total nitrogen loads to Wekiva Springs (MACTEC 2009) and 79% of nutrient loads to Lake Tarpon (Leggette, Brashears and Graham, Inc. 2004). Increased fertilizer use has been associated with increased nitrate concentrations in groundwater wells (Baker *et al* 2001) and in estuaries (Bowen and Valiela 2008), but little research has focused at the subdivision scale to understand the household-scale actions that potentially cause excess nitrogen loading.

Solutions are needed to reduce the amount of industrial nitrogen on the earth by promoting the efficient use of agricultural fertilizers and minimalizing the use of fertilizers for non-agricultural purposes. Nitrogen management strategies that conserve natural resources, minimize adverse environmental impacts, and maintain crop productivity are required. Understanding how human behaviors contribute to nitrogen loads is an important part of developing alternative landscapes that are resource efficient, acceptable, and sustainable.

Over thirty years ago, Vitousek and Reiners (1975) proposed a hypothesis that biogeochemical cycling of nutrient inputs and outputs changes over the course of succession. They suggested that nutrient inputs relate to outputs differently over timeframes of disturbance and succession. Element outputs are initially equal to inputs, then they drop as elements are accumulated by biomass and then rise again to equal the nutrient inputs as the system reaches capacity and net ecosystem production approaches zero. Examining these trends in biogeochemical cycling over human development timeframes became a fundamental area of urban ecology research.

Urban ecology recognizes that human decisions, cultural institutions, economic markets and other human activities are the drivers of biogeochemical cycling in urban environments. Kaye *et al* (2006) identified three significant human actions that impact biogeochemical cycles: 1) engineering; 2) urban demographic trends; and 3) household-scale actions. Understanding the interaction of these human-oriented actions and biogeochemical cycles required interdisciplinary research methods and complex models to integrate human choices and biogeochemical cycling across spatial and temporal scales (Baker *et al* 2001, Redman *et al* 2004, Kaye *et al* 2006, Pickett *et al* 2008). Urban ecology research provided the framework and methods used in this dissertation to examine the interaction of residential landscape management and its impact on biogeochemical cycling.

Many education programs exist that promote environmentally-friendly landscaping. Program goals may encourage the use of native and drought-tolerant plants, efficient irrigation systems, integrated pest management, rainwater harvesting, infiltration, and other environmentally-friendly practices. These programs can benefit from information on residential landscape preferences, behavioral influences, current landscaping practices and intentions to change to assist them with targeted messaging and evaluation measures. Understanding household motivators and inhibitors to adopting a more sustainable landscape help target audiences, create educational messages, and employ environmental marketing strategies. Social marketing provides a toolbox of strategic research methods to collect evidence that can be used to accommodate and evaluate social change through human-related education and policy interventions.

This dissertation drew from and contributed to the growing body of urban ecology literature by identifying household-scale actions and suburban demographic trends that are related to high fertilizer inputs. Data were collected at statewide, community, and individual levels to identify high maintenance landscape managers and their likelihood to change. The research involved homeowners as research participants to understand the psychological and community influences of landscape decision-making. It constructed a predictive model of residential landscaping behaviors, initiated a method to integrate socio-behavioral and environmental quality data, and recommended outcomes of appropriate environmental indicators.

The dissertation was initiated with an extensive literature review that crossed disciplinary lines. The literature review summarized in Chapter One covers the nitrogen cycle and the use of stable isotopes to understand it; human dimensions of landscape management; behavior prediction models; spatial analysis; and social marketing. The research was counseled by a multi-disciplinary advisory committee and researchers with expertise in ecology, environmental sociology, socio-behavioral theory, and spatial analysis. The research considered qualitative and quantitative evidence to develop tools for modeling residential landscape management inputs to the nitrogen cycle.

Three projects contributed to this dissertation. The Landscape Exchange collected descriptive, ethnographic information from residents in a deed-restricted community who decided to change to an environmentally-friendly front yard. The research participants and their neighbors were interviewed to understand their perceptions of changing to a Florida-friendly landscaped front yard. By overcoming the initial challenges of yard design, committee approval, and plant selection, important information about homeowners and neighborhood perceptions of environmentally-friendly front yards was collected. This information was foundational to developing the theoretical framework and operationalizing survey measures.

The Land-water Connection project used spatial analysis and audience segmentation techniques to examine and relate socio-behavioral and environmental quality data. Individual, social, and environmental data collected in the Wekiva Study area north of Orlando were mapped and spatially analyzed to better understand the land use and spatial characteristics of communities exhibiting high N inputs. The outcomes of this project helped create a Land Use Intensity Index that can predict N hotspots based on human actions and to differentiate residential landscape based on differences in landscape related nitrogen inputs.

The third project titled "Predicting Landscape Maintenance Intensity" used a predictive behavioral model that integrated two relevant socio-behavioral theories: the Theory of Planned Behavior (Fishbein and Ajzen 1975) and Normative Action Theory (Schwartz 1977) to understand the influences and controls on residential landscape management. The outcomes of this research provided insight to socio-demographic, behavioral and attitudinal variables associated with high landscape maintenance intensity.

The three projects are covered individually in chapters 3, 4 & 5 of this document. In chapter 6, general results are interpreted, a conclusion is summarized, and future research directives are recommended. Before getting into the three projects, the following chapters introduce the research questions with a comprehensive literature review organized by disciplinary topics. Chapter 1 reviews the background literature that describes the socio-ecological nitrogen ecosystem by looking at the nitrogen cycle and its human-related drivers. In Chapter 2, the literature provides the outline for the research questions specific to this dissertation.

CHAPTER ONE: BACKGROUND

During the completion of this dissertation, information was collected to measure the extent that residential landscape management practices drive nitrogen (N) inputs in the suburban ecosystem. Socio-demographic, attitudinal, and behavioral data were related to existing landscape maintenance practices, preferences, and intentions to change as well as ground and surface water quality. Residential landscaping effects on biogeochemical cycling was investigated by relating social, behavioral, and ecological data that link human behavior to water quality at multiple scales of influence. Results confirmed that the current residential landscape is a non-sustainable societal norm that will be challenging to change and expensive to remediate.

This research relied heavily on similar research being conducted at the Baltimore Ecosystem Study (BES). One of the key research goals of the BES is to understand the patch dynamics of human ecosystems by integrating biophysical and social components of urban ecosystems (Pickett *et al* 2008). By relating structural components like socio-economics, physical and ecological features, and land use, with human components like behaviors and inputs and examining the fluxes between them, a thorough understanding of the human dimensions of the nitrogen (N) cycle can be accomplished. I relied heavily on BES studies to continue to build and expand an understanding of human-ecosystem dynamics that provides the science behind environmental solutions.

The research also benefitted from decades of literature on suburban landscape perceptions and landscape design preferences by urban planners and landscape architects. Following closely the research of Nassauer who has investigated suburban landscape preferences and practices through landscape demonstration sites and visual tools, this research continues to build on the scientific evidence that clarifies residential landscape influences.

Using mixed methods and spatial tools to integrate data, this research also made several important and valuable contributions to the expanding realm of interdisciplinary science. First, the research related socio-behavioral and biogeochemical data to understand the effects they have on each other. The research collected much needed socio-demographic and behavioral data to understand the suburban landscape management patterns associated with fertilizer N inputs (Law *et al* 2009). The use of spatial analysis methods to integrate data using regression and interpolation analyses contributed to a better understanding of temporal and spatial relationships key to integrating socio-environmental science.

This interdisciplinary research project blended theoretical bases, designed a palette of research methods, and interpreted results from behavioral, social, and biogeochemical data. Research outcomes and methods are particularly important to improving actionable science designed to apply interdisciplinary research to environmental problem-solving. The recommendations of this research can be applied immediately in the policy and program realm to help guide program strategies, clarify appropriate messages and methods, target polluting communities, and evaluate program results in terms of the potential reduction in nitrogen loads.

The research included a thorough literature review of both the biogeochemistry and the socio-psychology of the suburban landscape. The next section of this chapter summarizes literature on the nitrogen cycle and the use of stable isotopes to understand nitrogen system function (and dysfunction). Thereafter, the literature review switches to the human dimensions of residential landscaping and the theoretical framework that will be used to predict behavior.

Nitrogen Cycle

Nitrogen (N) is an essential element necessary for the formation of the amino acids and proteins that are the building blocks of life. It is found in nearly everything, changing form and location in the air, earth, water, and ecosystem. Nitrogen gas (N_2), is the most stable form of nitrogen (N) and although it makes up most of the earth's atmosphere, the largest storage of N is in the rocks, sediments, and organic matter of the lithosphere (Reddy 2002). There are many forms of N in the lithosphere, hydrosphere and biosphere that are constantly undergoing nitrification, denitrification, ammonification, mineralization, and assimilation processes that change it from one form to another.

Nitrogen (N) in the cells, tissues, and fluids of living organisms cascades through the food chain as bacteria, plants, and animals assimilate N into their tissues when they eat and release it as ammonia compounds, proteins, and amino acids in their waste products and during decay. In the substrate, these N compounds and structures undergo any number of reactions depending on the substrate conditions and the structure of the N compound. N may exist as ammonium (NH_4^+), it may be adsorbed onto soil particles, it may volatilize to the atmosphere, be assimilated by plants and microbes, it may be oxidized to nitrate NO_3^- or nitrite NO_2 by aerobic bacteria via nitrification, or be reduced to N_2 gas by anaerobic bacteria during denitrification.

In the natural nitrogen cycle, the fixation of N_2 gas to ammonia (NH_3) occurs either as a result of abiotic processes such as lightning and fires, or biotic processes during which bacteria, cyanobacteria, plankton, and periphyton convert atmospheric nitrogen (N_2) to ammonia (NH_3). N fixation is an energy intensive process that very few organisms utilize (Reddy 2002) and thus little natural atmospheric fixation occurs. The Haber-Bosch industrial process used to fix atmospheric nitrogen (N_2) to ammonia (NH_3) is also energy intensive, utilizing about 1% of total global energy use, (IVA 2008). In the natural environment, the large amount of energy required to fix N_2 to NH_3 would rarely occur. In society, the large amount of energy required to fix N_2 to NH_3 is provided by burning fossil fuels. The man-made efficiency of N_2 fixation has altered the N cycle by greatly increasing the amount of atmospheric nitrogen (N_2) converted to ammonia (NH_3) without increasing the efficiency of denitrification processes that convert it back.

In the natural N cycle, small amounts of N_2 gas fixed into ammonia through the process of fixation are balanced with the limited denitrification processes that return N_2 gas to the atmosphere. Although each step of the cycle is subject to constraints related to the biological and physical environment (Dundee 1987, Pg 9); the natural nitrogen budget is relatively balanced. The few inputs to the lithosphere, biosphere, or hydrosphere from the atmosphere are balanced by the outputs of reduced N_2 gas to the atmosphere. Steps must be taken to remedy this man-made, nitrogen imbalance caused by the excess N being taken from the atmosphere and deposited onto the lithosphere.

A better understanding of the nitrogen cycles can be accomplished by examining naturally occurring stable N isotopes. Nitrogen occurs in two stable isotopes ^{14}N and the less common ^{15}N isotope. The ratios of these isotopes help clarify N processes as well as fate and transport. The following section introduces the ^{15}N isotope and its use as a tracer of N dynamics.

Isotopic Nitrogen

Isotopic nitrogen (^{15}N) is a naturally occurring N stable isotope that has one more neutron than the more common form of N, (^{14}N). The ratio of ^{14}N to its isotope ^{15}N is 273:1 in the atmospheric gas N_2 ($^{15}N/^{14}N = 0.0036765$), which is used as the standard for comparison (Junk and Svec, 1958). This ratio of ^{15}N:^{14}N differs only slightly in N pools, typically falling within the range of -0.0040 to +0.0060. Isotopic signatures are measured and described as delta values of the isotope ratio (δ X) expressed in percentage parts per thousand ($^{0}/_{00}$) as calculated with Equation 1, where X is the isotope (^{15}N, ^{18}O, ^{13}C, etc…) and R is the ratio of the isotope to its lighter form ($^{15}N/^{14}N$, $^{18}O/^{16}O$, etc..).

$$\delta X\ (0/00) = [(R\ sample / R\ standard) - 1] \times 10^3 \qquad (1)$$

Increasing δ X indicates an increase in the heavier isotope (Peterson and Fry 1987). Because isotopes have an additional neutron, they react more slowly, require more energy, and are thereby not as reactive as the lighter and more common form of N. As a result, heavier isotopes accumulate in reaction substrates and solutions resulting in organics that tend to be enriched in the heavier isotope (high δ X). The potential for isotopic enrichment from biogeochemical processes are measured using isotope fractionation values. The following paragraph describes fractionation values for varying N processes that can illuminate N fate and transport through ecosystems.

The process of denitrification has a median isotope fractionation of 1.0185, meaning that when NO_3^- converts to N_2O or N_2 gas; the unreacted NO_3^- in the substrate becomes enriched in ^{15}N and the N_2O or N_2 gas produced is depleted by 18.5 $^0/_{00}$ (Bedard-Haughn *et al* 2003). Ammonium (NH_4^+) enriched with ^{15}N may be the remaining unreacted substrate from either nitrification of NH_4^+ to NO_3^- (25.0 $^0/_{00}$) or its volatization to NH_3 (24.5 $^0/_{00}$). In contrast, the reactions associated with N_2 fixation to ammonia (1.3 $^0/_{00}$) or ammonification of organics to ammonium (2.5 $^0/_{00}$) are near 0, resulting in little enrichment of the substrate. These naturally occurring bio- and physio-chemical enrichment processes display distinct landscape-scale patterns that vary according to micro-climate, soil moisture, nutrient levels, and soil formation (Bedard-Haughn *et al* 2003). In the environment, ^{15}N becomes increasingly enriched in organic materials and substrates with active nitrification or volatization processes. This pattern is the opposite of what we would expect if artificially produced fertilizers are applied.

Atmospheric gases and products of atmospheric gases are depleted relative to organic biomass, waste products, and NO_3^- resulting from denitrification. Varying enrichment patterns can be seen in the findings of Showers *et al* (2007) who found that δ $^{15}N/ NO_3^-$ varied between natural soil organics (+4 to +7 $^0/_{00}$); commercial fertilizers (near 0 $^0/_{00}$) and septic wastes (+8 to +10$^0/_{00}$). The challenge of using isotopes to understand nutrient dynamics is to consider the naturally occurring enrichment patterns along with the isotopic patterns expected from different human sources of nitrogen. Examining the patterns of enrichment and depletion in substrates and products over time and space can be used to link nutrient sources and sinks throughout the system.

Nitrogen stable isotope studies have been used successfully to clarify nitrification processes in forest regrowth after disturbance and soil/water N interactions (Compton *et al* 2007); to identify groundwater and surface water N sources (McClelland *et al* 1997, Showers *et al* 2007, Bowen and Valiela 2008); and to estimate appropriate fertilizer application rates (Quinones *et al* 2007.) Some studies focus at the large scale, examining the naturally occurring variations in landscape $\delta^{15}N$. This requires a thorough understanding of the isotopic signatures of N input and outputs, the effects of N transformative processes, and the compartmentalization of N within the system (Hogberg 1997).

Other studies apply an artificially enriched N compound to better understand the fate and transport of N through the system. If the $\delta\ ^{15}N$ is enriched greater than the natural abundance range, it can be easily distinguished from naturally occurring compounds, illuminating fate and transformations of N from source to sink. Research that examines both naturally existing $\delta\ ^{15}N$ and uses ^{15}N- enriched tracers can provide a complete, accurate picture of the N cycle and potential impacts (Bedard-Haughn *et al* 2003).

Due to worldwide efforts to reduce excess fertilizer inputs that inflate agricultural costs and adversely impact the environment, agricultural researchers have been contributing much of the literature on ^{15}N as a tracer tool. Because it is fixed from atmospheric N_2 gas, manufactured fertilizer has a unique isotopic signature that differs from the enrichment expected of organics. With its unique, depleted $\delta\ ^{15}N$ signature, commercial fertilizers can be used as tracers in small scale N budget studies. In some cases, fertilizers are enriched artificially with ^{15}N to enhance their visibility relative to background concentrations. The following paragraphs summarize research that used the isotopic signatures of fertilizers to identify sources of pollution, to evaluate potential N inputs and outputs, and to determine how N cycles through small scale systems.

Vitoria *et al* (2004) characterized commercial fertilizers by their isotopic composition to demonstrate that each fertilizer has a unique isotopic signature dependent on how and where it was manufactured. The analysis of $\delta\,^{13}C_{CTotal}$, $\delta\,^{15}N_{NTotal}$, $\delta\,^{15}N_{Nitrate}$, $\delta\,^{18}O_{Nitrate}$, $\delta\,^{34}S_{Sulfate}$, $\delta\,^{18}O_{Sulfate}$, and ^{87}Strontium - ^{86}Strontium were used to identify the origins of fertilizer compounds and the isotopes most effective as fertilizer indicators. They found no correlation between the isotopic signatures of twenty-seven different fertilizers confirming that the source of the ingredients in each blend created a unique fingerprint. They also found that coupling the heavy isotopes of rare earth elements like strontium and sulfur (S) with nitrogen (N) and oxygen (O) in chemical compounds improved the differentiation of fertilizers and provided an excellent tool to quantify fertilizer contributions to water pollution in environmental studies. Their study demonstrated a method to identify fertilizer in the aquatic environment by examining the isotopic signature. The purpose of their research was to help environmental officials identify responsible parties for nitrogen pollution (Vitoria *et al* 2004).

In another study, Li and Wang (2008) examined the fate of $\delta\,^{15}N$ in cropland soils fertilized with urea and ammonium bicarbonate to understand the N isotopic information for soil-derived nitric oxide gas (NO). Before and after fertilizer application, they trapped NO gas and captured soil NH_4^+ and NO_3^- using a sequential diffusion method. As with Bijoor *et al* (2008) that follows, they found that NO emissions increased rapidly after fertilizer application. Because nitrification and denitrification processes kinetically favor the lighter N isotope (^{14}N), during these reactions, NH_4^+ and NO_3^- were enriched in soils and the NO gas was depleted in ^{15}N. Measures of $\delta\ ^{15}N$ in the substrate compounds were used to calculate NO enrichment factors associated with nitrification and denitrification processes and to demonstrate the unique signature of fertilizer derived NO. They concluded that the $\delta\ ^{15}N$ signature of urea-fertilizer emitted NO (-48.9 to -28 $^0/_{00}$) and ABC-fertilized soil (-48.6 to -19.8 $^0/_{00}$) are easily distinguished from vehicle sources (-14 to 3.9 $^0/_{00}$) or power plant emissions (5.2-13 $^0/_{00}$). Their research confirmed the unique signature of fertilizer-derived reactants and the enrichment of products during nitrification and denitrification processes. Bijoor *et al* (2008) continued this line of investigation by examining how varying temperature and fertilizer treatments influence N_2O flux.

Research conducted on N dynamics within the residential yard by Bijoor *et al* (2008) looked at foliar and soil nitrogen isotope ratios to determine how temperature, fertilizer and their combination influenced N cycling. A common commercial fertilizer of 29:3:4 NPK with a $\delta\ ^{15}N$ of -0.64 +/- 0.09$^0/_{00}$ was applied at two different fertilizer rates and two different heat treatments. Low fertilizer treatments received a total of 76.4 kg N/ha/yr (1.56 lbs N/1000 ft^2 /yr) divided in two applications. High fertilizer treatments received 118.5 N/ha/yr total (2.43 lbs N/1000 ft^2/yr) over four applications. Soil moisture, temperature, nitrous oxide (N_2O) flux, and C:N ratios and $\delta\ ^{15}N$ in soils and aboveground biomass were measured over the course of a year.

They found that N_2O flux and soil moisture were positively related, that N_2O flux increased immediately after fertilizer application, and that the highest N_2O flux occurred in the high temperature, high fertilizer plots. Heating had a significant effect on N_2O flux compared to control plots. Consistent with the other research, they found increased enrichment of ^{15}N in soils of heated plots relative to control plots due to increased gaseous losses of ^{14}N in the heated plots during nitrification. The aboveground plant biomass in heated plots also became isotopically enriched relative to the control. In their research, Bijoor *et al* (2008) used replicable sampling and analyses methods to demonstrate that "best management practices for turf grass should optimize the tradeoff between soil moisture enhancement and gaseous N emissions."

The previous three research examples relied on the $\delta\,^{15}N$ signature of commercially available fertilizers to identify sources, trace N variations in controlled experiments, and to understand N nitrification and denitrification processes. Because they were working in a controlled environment, they were able to confidently identify the fertilizer-derived N as it was taken up by plants or enriched in soils. Research that seeks an understanding of natural nitrogen fate and transport in the environment can benefit from the use of fertilizers artificially enriched with ^{15}N. The following studies attempt to construct a mass balance of N in agricultural plots using artificially enriched or labeled fertilizer nitrogen (LFN).

Engelsjord *et al* (2004) applied ^{15}N enriched (24.75% excess) ammonium sulfate to Kentucky bluegrass and perennial ryegrass in order to measure the effect that thatch has on N efficiency and leaching. Treatments received a total of 293 kg N/ha (6 lbs N/1000 ft^2) over the course of a year divided into six applications during the months of June, July, August, September, November and June the following year. Kentucky bluegrass forms a thick thatch layer (20-25 mm thick) containing dead and living plant tissue, microorganisms and soil particles. Ryegrass is a bunch grass that doesn't form a thatch layer, but has a thin (5-10 mm) mat of partially decayed organic matter and soil. The fertilizer uptake of these two species was compared along with their associated thatch and mat transitional areas where plant and soil interact. Both species showed high fertilizer uptake immediately following application and both showed reduced uptake rates in July and August followed by a period of increased N uptake in September and October. These findings were consistent with Bijoor *et al* (2008) who found that fertilizer-derived N_2O fluxes declined in the summer, when soil moisture content was low.

The research by Engelsjord *et al* (2004) traced the labeled fertilizer nitrogen (LFN) from the thatch or mat materials of both species into the roots, rhizomes, and plant verdure. LFN recovered in Kentucky bluegrass ranged from 91-77%, while recovery in perennial ryegrass ranged from 79 - 67% with little downward mobility detected. Results after 365 days showed that thatch retained more LFN than mat, indicating that it is a significantly larger N sink than mat. Although small amounts of LFN were found in the 20- to 40-cm soil depth, the authors concluded that this was likely "more related to N transport in soil macro-pores shortly after application than downward leaching of N throughout the study." Leaching was not directly measured in the study.

Their study demonstrated valuable methods for using labeled fertilizer N (LFN) as a tracer of N utilization and immobilization in turfgrass plots. They found that LFN remained relatively consistent, predominantly in organic forms (99.8%) throughout the study. The thatch, mat, and verdure sampling techniques used in this research are useful for replication in research designs that construct small scale N mass balance. A study conducted by Frank *et al* (2006) had some similar and different outcomes.

Frank *et al* (2006) conducted a mass balance study of Kentucky bluegrass to determine the fate of labeled fertilizer nitrogen (LFN) among clippings, verdure, thatch, soil, and roots ten years after turf establishment. Additionally, they measured nitrate-nitrogen (NO_3^- - N) and ammonium-nitrogen (NH_4^+- N) concentrations in leachate receiving two different treatments of urea fertilizer in solution. In October 2000, LFN labeled with 10% excess ^{15}N was applied to low fertilizer treatment plots at a rate of 24.5 kg N/ha (0.5 lbs N/1000 ft^2) and high fertilizer treatment plots at a rate of 49 kg N/ha (1 LB N/1000 ft^2). The following growing season, unlabeled urea in solution was applied to low treatment plots at a rate of 98 kg N/ha (2 lbs N/1000 ft^2) in four applications and applied to high treatment plots at a rate of 245 kg N/ha/yr (5 lbs N/1000 ft^2), divided into five applications.

Their results showed similar recovery rates as the Engelsjord *et al* (2004) study with total LFN recovered averaging between 78% and 73% for the low and high treatment plots, respectively. The majority of applied LFN was recovered in the soil, averaging 51 and 38% for the low and high N rates, respectively. These results suggest that more fertilizer stayed in the soil when fertilizer was applied at lower rates. Unlike Engelsjord *et al* (2004), their research results found high amounts of LFN in leachate. In particular, leachate NO_3^- concentrations in high fertilizer plots were more than double the EPA drinking water standard of 10 mg NO_3^-. The outcomes of the research by Frank *et al* (2004) indicated that high rate, water soluble N applications to mature turfgrass stands should be avoided to reduce the amount of NO_3^- leaching.

Using the labeled fertilizer method they were able to successfully trace N through the turfgrass system, demonstrating losses attributed to leachate, gaseous exchange, and bacterial immobilization. The previous two studies recorded N losses that ranged from 33% for perennial ryegrass fertilizers (Engelsjord *et al* 2004) to 22% for low-application rates on Kentucky Bluegrass (Frank *et al* 2006). The next study investigates the N utilization of another important Florida agricultural product, citrus.

Groundwater wells in the citrus producing regions of Central Florida have consistently exceeded drinking water standards for nitrate (USGS 2010) and much research has been dedicated to managing citrus production to optimize fertilizer uptake by plants and minimize the fertilizer lost to ground and surface waters. Previously in this section, the research demonstrated that fertilizer uptake efficiency depends on soil moisture, temperature, and microbial activity that drives nitrification and denitrification processes. The following research used enriched fertilizers in citrus production to closely examine plant uptake efficiency and inform agricultural best management practices.

Quinones *et al* (2007) used ^{15}N labeled potassium nitrate (KNO_3) to evaluate the impact of management strategies on plant N uptake and the seasonal distribution of N in the soil profile. Orange trees planted in large pots were randomly divided into two treatments both receiving 175 g N/year of the fertilizer, of which 125 g were supplied as labeled (7%) KNO_3. The difference in the two treatments was that one treatment received fertilizer over two applications using low frequency flood irrigation (LFFI) techniques. The other received high frequency drip irrigation (HFDI) with eight partial fertilizer applications monthly from March to October. Tree biomass and soil samples at five depth intervals were analyzed for ^{15}N content and N compounds.

By measuring variations of ^{15}N ratios in this mini-N cycle, the research clarified fertilizer uptake by plants across treatments as well as soil retention and leaching potential. Findings demonstrated that multiple applications of N in relatively small amounts via drip irrigation (HFDI) resulted in lower NO_3^- residuals that can lead to groundwater pollution. HFDI fertilizer management also resulted in more efficient plant uptake (75% for HFDI vs 63% for LFFI) and contributed to a consistent flow of nutrients needed to maintain microorganisms in the soil. The researchers concluded that reducing the amounts of N and water applied to citrus would not only reduce the environmental impact but also increase the N uptake efficiency of the plants. Applying fertilizer in frequent small doses via drip irrigation proved to be more efficient for citrus tree uptake. The N loss in this study was estimated to be 25% for the high-frequency, drip irrigation fertilizer method and 37% N loss for the low frequency, flood fertilizer method.

The previous studies demonstrated how ^{15}N can be used to trace nutrient uptake and utilization in small scale agricultural experiments. Isotopic N can also be used as an indicator of large scale system dynamics to understand ecosystem nutrient dynamics. Amundson *et al* (2003) found climatic and spatial patterns of $\delta\ ^{15}N$ in soil and plant organic matter worldwide. These patterns clarify N cycling processes and efficiencies that can be used to predict ecosystem resilience to additional N inputs resulting from anthropogenic disturbance. Plants in a N-limited systems typically found in tropical climates with sandy soils have a high C:N ratio and soils that are more depleted in ^{15}N. This is because N-limited systems are characterized by plants and microbes that uptake more NH_4^+ than NO_3^-. High rates of NO_3^- and NH_4^+ immobilization occur due to high levels of mycorrhizal soil fungi and low rates of N_2O production (Amundson *et al* 2003). By measuring $\delta\ ^{15}N$ values in plants, soils, and the difference between the two ($\delta\ ^{15}N_{plant-soil}$), the researchers found patterns indicative of different sources of plant-available N and of system N storage capacity. Their findings suggested that N-limited systems with more enriched $\delta^{15}N$ soil values and lower $\delta^{15}N_{plant\text{-}soil}$ are the most susceptible to immediate negative impacts of increased N depositions, (Amundson *et al* 2003). Wetter and colder systems were more efficient at conserving and recycling N than drier and warmer systems. From this research, it is clear that climate level influences played a significant role in N isotope processing and retention and that Florida's N-limited systems are particularly susceptible to environmental problems resulting from increasing N inputs. This will be discussed further in the following research which examined different land uses to clarify N dynamics in changing systems.

Bowen and Valiela (2008) evaluated the extent of coupling between estuaries and watersheds with varying human land uses and different biogeochemical and meteorological drivers. By examining the ^{15}N ratios in surface water, groundwater, and primary producers, the research demonstrated a method to trace N from the watershed into receiving waters. Clarifying the land-water connection predicted the resilience of estuaries to land-based N inputs.

They found that land use differences in the watershed were noticeable in the values of $\delta^{15}N$- NO_3^- in ground waters. In forested systems, groundwater NO_3^- concentrates were relatively low and depleted in $\delta^{15}N$, suggesting an atmospheric source of N as the primary input. In contrast, watersheds with urban land uses had much higher NO_3^- concentrations with a larger range of $\delta^{15}N$ signatures, indicative of wastewater derived sources of N. They also found that NO_3^- concentrations in groundwater tended to be orders of magnitude higher than NO_3^- concentrations in surface water, except where extensive agriculture took place. In agricultural areas, NO_3^- concentrations were higher and the $\delta\ ^{15}N - NO_3^-$ signature was near 0 $^0/_{00}$ due to the input of atmospherically derived fertilizers.

They evaluated coupling by comparing the $\delta\ ^{15}N$ isotopic signature of primary producers with those of the incoming ground and surface waters. They found that the isotopic signatures of rooted vegetation and non-rooted macroalgae and particulate organic matter differed among estuaries. Primary producers in receiving waters from forested watersheds had $\delta\ ^{15}N$ isotopic signatures that were depleted relative to the atmospheric standard, consistent with the groundwater $\delta\ ^{15}N$ isotopic signature. Primary producers in one of the mixed use watersheds had an enriched $\delta\ ^{15}N$ isotopic signature, also consistent with the enrichment found in the groundwater. However, primary producers in one of the estuaries did not reflect the $\delta\ ^{15}N$ signature of the enriched groundwater, indicating that groundwater was not the primary N source.

Their research demonstrated a mechanism for evaluating the land-water connection which can predict the sources of N and potential for estuarine eutrophication based on coupling effects. The researchers concluded that if shifting land uses affected receiving waters, the relative importance of these land uses could be indicated by the $\delta\ ^{15}N$ signatures of estuarine biota. "In coupled systems, the $\delta\ ^{15}N$ isotopic signature of primary producers would be determined by the isotopic signatures of the incoming groundwater and by any fractionating processes that occur in the estuary. If the system is uncoupled, then internal fractionation would be the sole source of the $\delta\ ^{15}N$ signatures of the primary producers," (Bowen and Valiela, 2008).

The dynamics of system coupling was also investigated by Compton *et al* (2007), who examined N dynamics and $\delta\ ^{15}N$ patterns in forest re-growth after agricultural abandonment. They found decreasing δ ^{15}N in plant biomass and increasing δ ^{15}N in soils over time. They explained this "uncoupling" of plant and soil as resulting from decreasing N availability. Soils became increasingly enriched in δ ^{15}N due to high nitrification rates immediately following agricultural abandonment. As a result, increasing $^{15}N - NH_4^+$ became available for plants during early successive phases. Over time, nitrification was reduced and mineralization-mycorrhizal processes become more important sources of plant available N. This resulted in depleted ^{15}N in plant tissues years after abandonment. The extent to which plants and soils are coupled varied over time after disturbance, becoming increasingly uncoupled over time.

The research by Compton *et al* (2007) contributed important ecosystem level N linkages demonstrating fractionating losses and enrichment over time after disturbance. In a system without disturbance, it would take a long time for nitrate leaching and denitrification processes to enrich ^{15}N in soils and plants. Compton *et al* (2007) found that immediately after agricultural abandonment, the soils and plant biomass had high δ ^{15}N due to the nitrification and denitrification processes which discriminate against the heavier ^{15}N and leave it behind. They found that the ^{15}N in plant biomass depleted rapidly after agricultural abandonment, more rapidly than the soil δ ^{15}N. They suggested that this may be an uncoupling of plants and soils, perhaps due to plants becoming more efficient at mineralizing their own N via the mineralization–mycorrhizal uptake pathway (Compton *et al* 2007). It could also be that the plant uptake flow path also prefers the non-isotopic N compounds if they are available.

It is important to understand the stoichiometric ratios of essential elements because the relative proportions of nutrients will determine how downstream recipient systems will respond (Kaye *et al* 2006). This section summarized research on the N cycle, N dynamics, and the use of isotopic N to understand N fate and transport from small scale to large scale ecosystems. This information is important to predicting and mitigating long-term ecosystem impacts resulting from land use changes and increasing anthropogenic N inputs. Applying an understanding of N dynamics to the landscape can be challenging, particularly when it is highly disturbed, fragmented, and managed by a variety of landscape managers. The final research project to be discussed looks specifically at N retention in urban lawns relative to forests in order to better understand the lawn ecosystem so that better management strategies can be applied to reduce the potential for N losses in the suburban ecosystem.

Raciti *et al* (2008) conducted a pulse $^{15}N- NO_3^-$ experiment simulating the effects of N atmospheric deposition. They applied a labeled (99% enriched) KNO at a rate of 0.3 kg N/ha (0.006 lbs N/1000 ft^2) to four turf grass and four forested experimental plots. They measured soils, roots, thatch, aboveground biomass, microbial biomass, inorganic N, and N_2 gas in urban lawns and forests several times over the course of one year. They found that lawns retained a higher proportion of $^{15}N- NO_3^-$ overall and suggested this was largely due to lawn clippings in thatch contributing to mineral soil organic matter.

Lawn thatch was found to be a significant N sink consistent with other turfgrass studies (Engelsjord *et al* 2004; Frank *et al* 2006). While soil organic matter acts as a sink, it also limits the amount of available N for plant uptake. They suggested that large inputs of labile N to lawns decreased the need for plants and microbes to access N from the soil organic matter. Feeding the lawn artificial fertilizer resulted in it being less likely to mineralize N from the naturally occurring organics, in essence creating a chemical dependent grass.

Both lawns and forests were found to have tightly cycled N dynamics with low leaching potential. However, the likelihood for leaching was greater in lawns which had more pools of available NO_3^-. It is hard to know how long lawns can retain N inputs before leaching starts to incur. The research by Frank *et al* (2006) suggested that as the lawn aged, its capacity to retain N decreased and thus the potential for leaching increased. This would also support the suggesting that leaching increases as NO_3^- pools saturate the soil organics. Raciti *et* al (2008) also found that lawns effectively sequestered small concentrations of labile NO_3^- indicative of atmospheric deposition, but that the mechanism by which the N was retained changed over time from soil organic matter to short-term biomass and back to soil organic matter. Factors such as lawn age, lawn management practices, soil disturbance history, soil type and seasonal variations in N deposition may be key to understanding the potential for urban lawns to leach NO_3^-.

A study by Roadcap *et al* (2001) investigated the effectiveness and applicability of using the nitrate-oxygen isotope ratio to identify sources of nitrate (NO_3^-). They focused on characterizing the isotopic shift that occurred during microbial denitrification processes that preferentially select the lighter ^{14}N-NO_3^-, leaving behind ^{15}N-NO_3^-. Based on previous findings (Bottcher *et al*. 1990, Aravena and Roberston, 1998, in Roadcap *et al* 2001), they developed an equation that used the concentration and isotopic ratio of the source NO_3^- to measure the extent of denitrification of NO_3^- as it traveled through the system and confirmed that the enrichment of ^{18}O :^{15}N is 1:2. They also used $\delta\ ^{18}O$ and $\delta\ ^{15}N$ measures to understand source contributions from organic or atmospherically derived

NO_3^-. They developed a source allocation matrix (Figure 1) to plot concentration points of δ ^{18}O- NO_3 and ^{15}N-NO_3 from two groundwater monitoring wells with referenced source ^{18}O and ^{15}N values such as those expected of synthetic fertilizers or manure or septic wastes.

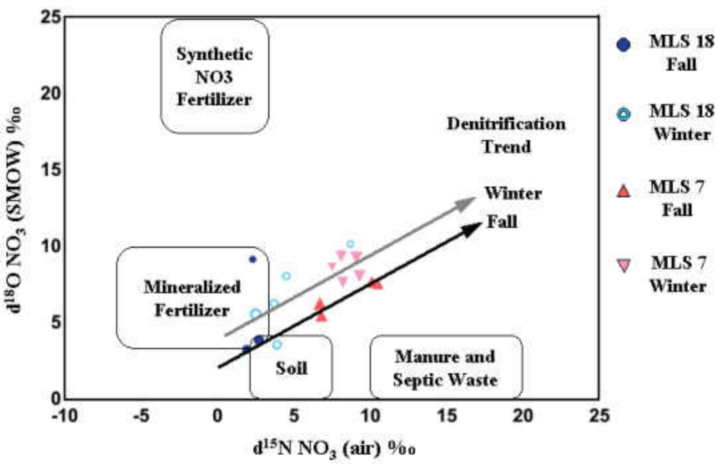


Figure 1: Crossplot of Nitrate Isotopic Values from Roadcap *et al* (2001)

The MLS-7 monitoring well located down gradient of a corn field was more enriched in ^{15}N and followed a linear trend of enrichment that is typical of denitrification. The monitoring well, MLS-18, nearest the corn field had isotope values typical of nitrate from nitrogen fertilizers. The isotopic pattern between these two wells showed the mineralization and denitrification processes as the NO_3^- flowed downstream from the agricultural field. Their findings provided valuable information about the use of isotopes to understand source and pathways of NO_3^- in the human ecosystem. They also showed that NO_3^- from partially denitrified fertilizer can have a similar ^{15}N value as NO_3^- derived from animal waste after it has undergone denitrification processes. Adding the oxygen isotopic ratio helped overcome this challenge.

Nitrogen Impacts

In 2008, the FAO (2010) estimated that fertilizer manufacturers fixed 101.6 million tons of N_2 with projections forecasted to increase 23.1 million tons by 2011/12. Unless this additional input of industrially fixed N_2 is balanced by denitrification processes, the excess will have adverse environmental impacts.

The human input of nitrogen in the form of industrially fixed nitrogen products, food products, and commercial fertilizers has greatly increased N outputs and "most of this additional nitrogen is applied as fertilizer that can run off into groundwater, rivers, and coastal waters," (Driscoll *et al* 2003). While the world's population increased 78%, the amount of reactive nitrogen entering the system increased 120% (Galloway *et al* 2008), showing that impact increases at a disproportionately higher rate than population growth.

The land use change from rural and forest landscapes to the monoculture turf grass suburban landscape remains understudied although its significance increases with increasing development pressure (Robbins and Birkenholtz 2003). The area of lawn is increasing at a rate disproportionate to population growth, as smaller families are moving into larger homes and occupying larger lots. New residential development with larger turfgrass areas are growing along with the associated fertilizer inputs. The land use change from agriculture to residential does not result in less N lost to the environment (Gold *et al* 1990).

The nitrogen compound most commonly found in ground and surface water is nitrate, which is toxic to aquatic organisms and can be toxic to humans in high concentrations. Nitrate (NO_3^-) affects the oxygen-carrying capacity of the blood, alters blood chemistry, affects immune response, and acts as an endocrine disruptor (Cantor 1997, Fan *et al* 1996). NO_3^- has been found to be toxic to aquatic organisms such as insects (Camargo *et al* 2005, Beketov 2004), amphibians (Hecnar 1995), fish (Edwards *et al* 2004), and alligators (Guillette and Edwards 2005). Ingestion of excess nitrate by humans can cause methahemoglobine disease in children (blue baby syndrome) and has been linked to stomach cancer (Cantor 1997, Vitoria *et al* 2004).

Nitrate (NO_3^-) and other nutrients also contribute to the degradation of aquatic systems through eutrophication, reduced dissolved oxygen, high chlorophyll levels, and excessive algae growth. Although federal drinking water, surface water, and groundwater standards exist for nitrate, no water quality standard establishes limits to address NO_3^- loading to surface waters (Driscoll *et al* 2003). If nitrogen causes aquatic systems to exhibit signs of eutrophication such as low dissolved oxygen, high turbidity, and high biological oxygen demand, than federal standards to reduce Total Maximum Daily Loads (TMDLs) of nutrients will come into play. TMDLs are a federal EPA mandate that guides state governments to establish appropriate water quality goals and implement management practices to achieve those goals. Using long-term monitoring data, the TMDL regulatory process identifies and lists “impaired” surface waters on the US EPA 303(b) list when management actions must be taken to reduce specific pollutants.

In Florida, nearly every surface water body is listed for nutrient impairments with impaired tributaries flowing into impaired estuaries and bays. The nutrient impaired Apalachicola and Chattahoochee Rivers discharge to the nutrient impaired Apalachicola Bay, an important area for shellfish management. The nutrient impaired Alafia, Manatee, and Hillsborough Rivers lead to the nutrient impaired Tampa Bay along Florida's west coast, a popular tourism destination and estuary of national significance. On Florida east coast, the nutrient impaired Sebastian River, Eau Gallie River, and Crane Creek discharge to the nutrient impaired Indian River Lagoon, an estuary of national significance designated the most diverse estuary in North America. Perhaps even more disconcerting is the increasing nitrate levels found in Florida's groundwater, where most of the population gets its drinking water.

Nitrate (NO_3^-) concentrations in Florida's springs have increased with increasing land use development over the past fifty years (SJRWMD 2007). Central Florida groundwater wells monitored for nutrients and pollutants have consistenty exceeded drinking water standards for nitrate (USGS 2010). Since the Floridan aquifer spring source is also the primary source of residential drinking water, increasing groundwater NO_3^- concentrations present a public health issue that will be challenging and costly to remediate.

In a stormwater best management practices cost analysis by England & Listopad (2012), the mean values of cost per pound of TN removed per acre treated were $3,630 for dry retention pond, $63,196 for floating vegetated island, $112,819 for exfiltration trench, and $427,695 for wet detention pond, an average of $151,835 TN lb/acre treated. With cleanup estimates in the billions of dollars statewide, drinking water at risk, and Florida's important fisheries and tourism industries at stake, the state has initiated a strong directive to understand and reduce sources of nitrogen. Understanding the sources of nitrogen in the suburban landscape necessitates an investigation of human behaviors, social influences, and institutional controls. The following section focus on the human dimensions of suburban landscaping impacts.

Human Dimensions of the Nitrogen Cycle

Research attempting to measure nitrogen inputs to and runoff from residential lawns shows varying results observed at different scales. At broader scales, research shows that demographics like population size and density, types of land use, education, and income relate to increased fertilizer use and increased concentrations in runoff (Boyer *et al* 2002, Robbins *et al* 2001). Larsen and Harlan (2006) found an interesting, non-linear relationship between income and environmentally-friendly front yard landscape preferences design in a desert climate. The environmentally-friendly yard designs contained more xeriscape plants that were drought tolerant and require less water. The research found that low-income homeowners preferred mostly lawn front yards, middle income homeowners preferred environmentally-friendly landscaping, and higher income residents were divided between the two. Housing age is a significant positive predictor of yard vegetation cover, plant diversity, and lower fertilizer application rates (Grove *et al* 2006; Whitney and Adams 1980; Hope *et al* 2003; Law *et al* 2004).

How are housing age, landscape preferences, and fertilizer use related? It may be that lawns in older homes don't require fertilizer because more efficient uptake is accommodated by soil nutrients available to the lawn from biological activity. As suggested by Compton *et al* (2007), the plant and soil interface needs to recover from development disturbance so that mycorrhiza and bacteria can function efficiently to mineralize N from organic matter. This will tighten the N cycle, hold N in the soil and root zone, and reduce N losses.

The reason for the reduction in lawn fertilizer use over time may also be cultural. It may be that older communities are more relaxed about individual yard care and the social pressure to conform to a high-maintenance landscape decreased over time. Or the homeowners may become more relaxed or interested in making changes to the yard. The homeowner's perceived community landscape expectations have an influence on their landscape choices.

It is clear that suburban landscapes operate as a communication system for people to seek information about each other. Society views the lawn as an indication that the community conforms to an aesthetic of purity and homogeneity (Feagan and Ripmeester 2001). Good citizens and good neighbors are characterized by the appearance of their home's landscape which is expected to be neat and picturesque, safe and inviting, or exhibiting power and affluence (Nassauer 1995, Shern 1994). The lawn aesthetic demonstrates a classed expression of community participation, family interaction, and a controlled association with nature (Robbins and Sharp 2003). The front yard in particular represents the socially acceptable, highly visible image that communicates status and identity to society (Larsen and Harlan 2006). People tend to perceive landscapes that are not manicured monocultures as messy and unkempt.

Interestingly, research shows that people are willing to pay more for alternative landscape designs, but the adoption of such is often impeded by societal level barriers such as local ordinances; homeowner's association covenants and restrictions; inadequate information about plant materials, installation, or maintenance, and lack of adequate plant availability and knowledge (Helfand *et al* 2006). As a result, alternative landscape designs requiring low intensity maintenance are rarely chosen by homeowners, owing both to consumer and community aesthetics (Bormann *et al* 2001) and to the time and expense of alternatives (Templeton *et al*. 1999). Even in a willing community, challenging the normative landscape appearance is difficult at best and in many cases, nearly impossible due to the powerful pressure of institutional and societal norms.

Individual beliefs about landscape aesthetics, landscape maintenance preferences, neighborhood conformity, perceived market influences, and fertilizer requirements play an integral role in predicting the environmental impact of suburban landscape management that may be just as important to understanding the potential for nitrogen loss as soil characteristics and moisture content (Raciti *et al* 2008, Erikson *et al* 2008, Law *et al* 2004). Residential landscape management decisions are highly-motivated by community level expectations and homeowners association requirements. In some cases, individuals are so powerfully motivated by social expectations and normative landscape appeal that it is difficult for them to act on their personal beliefs at the risk of losing social status or worth. Robbins (2007) describes "lawn anxiety" as an emotional state where an individual recognizes the polluting potential and toxicity of their landscape maintenance regime but is bound to it nonetheless by society's overwhelming influence. This conflict between individual beliefs and social expectations is demonstrated in research that shows fertilizer use is disproportionately heavy among those who not only claim environmental concern but who also acknowledge the negative effects of their actions (Robbins *et al*. 2002). Since individuals' landscaping practices are highly motivated by the communities in which they live, it is important to investigate the power of community level influences when identifying N source hotspots.

Decades of social research demonstrate that community norms and expectations to a certain residential landscape type can strongly influence homeowners' landscape management practices which relate to potential environmental impacts. A strong link between individual actions and community expectations is evident.

Institutional Influences on Residential Landscape Norms

Since the post-world war suburban boom, society has been sold the lawn as the normal neighborhood landscape supported by academic and agrichemical research to require synthetic, chemical inputs as the "intelligent" way to maintain it. Suburban development was accommodated by fast-growing, easily transported and readily installed turfgrass ground cover that functioned perfectly as an aesthetically pleasing, soil and erosion control mechanism. Grass became big business, big research, and big advice with the goal to use experimental turf science to promote suburban lawn-scapes as the ideal (Whitney 2010). The birth of a new research agenda began and a partnership of turfgrass and chemical industries and academia to create a place where social status, conformity, and acceptance was contingent on having a lush, green lawn. This was reinforced in the decades that followed by landscaping professionals, real estate developers, nurseries and growers, and chemical manufacturers who sold the 'green lawn' to consumers as a commodity, imposing false needs and wants upon people's attitudes, values, and ultimately self-worth as it related to their community (Dorsey 2009). Overcoming the market reinforced sense of place, worth, and value associated with the high-intensity maintenance lawn requires a change in social norms, perceptions and values, it requires a paradigm shift. This change will not happen easily and certainly not without institutional support to reinforce it.

The residential lawn as an ordered monoculture has proven nearly intractable to reform due to the societal and institutional controls that sustain it (Feagan and Ripmeester, 1999). In the past, few management practices were implemented to specifically reduce nitrogen pollution resulting from residential landscaping practices, and some management practices such as water conservation simply transform nitrogen from one form to another rather than reduce it (Baker *et al* 2001).

Attempts to implement fertilizer application best management practices and residential fertilizer use restrictions have been initiated recently in Florida with on-going challenges from powerful turfgrass and fertilizer industries. The politics of turfgrass can be more powerful than the politics of water quality. Identifying responsible parties associated with N inputs becomes a game of dodge-ball during which stakeholders are quick to accuse others or cite irrelevant scientific literature to support their argument instead of addressing their role in preventing N pollution.   Committees established to advise water quality standards may also be inundated with suburban development interests and traditional point-source industries eager implicate agriculture instead of addressing nonpoint sources such as suburban landscapes (Maddock, 2004).

In Florida, the on-going policy debate regarding fertilizer regulations, local fertilizer ordinance control, and the potential for fertilizer impacts is reinforced by a research agenda largely funded by the turfgrass industry ("Advisors on Fertilizer Ban" St. Pete Times 2009). The state's recommended fertilizer application rates (Table 1) which are linked to the pre-emptive ordinance language and Rule 5E-1.003(2) Labeling Requirements for Urban Turf Fertilizers are based on turf grass quality research that fails to consider environmental impacts (Sartain *et al* 2009, IFAS Publication ENH 1115).

Table 1: FDEP Recommended Turfgrass Fertilizer Application Rates (2008)

Nitrogen Recommendations (lbs N/1000 ft2/ year)			
Grass Species	North Florida	Central Florida	South Florida
Bahia	2-3	2-4	2-4
Bermuda	3-5	4-6	5-7
Centipede	1-2	2-3	2-3
St. Augustine	2-4	2-5	4-6
Zoysia	3-5	3-6	4-6

Little research in Florida has been dedicated to measuring the polluting potential of turfgrass fertilizers on surface water quality or to evaluate the effectiveness of the state's Florida-friendly landscaping program at reducing nitrogen loads. International turf-grass and agrichemical companies are powerful forces directing the Florida legislatively backed research agenda. Industry lobbied for weak model fertilizer ordinances that didn't consider environmental impacts and then pre-empted local authority from adopting more stringent ordinances, (SB 606 2011, HB 1414 2010, 2009). This happened at a time when nitrate levels were increasing in surface and ground waters and regulatory requirements funded with public tax money were required to remediate the problem.

Even with all of these challenges, in 2009 the Florida legislature passed Senate Bill 2080 to promote the use of Florida-friendly landscaping among homeowners association (HOA) governed communities as a means to protect the state's water resources. The law stated that "covenants, restrictions, and ordinances may not prohibit Florida-Friendly Landscaping practices" (FDEP, FDACS, Frequently Asked Questions, n.d.). The law provided leverage for homeowners seeking an environmentally-friendly landscape to bring to their HOA when they requested changes. In some cases, the HOA was motivated to seek out the Florida-friendly Landscaping Covenants, Conditions and Restrictions (UF 2009) and they pro-actively adopted new committee review standards to allow alternative landscape designs.

Unfortunately, in other cases, implementation of SB 2080 was not proactively undertaken by the HOA, but became a reaction to a homeowners request. At that point, the HOA's governing board had the existing covenant to reinforce its will. For example, if the covenant language specified a required type or coverage amount of turf-grass, the homeowner had little ground to stand on to make the HOA change. If the HOA required a certain appearance of the turfgrass, the homeowner could be fined if not in compliance. If the homeowner interpreted the law so that turfgrass was a Florida-friendly plant, than the homeowner had no recourse but to comply with a turfgrass lawn. According to the Florida-Friendly Landscaping Covenants, Conditions and Restrictions (UF 2009), the HOA has strength of the existing covenant that requires the "basic expectations created in the original scheme" of development to be maintained. HOAs that are not motivated to change their covenants to allow environmentally-friendly landscaping can fall back on their existing covenants to refuse to change. This was true in the case studies summarized below.

After the passing of SB 2080, two residents who heard about this study contacted me to disclose how the bill failed to support them when they requested an environmentally-friendly landscape from their HOA (L. Souto personal communication 2009, 2010, 2011). In the first case, a coastal resident wanted to replace his St. Augustine turfgrass lawn with beds of native plants. The primary reason for the change was to reduce the need for turfgrass pest control chemicals that adversely affected the health of a family member. The homeowner also wanted to increase the diversity of plants, reduce outdoor water use, and minimize reliance on fertilizers. He hired a landscape designer and presented an architectural design to his HOA's Architectural Review Committee for approval. The HOA committee denied his request by defining the St. Augustine turfgrass that covered his yard as a Florida-friendly plant, arguing that his yard was in essence already Florida-friendly, and that he was maintaining the yard with Florida-friendly landscaping practices by applying the prescribed amount of nitrogen fertilizer annually and applying pesticides "as needed." This case demonstrated how this law can be loosely interpreted by the HOA to maintain the status-quo and how the homeowner takes on the risk of incurred costs to no avail. Although he paid for a landscape design and spent time working through the review process, the homeowners request was ultimately denied.

In a second case, a Central Florida resident wanted to replace the St. Augustine turfgrass in his yard because he wanted to reduce the amount of fertilizer, chemicals, and water needed to maintain it. The homeowner determined that maintaining the St.

Augustine lawn required too much fertilizer to survive. To prove his point, the homeowner applied the lowest recommended amount of nitrogen (2 LBs N/1000 ft^2 /year) and irrigated twice a week as required by water restrictions. His lawn deteriorated and as a result, the homeowner wanted to eliminate about 4000 ft^2 of turfgrass and plant bed areas, vegetable gardens, and trees. He also wanted to replace the remaining St. Augustine turf grass with a more hardy and drought-tolerant bahia-grass variety.

He planned these changes over several months and requested permission from the HOA Architectural Review Board. He was informed that if he replaced the St. Augustine grass with bahia-grass he would be sued by the HOA on the basis that St. Augustine was required by their covenants. Changing the covenant to remove the St. Augustine turfgrass requirement would require a supermajority (80%) vote by the residents of the community. The homeowner was also required to submit certified architectural plans with his request to install flower beds or vegetable gardens. Some HOA board members viewed the bahia-grass and vegetable garden beds as “lower-class” and inappropriate for their “upper-class” neighborhood. Their response demonstrated the power of turfgrass status in residential neighborhoods, not only that there was turfgrass, but that it must be “upper-class” grass. This case also demonstrated the extensive effort and cost burden on the homeowner to seek HOA permission for installing a more environmentally-friendly landscape. The resident had to develop his argument, hire a landscape architect, apply to the HOA committee, and argue before his neighborhood council and his peers for the right to plant what he wanted in his yard. The news of his experience would likely discourage other in his neighborhood and in other HOAs from attempting to do the same.

The third and last case study included in this section about HOA changes and SB 2080 is a little different. As a result of applying for a new landscape design from his HOA, the homeowner in this case study risked the plants he already had. A third interview was conducted of a homeowner in a HOA managed subdivision who was interested in have a Florida-friendly front yard installed. He submitted an architectural landscape design and plant list to the HOA committee responsible for reviewing and approving landscape changes. During the approval process, board members visited the homeowner's yard and found that he had too many fruit trees than the number of trees listed in the covenants. The homeowner had an extensive collection of trees grafted with multiple varieties of exotic fruits grafted onto each stem. He had collected and grafted the fruit varieties over years, starting when his house was first built, before the covenants were even in place. He was told by the developer that his trees were "grandfathered in", meaning the new covenants wouldn't apply to them. Nearly ten years later, the HOA committee demanded that he remove all of the trees, except the two permitted by the covenants. The homeowner hired an attorney to defend his rights to keep the trees on the basis that he had developed his lot and planted the trees prior to the covenants. The outcome was that the homeowner and the community spent tens of thousands of dollars in legal fees and the homeowner was denied the right to keep his trees. In this case, bringing his yard to the attention of the HOA resulted in him losing something he loved and valued. It's a risk to involve the HOA.

Even with the passing of Florida's SB 2080, the burden remains with the homeowner to present an arguable case to his community about an alternative landscape. Interviewed homeowners talked about the HOA review committee members as being

“Nazi types” who are aggressive and power hungry (Landscape Exchange Project 2010). Some suggested that committee members were inconsistent and biased when they decided which plants were appropriate and which were not and when to apply the covenants and when not to apply them. In some cases, they overstepped their bounds as a committee and in other cases the committee’s inactivity allowed the landscape change to be approved by default. It is an unknown and potentially costly first step that a homeowner in an HOA mandated community will need to take to adopt an environmentally-friendly landscape.

Ultimately, homeowners must hire an attorney to battle the community in which they live, costing the homeowner social status and money. When asked if he referenced SB 2080 to support his case for an alternative landscape, one Central Florida resident thought it didn’t go far enough to enable homeowners, claiming “The legislature didn’t have the power to stand up to industry and to specifically restrict St. Augustine grass. I am not naïve about the business and economic impact that this will have, but the short-term focus and compromises that were made today knowing the needs that we are going to face in the future…” (Personal communication, L. Souto 4/13/2011). Landscape design is controlled by human preferences and the community norm will likely prevail. Although recommendations limit “excessive” application of fertilizers and pesticides or “recommend” plants that are drought-tolerant, Florida is hesitant to recommend, require, or enforce a turfgrass limitation or ban the chemicals required to maintain it.

Other areas of North America have banned the use of lawn pesticides and fertilizers with interesting societal and environmental results. Sandberg and Foster (2005) investigated the societal response to pesticide bans in Canada. Contradictory to the market collapse predicted by industry as a result of the ban, the research found that the lawn and pesticide reforms in Canada did not impact the capital accumulation process. In fact, substitutes to the conventional lawn increased and diversified garden sales and launched new landscape management techniques specializing in integrated pest management. In Toronto, where pesticides were banned, homeowners invested in landscape alternatives in a "power of the plant" showing that in some cases resulted in expensive gardens considered more valuable than the houses (Sandberg and Foster 2005).

Similar to other research, they found that although homeowners were wealthy, well educated, and knowledgeable about the negative health effects and environmental impacts, they still applied pesticides and herbicides to the lawn (Sandberg and Foster, 2005). The pesticide ban provided these homeowners the normative reinforcement they needed not to apply poisons to their lawn. It released people from the normative pressure and allowed them to act in accordance with their personal beliefs. The Canada pesticide ban demonstrated that markets and homeowners will adapt to meet the needs for different kinds of landscapes. When they banned lawn pesticides in Canada, people responded by creating beautiful gardens instead of green lawns.

Although people are willing to pay more for alternative landscape designs, the adoption of alternative landscape designs is impeded by local ordinances, homeowner's association restrictions, lack of knowledge about plant materials and design, lack of understanding of installation or maintenance, and lack of adequate plant availability and knowledge (Helfand *et al* 2006). At a finer scale, low-input landscape design and management are rarely chosen by homeowners, owing both to consumer and community aesthetics (Bormann *et al* 2001) and to the time and expense of alternatives (Templeton *et* *al*. 1999). Even in a willing community, challenging the normative landscape appearance is difficult at best and in many cases, nearly impossible.

This dissertation research provides a method to meet the challenges of sustainability by investigating the polluting behaviors in terms of human motivations for a non-sustainable landscape and the barriers that prevent change. Because this is an applied research project that is seeking to model the drivers of human action, a research framework is needed that can be interpreted for program implementation and evaluation. Social marketing provides the framework for applying research results to policy program strategies.

Social Marketing

The term "Social Marketing" was introduced by Philip Kotler and Gerald Zaltman in the 1970's to describe a method of applying market research to deliver social messages that influence behavior for the good of society (Kotler 1982). It is based on the assumption that humans use rational thought when deciding on a course of action and that each individual goes through a "cost/benefit" analysis before realizing their intentions. The social marketer seeks to understand and segment audiences by the values and preferences, perceived controls, social norms, and motivators and barriers that influence the individual's behavior (Kotler *et al* 2002). Research helps prioritize target populations based on their potential impact and likelihood to change (McKenzie-Mohr and Smith 1999.) Sometimes the behavior that would result in the greatest reduction in impact is not attainable because the barriers preventing the behavior change are too great. Understanding the determinants influencing the behavior can help program implementers develop strategies, prioritize actions, and evaluate results. Measuring social marketing outcomes can be challenging and in some cases, changes are so gradual that outcomes measures are nearly imperceptible in the short-term. Seeking an antecedent measure or appropriate indicator of change is sometimes necessary. Finding the appropriate indicators of change and the methods to link behaviors to those indicators has become the charge of social marketing research.

Although there is dispute over the use of marketing terms as the constructs of behavioral analysis and the need for more rigorous methodologies (Andreasen 2003, Gordon *et al* 2006, Helmig and Thaler 2010), social marketing research and implementation over the past forty years demonstrate its capabilities at predicting and measuring behavior change, particularly in the health arena (Thackeray *et al* 2012). Social marketing has been widely adopted by U.S federal agencies, particularly the U.S Department of Agriculture and the Centers for Disease Control and Prevention (Andreasen 2002), addressing such issues as tobacco use, obesity, teen pregnancy, hepatitis, and other health issues. It has also been used as a means to reduce injury (Trafimow and Fishbein 1994), to understand social involvement (Kelly and Breinlinger 1995), encourage voter turnout, pet care, and volunteering and to prevent illegal drug use, drunk driving, and crime (examples of case studies downloaded from www.cbsm.com). Social marketing research has been increasingly used to increase environmentally responsible behaviors such as energy consumption and efficiency (Pallak *et al* 1980, Niemeyer 2010), waste recycling (Tabanico and Schultz 2007, Haldeman and Turner 2009), alternative transportation (Cooper 2007, Hunecke *et al* 2010) and climate change policy (Nilsson *et al* 2004).

Social marketers utilize relational and cluster analyses to segment audiences based on their behavioral determinants as defined by a predictive framework. Program implementation strategies depend on understanding and defining homogenous groups, whether they be individual, products or behaviors. Identifying groups within the population would not be possible without an objective methodology (Hair *et al* 2006 pg 555). Cluster Analysis is the most common method of segmenting groups within a population. Also called Q analysis, typology construction, classification analysis, and numerical taxonomy, cluster analysis uses numerous multivariate techniques to group objects based on similar characteristics (Hair *et al* 2006 pg 559). If the classification is successful, objects within a cluster will have high internal homogeneity and high external heterogeneity on the selected characteristic. It is important for the researcher to select variables used for cluster analysis that have strong conceptual support. Framing variables within the well-established framework of proven socio-psychological theory provides the foundational support for identifying clusters of varying behavioral groups.

Social-psychology theories like the Theory of Planned Behavior (Fishbein and Ajzen 1975, Ajzen 1988, 1991) have been used to segment audiences according to the determinants of performing a specific behavior based on associated motivators and deterrents. According to this theory, behavioral intentions are influenced by behavioral and social norms as well as the perceived behavioral controls (Ajzen 1988). Defining behavioral intention as the immediate antecedent to behavior allows a measurable variable for analysis when observable changes are not practical. The Theory of Planned Behavior (TPB) has been successfully used by researchers to understand many environmentally responsible behaviors that could not be readily observed (Tabanico and Schultz 2007, Brown *et al* 2010, Nigbur *et al* 2010, Wagner 2011).

Another important contribution of social-psychology theory to social market research is the use and understanding of social norms that affect the behavior and the framework of normative influence that is provided by Normative Action Theory (NAT). According to NAT, social norms influence individual decision-making through the perceived social costs and benefits and the pressure to conform to important referent groups (Schwartz, 1977, p 223). Understanding the extent that a behavior is influenced by social rather than individual influences can help practitioners develop strategies to motivate behavior change.

Social-Psychology Theory

Theory of Planned Behavior

Icek Ajzen's Theory of Planned Behavior (1988) is one of the most influential and well-supported social-psychological theories for predicting human behavior based on intentions (Tabanico and Schultz 2007, Brown *et al* 2010, Nigbur *et al* 2010, Wagner 2011). The central premise of the Theory of Planned Behavior (TPB) is that behavioral decisions are not made spontaneously but are the result of a reasoned process. The TPB postulates that an individual's behavioral intentions are influenced by their attitudes, subjective norms, and their perceptions about the ease or difficulty of performing the behavior based on previous experience or anticipated obstacles. The last component referred to as the Perceived Behavioral Control (PBC) is thought to have both a direct effect on behavior and an indirect effect via intention (Smith *et al* 2008).

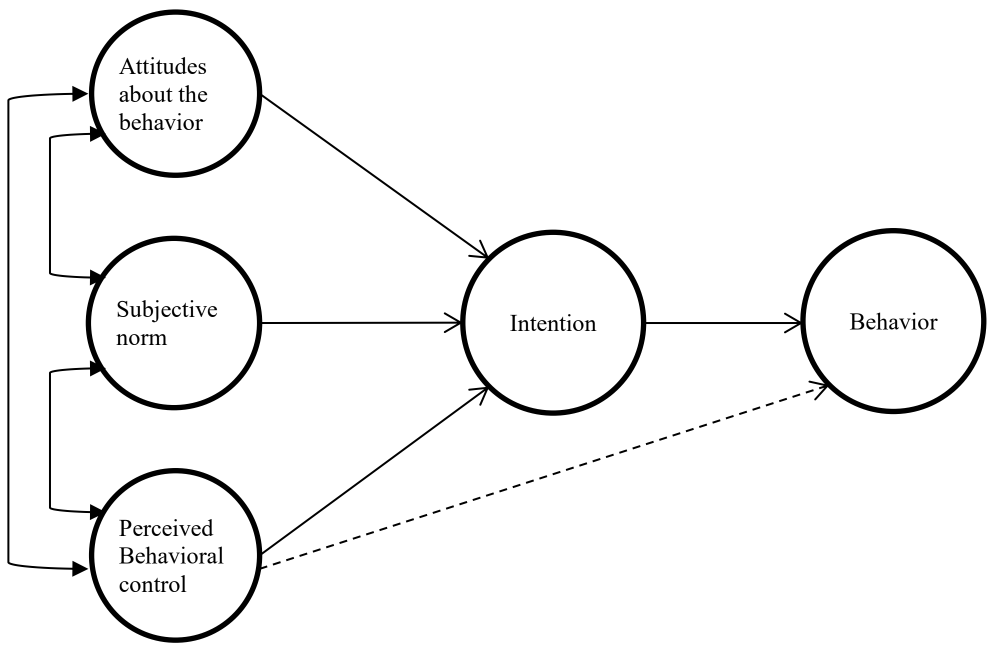


Figure 2: Theory of Planned Behavior (Ajzen, 1988, pg 133)

The TPB structural model (Figure 2) shows the relationships between attitude (the evaluation of the target behavior), subjective norms (perceived social pressure regarding performance of the behavior), and perceived behavioral control (PBC, perceived control over performance of the behavior) influence behavior primarily through their impact on behavioral intention. Hence, intention is seen as the proximal determinant of behavior. According to Ajzen (1988, pg 133), behavioral intentions represent the individuals' willingness to try performing certain behaviors, recognizing there are constrains and controlling factors that may prevent the behavior from being successfully implemented.

Attitudes are formed as an individual accumulates beliefs associated with events, objects, or characteristics about some action. There is reason to believe that individuals will form attitudes that are consistent with their beliefs (Fishbein and Ajzen 1975; Ajzen and Fishbein 1980). Although an individual may hold many behavioral beliefs, only a relatively small number are evaluated based on the expected outcome to determine the prevailing attitude and intention toward the behavior. Attitude toward a behavior is the degree to which performance of the behavior is positively or negatively valued. According to the model, attitude toward a behavior is determined by the total set of accessible behavioral beliefs linking the behavior to various outcomes and other attributes. The strength of each belief (b) is weighted by the evaluation (e) of the outcome or attribute, and the products are aggregated as shown in the Equation 2 (Ajzen 1988, pg 32.

$$A = \Sigma b_i\, e_I \;\; \textit{where } b = \textit{beliefs and } e = \textit{subjective evaluation} \qquad (2)$$

Normative beliefs refer to the perceived behavioral expectations of important referent individuals or groups. According to Ajzen (1988, pg 117), individuals are more willing to perform a behavior if they believe others think they should perform it. The subjective norm (SN) therefore includes both the perceived social pressure to engage or not to engage in a behavior and the individual's motivation to comply with the referent group. Equation 3 summarizes the relationship of Subjective Norm (SN) with the strength of the normative belief (b) and the motivation to comply (m).

$SN = \Sigma b_i \, m_I$ where b = normative beliefs and m =motivation to comply
(3)

Control beliefs have to do with the perceptions that may facilitate or impede performance of a behavior. The control beliefs in combination with the perceived power of each control factor determine the prevailing perceived behavioral control (PBC). Perceived behavioral control refers to people's perceptions of their ability to perform a given behavior as determined by the set of accessible control beliefs. The strength of each control belief (c) is weighted by the perceived power (p) of the control factor as shown in Equation 4. To the extent that it is an accurate reflection of actual behavioral control, perceived behavioral control can, together with intention, be used to predict behavior.

$PBC = \Sigma \, c_i \, p_I$ where c = control beliefs and p =power of the control factor
(4)

Intention is an indication of a person's readiness to perform a given behavior, and is considered to be the antecedent of behavior. The intention is influenced by attitude toward the behavior, subjective norm, and perceived behavioral control, with each predictor weighted for its importance in relation to the behavior and population of interest. In some cases, such as intention to lose weight or intention to get an “A” in a class, the actual behavior may be more influenced by the control factors than by the individual’s intentions. Ajzen (1988, pp. 141-142) demonstrated that college students’ attainment of getting an “A” in class was predicted more strongly by their intentions at the beginning of the semester and more strongly by their perceived behavioral control later in the semester. The perceived behavioral controls that could facilitate achieving the goal such as course materials, teaching abilities, and available assistance as well as obstructing factors like other coursework and extracurricular activities presented an additional influence to the student accomplishing the intended goal. At the beginning of the semester, when these other controls were unforeseen, the students intended to get a good grade. As the semester progressed, these additional influences that were not within their control started to play an important role in the outcome of whether their behavioral goal was attained. He concluded that the more the individual believed that the behavioral goal was under their control, the stronger their intentions were to try, and that the power of perceived behavioral control improves the prediction of actual behavior beyond that predicted on intentions alone. The measure of perceived behavioral control is likely to be an important construct for predicting landscaping behaviors.

A thorough understanding of an individual's intention to act can be revealed by investigating their beliefs about the likely outcomes of the behavior and the subjective evaluation of those outcomes; their beliefs about normative expectations of important referent groups and their motivation to comply with them; and their beliefs about the factors that can prevent or facilitate attainment of the behavioral goal. Together, this information provides a detailed explanation of an individual's likelihood to perform or not perform a particular behavior. Davis *et al* (2002) demonstrated that behavioral intention effectively increased the likelihood that tasks will be performed although it is harder to predict the amount of time that will pass between intention and action.

Although the TPB model has consistently been demonstrated to predict intentions and behavior, Armitage and Conner (2001) found that the predictive ability of the subjective norm construct was improved if a more expanded measure was used to clarify different types of normative influences. They found that other normative influences such as injunctive and descriptive norms played separate roles in predicting behavioral intentions. An additional socio-psychology theory, the Normative Action Theory (Schwartz 1977) contributes additional normative influences such as personal norms and moral obligations, denial of ability, and awareness of consequences. By introducing the measure of personal norms (obligations) in addition to the social norms described in the TPB, Normative Action Theory allows the investigation of potential conflicts between the two.

Normative Action Theory

Normative Action Theory (NAT) developed by Schwartz (1977) assumes that individuals act as part of a group and have a collective obligation to preserve the group's integrity. Instead of individual costs and benefits like those constructed by the TPB, NAT considers social costs and benefits to determine the likelihood for action. In addition to the costs and benefits described in the TPB, the NAT theory assumes that "obligation" is a strong motivator for individual action. It also enables the application of research results by providing a framework for operationalizing influences that can be translated into actionable strategies.

The NAT model defines a series of steps that compel an individual to act, initiating with personal activation and then normative action. First, the individual perceives there is a need for action that can be remedied and that by taking action, he could relieve the need. To be recognizable to the individual, the need must be obvious, understandable, and believable. Schwartz describes the measurement of "Awareness of Consequences" as the extent that the individual perceives there is a need to act and feels responsible to do so. Next, the individual must perceive actions that will remedy the need. Although the individual is motivated to act, if he can't think of anything to do, he cannot. Schwartz also suggested that activation will cease if the individual cannot see themselves as capable of carrying out the act that is needed to relieve the need. After this phase of personal activation, the individual moves into norm activation during which social norms and personal obligations are key considerations.

Norms are the situation-specific expected behaviors learned from social experiences and important referent groups (Schwartz 1977). They represent socially defined ideals through which individuals evaluate and judge appropriate action in a given situation. Values are personally defined ideals for evaluating appropriate action. Together norms and values make up Personal Norms (PN) which are tied to the individual's conformity to his own self-expectation when viewed in terms of adherence to important norms and values.

Nolan, Schultz, Cialdini, Goldstein, and Griskevicius (2012) demonstrated that normative influence was a highly effective way to motivate energy conservation behaviors. Their research compared explanations of household energy use and actual predictors of energy use to find that normative influence motivated people to conserve energy more than other appeals such as to be environmentally or socially responsible or to save money. What was even more interesting about this study was that the study participants did not rate the normative reason as the primary reason for their behavior change. They tended to rationalize their behavior based on their preference to be environmentally or socially responsible, not because they were normatively influenced by their neighbors actions. The study clearly showed the powerful, yet understated motivation of normative influence.

Cialdini (2003) suggested two types of social norms that differ in how they motivate action in the individual. Injunctive norms are the individuals' perceptions of the whether the behavior is one that is approved or disapproved by society or other important referent groups. The individual may perceive that littering, for example, is a behavior that is disapproved by society. Contradictory to this belief, the individual sees litter all over the ground. Cialdini (2003) explained that the societal demonstration of the behavior (littering) has a relevant influence on the individual. He described visual cues of societal behavior as descriptive norms perceived by the individual to be the typical behaviors conducted by society or other important referent groups. Injunctive norms can work in concert or in conflict with descriptive norms. In the case of littering, the two norms have conflicting influences on the individual who perceives that littering is not acceptable by society but that many people do it anyway. It is likely that household landscape maintenance behaviors are highly influenced by the individual's perceptions of neighborhood norms.

Carlson (2000) added that if behavior change requires significant individual effort, activating social norms can prove unsuccessful without considerable incentives provided to motivate behavior change. In these cases, facilitating the responsible behavior is necessary. For example, providing adequate receptacles for trash may reduce littering by individuals who want to do the right thing. In the case of landscaping, homeowners need an easy alternative.

Norms can be activated if individuals are motivated to change and the effort required of them is minimized by overcoming the barriers to change. Socially reinforced behaviors, like landscaping, change slowly but can reach a tipping point where a new landscaping norm is created with a concomitant social pressure to conform. Landscape managers can be segmented based on their levels of motivation and their perceived barriers to change using measures of landscaping attitudes, influences, and intentions operationalized within the framework of social-psychology theory.

Schwartz demonstrated measures and analysis methods to capture these variables by asking questions about obligations, feelings of guilt, awareness of consequence, ability to act and the perceived efficacy of actions. NAT contributes additional measures to illuminate the stage of behavioral activation.

The TPB and NAT provide a framework for measuring the potential to change behavior, which is relevant to applied research and actionable science in cases where the behavior is not easily observable. Using the constructs of individual beliefs, normative perceptions, and perceived controls provides valuable information needed for social marketing communications that address behavioral motivations and barriers. The potential for individually focused personal norms to conflict with socially reinforced social norms exists in residential landscape management, and using the foundational information contained in these two theories provides a basis for interpretation

CHAPTER TWO: LANDSCAPING PERCEPTIONS AND BEHAVIORS

Stakeholders working to solve water quality problems would greatly benefit from a better understanding of soil-water interface dynamics, groundwater and surface water coupling, human land management practices, and the potential for N losses to the environment. Much more research was needed to contribute to a better understanding of nitrogen dynamics in the suburbanized watershed and the potential impacts from varying land use patterns. The Landscaping Perceptions and Behaviors (P&B) Research provided a comprehensive, interdisciplinary, multi-method investigation of the suburban landscape and its impact on water quality. It collected information from Florida homeowners in three distinct but overlapping research projects at varying spatial and organizational scales. Initiated in the homes of research participants living in a 1000-acre (405 ha) subdivision in southwest Florida, then within a 303,000 acre (122,620 ha) springshed in Central Florida, and then statewide, this research covered a full spectrum of evidence investigating attitudes and influences that predict landscape maintenance intensity.

The research focused specifically on homeowner-occupiers of single family homes in the state of Florida. The reason for selecting this population was that I was seeking individuals who were more invested in their residence and their neighborhood (Friedrichs & Blasius, 2009). I was also seeking the primary decision maker responsible for making landscape design and management decisions for the household. Homeowner-occupiers were more likely to be the primary landscape management decision-maker who was either responsible for performing landscape maintenance themselves or directing someone else to do it.

In her doctoral thesis, Shern (1994) interviewed Michigan homeowners who used various means to maintain their lawn. She investigated the attitudes and uses of the lawn and found that homeowners reported that few activities were actually conducted on the lawn other than lawn maintenance. In her study, she found that homeowners did not perceive lawn chemicals as a threat to health. Interestingly, she classified household lawn motives into three psychological categories, those directed toward the self, those directed toward others, and those directed toward nature. Her description of the three lawn motives somewhat fit into the theoretical constructs of personal beliefs, which are directed toward the self, subjective and descriptive norms which are directed towards others, and attitudes about nature. In this Landscaping P&B dissertation, these three constructs were investigated within the framework of personal norms, community influences, and personal enjoyment of the garden.

During this project, I investigated Florida homeowners using a variety of qualitative and quantitative methods. I recruited homeowners as research participants and monitored their actions and decisions over three years in a suburban landscape change ethnography. The qualitative study provided important information about the dimensions of individual, social, community, and institutional level landscape influences that could be operationalized for quantitative data collection. Using this supporting qualitative information, a survey questionnaire was developed and administered in a Central Florida community to identify communities with the greatest potential to contribute nitrogen to the ecosystem. Plotting behavioral and environmental quality data demonstrated a method to pin-point polluting communities and their proximity to regional landscape features. By clarifying the linkages between home owners, their communities, and nitrogen in receiving waters, the research identified the locations of communities contributing more nitrogen to the system and explored the socio-economics and beliefs of the homeowners in those communities.

In a third Landscaping P&B Study, I created a predictive model framed in socio-ecological theory to better understand homeowners' desires for and objections to environmentally-friendly landscapes. Using the general constructs provided by the Theory of Planned Behavior and Normative Action Theory, I operationalized the attitudes, beliefs, and normative influences that impact homeowner landscape management decisions. In doing so, I intended to segment homeowners based on the power of personal and community level influences.

The research was designed to be actionable. The methods, measures and results can help programs prioritize and target appropriate audiences and evaluate success based on environmental and behavior change. Understanding the extent of personal and social normative influences can assist program implementers develop environmental marketing strategies that encourage homeowners to adopt more environmentally-friendly landscapes. Landscape P&B contributed the important and often missing, household-level information about homeowner challenges and motivators to adopting a more sustainable yard, while simultaneously plotting them on a map with environmental quality data. Human beliefs and actions were integrated with nitrogen in ground and surface waters, contributing to a further understanding of the complex urban nitrogen ecosystem.

This dissertation included three research projects that collected and spatially integrated data from multiple scales to understand the influences on residential landscape design and management. With this information, the research began to construct a spatial model to predict nitrogen inputs to surface and groundwater. The goal of this dissertation was to understand how the influences of residential landscape design and fertilizer practices impact nitrogen fate and transport in suburban ecosystems.

One important contribution of this research was to collect information at the individual level and relate it to regional nutrient inputs. Information was collected to clarify homeowner landscape preferences and practices and how they related to culturally defined norms, mandates, and values. This information was used to differentiate residential landscape typologies that predict environmental impacts. Research questions that recognized human perspectives strengthened assumptions about land use and nitrogen runoff, evaluated the need for landscape management changes, and examined the potential for social acceptance of landscape design changes. Measuring different lifestyle groups' preferences and motivations also clarified the interplay of nitrogen inputs and ecosystem-level nitrogen balances in a spatially explicit context, (Baker *et al* 2001). To better understand the scale and strength of this impact, research questions were operationalized within the predictive framework of the Theory of Planned Behavior (Fishbein and Ajzen 1975, 1985) which was modified to include personal norms as defined by the Normative Action Theory and the additional measure of Descriptive Norms as defined by Cialdini (2003).

Research Goals

This dissertation research established a framework to target residential landscape managers based on their attitudes, values, beliefs, likelihood to change, and potential to pollute. The information can be used to clarify barriers and motivators to behavior change necessary for program and policy interventions; to inform appropriate communications, strategies, and controls; and to provide a baseline for comparison that demonstrate successful behavior change (Kotler and Lee, 2002).

Goal 1: Provide evidence to inform social interventions such as program strategies, social marketing efforts, and public education messages that reinforce and evaluate the societal adoption of residential low-intensity, environmentally-friendly landscapes.

A second research achievement was to contribute to the understanding of how individual behaviors and environmental quality relate across organizational scales. By measuring the predictive power of individual, community, and institutional level influences on residential landscape preferences and practices, the research contributed to the growing body of evidence on human-environment interactions and nitrogen cycle inputs. I intended to learn from and contribute to the growing body of urban ecology literature that defined the integrative methods and spatial and temporal models that aid in the maintenance of ecosystem function that enhance human quality of life (Pickett *et al* 2008, Kaye *et al* 2006, Redman *et al* 2004).

Goal 2: Advance research on urban ecology by accumulating evidence using mixed modes of research, cross-disciplinary methods, and multiple scales.

Results of this research were incorporated into land use patterns by relating data from individuals to communities, to land use, to pollutant loading, thereby building the foundation for pollutant load models that incorporate the human potential for behavior change. This provided a much needed, scientifically based measure of effectiveness for communities implementing environmental landscaping programs and interventions to reduce nitrogen inputs as required by TMDL regulations.

Methodology

Landscaping P&B collected and related data at three different organizational scales, from the individual homeowner, to the community, to the institutional drivers of high maintenance landcapes (Figure 3).

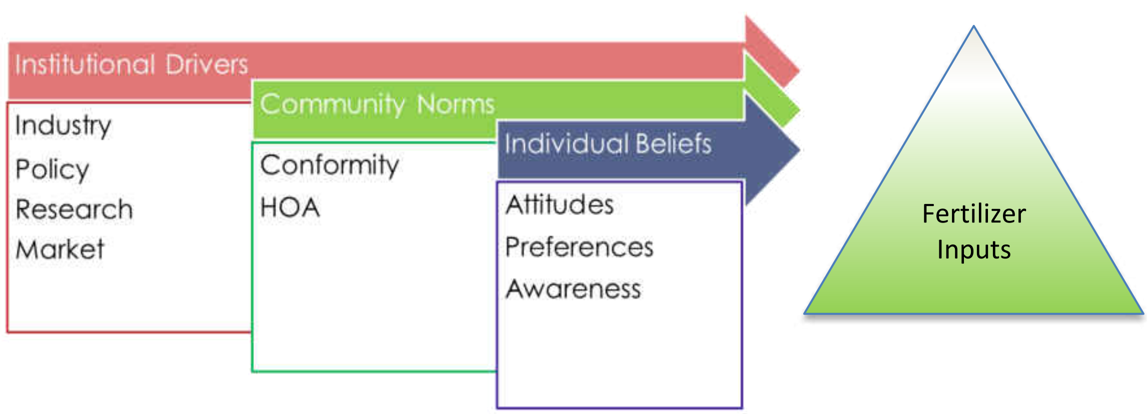


Figure 3: Drivers of Fertilizer Inputs at Different Organizational Scales

This dissertation involved a diverse research team in the collection and analysis of qualitative and quantitative data using mixed methods integrated across spatial scales. Observational studies, ethnographic data gathering, records reviews, representative telephone surveys, homeowner interviews, soil and groundwater sampling, and surface water data compiling have been conducted as part of this study. Our intention was to spatially correlate socio-behavioral and environmental quality data to predict polluting potential of individuals and communities. The long-term goal is to integrate behavioral data into watershed load models and in this project, we initiated and tested a methodology to do so.

Landscaping Perceptions and Behaviors included three distinct but overlapping research projects that collected information about landscape maintenance responsibilities, fertilization and irrigation practices, decision-making influences, institutional controls, and other socio-demographic predictors of high-intensity residential landscaping practices. A summary of the three projects being conducted as part of the Landscaping Perceptions and Behaviors Research Project is provided below and an outline of the research methods and hypotheses is included in Table 1.

The first project is the Landscape Exchange Project (LEP), which provided a theoretical foundation for measuring individual motivators and normative pressure. In this project, data were collected using a telephone survey, door to door interviews, and soil samples in a Homeowners Association (HOA) governed community in SW Florida. Eleven environmentally-friendly front yards were installed as part of the project and ethnographic information was collected on the receptiveness of this change. The LEP provided important descriptive and qualitative information about human aspects of changing to an environmentally friendly front yard. It also clarified the community pressure and neighborhood level influences on landscape practices.

Table 2: Landscaping P&B Project Summaries

Project	Landscape Exchange	Land-Water Connection	Predicting Maintenance Intensity
Criterion	Environmentally-friendly landscaping	Fertilizer frequency Water quality	High-intensity landscaping Likelihood to change
Predictors	Beliefs Values Community pressure	Responsible party Community pressure Fertilizer frequency	Beliefs & attitudes Personal and social norms Current practices
Research Questions	What motivators and barriers exist for individuals to adopt an environmentally-friendly landscape? How will the community react?	Do communities differ in their lawn fertilizer practices? How does this impact environmental quality?	What are predictors of high-maintenance landscaping and environmentally-friendly landscaping?
Methods	Telephone survey Interviews Qualitative Analysis	Telephone Survey Bivariate Analysis Correlative Analysis Regression Analysis Spatial Analysis	Telephone Survey Analysis of Variance Correlative Analysis Regression Analysis Amos Path Models

The second project, titled the Land-water Connection (LWC) project built upon the foundation provided by the LE project to identify neighborhoods based on the maintenance practices of the people within them. Behavioral data collected through telephone and door to door surveys was correlated with soil and groundwater data to integrate behavioral and environmental quality data using spatial analysis.

The third project, titled Predicting Maintenance Intensity (PMI), continued to build on the knowledge gleaned in the previous two studies by conducting a statewide telephone survey to understand the power of varying influences on landscape management intensity by weighing the predictive powers of salient independent variables. A predictive model is developed using the combined Theory of Planned Behavior and Normative Action Theory to understand what motivated landscape maintenance behaviors and intentions to more environmentally-friendly landscaping.

The research collected information at three organizational scales: 1) individual; 2) household and 3) neighborhood, examining close-range landscape management and fertilizer inputs that are needed for urban ecology and social marketing research. Multi-dimensional scales required multiple modes of research to collect and integrate data. Individual and household motivators and barriers to adopting an environmentally-friendly landscape were investigated using qualitative and ethnographic methods in the Landscape Exchange project. In the Land-Water Connection, communities were characterized based on their commitment to a monoculture, green turf grass lawn and their potential for N inputs. Through these efforts, a pattern of community behavior emerged to clarify the interplay of nitrogen inputs and exports to the ecosystem in a spatially explicit context, (Baker *et al* 2001). The final project uses a statewide, web-based panel survey to develop a predictive model of landscape maintenance intensity that identified the influences perpetuating non-sustainable suburban landscaping.

An overview of the research on human dimensions confirms that inputs of information from varying scales contribute to the overall understanding of the issue. This dissertation research incorporated results from three projects collecting data at different scales to understand the comprehensive system of influences from individual beliefs and community expectations and the extent that they impact regional nitrogen loads. This research is increasingly important in that it considers both socio-behavioral and environmental data to understand how one level of influence drives another (Young *et al* 2006). In the context of landscaping perceptions and behaviors, the influences of landscape impacts to the ecosystem are predicted on different scales. The challenge is extrapolating the results from research at one scale to potential impacts at another.

CHAPTER THREE: THE LANDSCAPE EXCHANGE PROJECT

Introduction

One challenge to examining the independent normative and attitudinal predictors of changing landscape design is the prohibitive nature of the situational impacts. Even if personal beliefs and social norms are supportive of changing landscape design, the overwhelming burden of the task can be prohibitive, a negative influence of the low perceived behavior control. The homeowner's limited knowledge of design principles, appropriate plant materials, and implementation strategies can greatly impede motivation. The negatively associated perceived behavioral control will outweigh the motivations present from individual and normative beliefs. In the Landscape Exchange Project (LEP), the power of perceived behavioral controls was reduced by working with motivated homeowners in a deed restricted community to design and install resource efficient yards. By removing these barriers, the Landscape Exchange aims to understand the impact that landscape change has on individuals and neighborhoods.

The LEP project collected telephone survey data, interview data, and ethnographic information from project participants for three years in a subdivision in southwest Florida. The subdivision was located immediately adjacent to a Florida-friendly landscaped (FFL) subdivision and the original study design was to compare residents in the side by side communities to address their concerns and desires for FFL. However, shortly after the project began, the homeowners in the FFL community changed their by-laws to allow the removal of the FFL and replacement with St. Augustine turfgrass. At the same time, homeowners in the non-FFL community started re-vegetating their lake shore with littoral zone plantings and installing butterfly gardens in common areas. As a result of this change, the project changed to focus entirely within the non-FFL community, where homeowners were recruited to participate in the study by having their front yards replaced with Florida-friendly landscapes.

The Landscape Exchange Project took place in a homeowners association (HOA) governed subdivision of 540 residences in southwest Florida that was located directly adjacent to one of the state's award winning FFL subdivisions. As a result of the proximity to the adjacent community, the LEP community residents already had heightened awareness and strong opinions about FFL as it was implemented in the adjacent community. The LEP research goals were to collect information on homeowners' landscape perceptions and maintenance practices; identify awareness and perceptions of Florida-friendly landscaping; understand motivators and barriers to adopting Florida-friendly landscaping practices; and determine if there were any linkages between landscape management and soil nitrogen concentrations.

LEP was an exploratory study of human landscape interaction, exploring the social-psychology of subdivision landscape management while taking a snapshot of the soil nitrogen concentrations in their yards. The research team spent three years at the study site, observing social interactions, governance procedures, and personal decision-making processes. The purpose of the project was to provide the important foundation and qualitative evidence to inform the research methods and protocols that would follow in the next two projects.

Social Research Methods and Analysis

Three different research methods were used in the study to collect quantitative and qualitative information on homeowners' landscape preferences and practices. A random digit dialed telephone survey of residents (n=73, C.I. = +/- 10.7 at 95% confidence) was conducted by the Florida Survey Research Center (FSRC) in March 2009 to collect representative data from the subdivisions' residents. Telephone survey results indicated that residents were mature (62% over age of 56), highly educated (73% completed college or above), had lived in Florida less than 10 years (60%) and were full-time residents (82%).

Additional qualitative information was collected from 100 residents via a door to door survey conducted from July 8th through July 25th 2009 by trained interviewers who followed a similar but more detailed questionnaire as the one used by the telephone interviewers. Copies of the survey and interview questionnaires are included in **Appendix A.** Approval and Consent documents from the Institutional Review Board (IRB) are included in **Appendix D**. From July 8th through July 25th 2009 trained interviewers completed 100 door-to-door residential surveys using a random sampling technique as follows. House numbers for all houses in the subdivision were printed and put into a hat. Each day, interviewers drew 10-15 house numbers and proceeded to those houses to collect responses. If the homeowner in the selected house refused to respond or was not available, interviewers flipped a coin to randomly select the neighboring house to the right or left. If the homeowner in the second house refused, the interviewer went to the next randomly selected house number. Interviewers completed an average of 6-8 interviews per day, working in pairs on the weekends and during the week. The interviews were completed in two weeks.

Interviewers asked to speak with the person in the house who was most knowledgeable about landscaping. Interviewers established a rapport with the respondents and had them sign a consent form to be interviewed and audio taped. A few people refused to be audio taped and their information was hand-written on the questionnaires. All audio-taped interviews were transcribed and data entered into two difference analysis software packages, SPSS and NVivo. In some cases, the questions were answered by two people in the household and this was noted.

Door-to-door respondents were similar to telephone survey respondents in socio-demographic composition. They were typically white (94%), male (56%), and had a median age of 60.5 years, which was about twenty years older than Florida's population at large (median age 40.7, U.S. Census 2010). About one-third (32%) of respondents had heard about the study being conducted in their community, mostly through the community newsletter (45%). Nine of the interview respondents had participated in the project by attending one of the project information workshops such as the project introductory workshop, one had attended the recruiting meeting, one respondent attended a design workshop, and two had attended the Bioblitz workshop. Only one homeowner who completed the door-to-door interview had also been interviewed on the telephone.

Lastly, the project recruited research participants to work with the research team to design, install, and maintain a Florida-friendly front yard. Research participants were expected to commit to three years of the study, complete surveys and questionnaires, attend information workshops, assist with yard installation if possible, and not change their yard during the project. Twelve residential front yards were designed by a landscape architect in the first year of the project during a series of workshops that involved research participants in the design of their yard and the selection of plants. Thereafter, the designs were finalized and submitted to the HPA Architectural Review Board (ARB) for approval. At this time in the project, Senate Bill 2080 was recently passed, requiring HOAs to allow Florida-friendly landscaping within their communities. The design review temporarily halted while the HOA and committee worked to reach consensus on how to integrate the recently passed legislation into their review process. Thereafter, the review process continued and all yards were approved for installation with one exception. A strip of turfgrass needed to be maintained along the sidewalk or roadway that was directly in front of the house. This minor change was incorporated into the landscape designs and the first six yards were installed in March and April, 2009. The last five new designs were installed and one existing yard renovation was completed in May and June 2010. One of the designs was never installed due to conflict between the homeowner and the HOA over existing trees on the property. The eleven installed yards were maintained by the LEP through June 2011, when the project ended.

To assist with maintenance, the LEP funded a comprehensive soil study to better understand the subterranean landscape features, plant nutrient needs, and soil characteristics. Researchers at the University of Florida Field Laboratory in Wimauma collected 192 composite soil samples from 48 residential yards within the subdivision and five (5) background samples from natural areas. They also collected 17 deep bore samples to characterize soil strata, 48 bulk density samples to understand organic content and compaction, and 8 irrigation water samples to assess nutrient and micronutrient content of well waters used for irrigation. The purpose of the soil study was to understand the soil organic and nutrient content across the subdivision and how it differed from native soils. This information helped guide plant selection, nutrient needs, and maintenance best management practices for the subdivision.

Social Research Results

Descriptive results of the telephone and door-to-door surveys are reported in this section as well as the ethnographic qualitative information and lastly the soil study results. Nearly all percentages reported are from the telephone survey results, except where specifically noted to be responses to the door-to-door interviews. Where qualitative information on the topic was collected by the door-to-door surveys, interviewed respondents' quotes are written in *italics* and interviewer questions are written in **bold**. Later in this section, a summary of the ethnographic study results appear, followed by the environmental results and soil maps.

Telephone and Door-to-door Interviews

The results of the telephone and door-to door surveys are organized in this section beginning with landscape maintenance practices followed by residents' perceptions and preferences for design and then specifically their adoption of Florida-friendly landscaping design and practices.

Landscape Maintenance Responsibility

This section on landscape maintenance is reported from the results of the door-to-door surveys because the questions asked door-to-door were improved after the telephone survey results were reviewed. Also, homeowners were given more time to think about responding to maintenance questions when they were recorded door-to-door and therefore interview responses to detailed questions about maintenance activities may be more accurate. The first question asked about residential landscape maintenance was, "Who is the responsible party?" The study subdivision has five independently governed sub-units, each with its own homeowners' association rules. Some of the sub-units were self-maintained, meaning the HOA collected fees and hired a single contractor to manage the yards in the sub-unit. In other sub-units, the homeowner was responsible for hiring a professional or maintaining the yard themselves. Table 3 provides a breakdown of responsible parties by landscape maintenance activity. The "Don't Know" column is included, because with landscape management, it is important to understand what the homeowner knows and doesn't know. In this case, the activity that homeowners were least sure about was fertilizing the plant beds.

Table 3: Division of Landscape Management Labor (n=100)

Activity	In-house	Professional	Both	Don't Do	Don't Know
Fertilize lawn	18%	76%	4%	1%	1%
Apply Pesticides	22%	64%	3%	11%	0%
Mow Lawn	24%	63%	12%	0%	0%
Fertilize plant beds	36%	53%	4%	1%	6%
Prune Trees and Shrubs	33%	50%	17%	0%	0%
Plant flower beds	65%	25%	8%	0%	2%

The majority of homes relied on professionals to apply fertilizers and pesticides and to mow the lawn. About half of the homes relied on professionals to fertilize plant beds and prune trees and shrubs, and the majority of homeowners (65%) planted their own flower beds. This shows that targeting an educational intervention on landscaping practices varies by activity. The following section covers general landscaping practices reported by both those who hire professionals and those who do the landscaping themselves. We asked a series of questions about how and why people were maintaining their yards to better understand homeowners' understanding and reasoning for their maintenance decisions.

Fertilizer Actions and Understanding

Nearly all respondents (99%) indicated that fertilizer was applied to their lawn. Of these, 71% indicated it was applied on a regular schedule, 16% said it was applied only as needed, and the remainder didn't know. Most (28%) respondents said dry, granulated fertilizer was used, slightly fewer (26%) indicated liquid fertilizer, 12% said the fertilizer was slow-release, 5% said weed and feed, 5% said organic fertilizer and a quarter of respondents (25%) did not know what type of fertilizer was used on the lawn. Of those who applied fertilizer to the yard themselves, 46% applied liquid fertilizer with a hose, 27% used a spreader, and 27% scattered it on the beds directly from a measuring cup or the bag. Most (75%) indicated that they typically water the lawn after applying fertilizer. People also indicted that they used different fertilizers and methods for the lawn and the garden beds. While most people said that they tried to follow the instructions on the back of the fertilizer bag, many respondents were confused about the amount of fertilizer as demonstrated by the following examples.

How do you know how much fertilizer to use?

I just read the instructions. I also use… its called earth food from super blue-green algae. It's super blue-green algae but it's the algae that has not been cleaned up. I use it for fertilizer for house plants.

Well, first of all I am a chemical engineer. I do read the labels and on the internet I get fertilizer programs and so on and I see what the University specifies and how much for a thousand square feet or something like that so I try to keep that.

I use a test space so I can figure out how many pounds per thousand square feet. On the back they always say six or five but that doesn't always work so I check it out.

Oh I forget, just like I forget bridge. But I've got it all down and I double check it and I don't put in what I shouldn't do.

I just pick one that says it's southern; you know it's picked for Florida grass.

No it's all right there in the bottle and I don't pay any attention.

I use two different types. For the ornamentals, for the plants I do 30-30-30 and for the grass I'm trying to remember because it's been a little bit of time. The nitrogen is a little higher but I don't remember the exact number.

About how frequently is fertilizer applied to the lawn?

Most of the respondents (n=100) indicated that fertilizer was applied quarterly (35%) or twice a year (30%) and 13% responded that fertilizer was applied to their lawn monthly. The remainder indicated it was applied once a year (3%) or at some other interval (19%). Table 4 below summarizes the months respondents reported that fertilizer is typically applied to the lawn. Respondents were able to It is interesting to note the drop off during the rainy season months of June, July and August. At the time of the interviews, a local fertilizer ordinance which specifically limits the application of nitrogenous fertilizer from June to September had been in place for two years.

Table 4: Months that fertilizer is applied to the lawn (n = 100, response frequency).

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
5%	10%	11%	14%	14%	5%	6%	4%	10%	18%	11%	5%

Although there was evidence from the interview responses that homeowners were aware of the ordinance, the low numbers of respondents who indicated that fertilizer was applied in the summer may have nothing to do with the ordinance, since most of the yards in the study subdivision are fertilized by professional companies who apply fertilizer regularly. The ordinance specifies that nitrogenous fertilizers are not to be applied in the summer months, but professionals can apply fertilizer containing micro-nutrients during those months. This was confirmed by examining the professional maintenance contracts provided by research participants. From the interviews, it appeared that homeowners knew that fertilizer was applied by the company, but they did not know what kind. It would be interesting to know if homeowners who apply fertilizer themselves apply less during the summer months as a result of the ordinance. A study by the Southwest Florida Water Management District (SWFWMD) showed a similar decline in fertilizer application in the summer that likely includes more homeowner applicators than the number we had in the study subdivision. The SWFWMD study found that residents in their southernmost counties, including the study site county, applied fertilizer most frequently in the months of October (22%), March (22%) and April (20%). In comparison, however, the regional study by SWFWMD showed a relatively lower percentage of respondents who fertilized in May (13%). It would be interesting to know how aware residents are of the local ordinance.

People who rely on professionals were not as knowledgeable about the type and amount of fertilizer applied to the lawn as those who applied it themselves, chi-square = 6.61, $p < .05$, n = 76. Although homeowners who hired professionals were likely to know how frequently fertilizer was applied, they were unsure what months and were unlikely to know what kind of fertilizer was applied. Homeowners were aware that fertilizer and irrigation were regulated although they were not certain about what the rules were. The following quotes from door-to-door interviews clarify homeowners' understanding of fertilizer application with quotes that suggest awareness of a fertilizer ordinance <u>underlined</u>. Some quotes suggest the influences of social and family expectations.

Do you know how often that is?

No. They put a thing out and they do it.

It's hard to say because they come for different things at different times. More like quarterly let's say but because of certain things…they call up and they say they are going to fertilize the shrubs today or fertilize the lawn tomorrow or we are going to do weed control or going to put pesticide down. ..I say quarterly they come only on four times a year because there are more things to do. <u>They are abiding by the new rules and all that not fertilizing hither and yon, near the ponds at certain times and whatever.</u>

I have no idea. The only thing I know is that they put up signs; you know those little signs saying that the lawn has been treated or whatever.

We just moved in and I know there are various restrictions down here so you go to the experts.

Quarterly, but they don't do it in the summer because we are not allowed to here.

Only as needed when I realize it does not look real good, could you put some fertilizer there?

I think they do it with the Florida guidelines, that's how they do it to my knowledge.

The guy that does my lawn gave me a schedule and I follow that. It is a very simple schedule.

I do fertilizing every spring, mainly to please my wife. She says "how come it's not green?" I say "well because it's not supposed to be green." There are times in Florida it's supposed to be brown. Of course if it gets brown you get a letter from the HOA saying "your lawn is brown." If you don't get it green… and now there is a new county ordinance here where you are not supposed to put in any nitrogen rich fertilizer past June first or something…During the rainy season, during the growing season.

All my neighbors had good looking yards and they had people coming and putting fertilizer and stuff down so I got [company name] which is a big name and when they came and put the fertilizer the lawn still didn't look very good, then I changed to another local place called [company name]and they did a real nice job.

We like the way the neighbor's lawns looked under their care and so we asked them to take on our lawn as well.

More than half of the door-to-door respondents (68%) admitted that they were not knowledgeable at all about the type and amount of fertilizer applied to the lawn. Some homeowners didn't distinguish between fertilizer, herbicide and pesticide in their explanations. For example, when interviewers asked about fertilizer, respondents often mentioned pesticide, something about bugs, or products they used to control bugs in the home.

Pesticide Action and Understanding

A large majority (89%) of respondents indicated that pesticides were applied to the yard. Of these, 25% of respondents applied pesticide themselves, 71% hired a professional and 4% said both. About half of respondents (46%) indicated pesticide was applied on a regular schedule and less (45%) indicated it was applied as needed. Nine percent didn't know. When asked how they know when pesticide is needed, most replied that they see bugs or damage from bugs or that the lawn turns brown. Of the respondents who knew a schedule (n=31), 19% said they applied pesticide monthly, 32% quarterly, 26% twice a year, and 23% annually. Many people reacted to bugs in the house by spraying the yard and establishing a regular pesticide application contract.

What prompted you to apply pesticide or how did you know it was needed?

Bugs in the home.

Actually the guy <professional company name>, he told me the last time he could see the bugs. I don't know how he did that. I can't see them. My eyesight is not great anymore.

… several months ago I had ants and I thought I was back in world war two because they were marching from the corner all the way to the house and up the wall into the attic, so I had to have people come out and spray. Now I don't have any at the house any more.

I don't like having the pesticide sprayed, like I said I'm not from here, so when I moved here everybody said it was something you have to do or you won't be able to live here.

Irrigation System Practice and Understanding

Nearly all respondents (95%) used an in-ground, automatic irrigation system as the primary method of watering the lawn. Ninety-one percent (91%) of respondents reported they watered their lawn one day per week and a few admitted to watering one and a half days (2%) or two or more days per week (4%). All respondents had an in-ground sprinkler system with 18% of respondents stating that they turned their sprinkler system off for one reason or another. When asked if their irrigation system had a rain sensor on it only 16% of respondents said no, with another 11% who didn't know. For those who had a rain sensor (n=79), 53% of the people said it worked properly, 23% said it did not work and 24% didn't know. When asked about their irrigation timer 64% of respondents said they were very confident using it, while 17% felt somewhat confident and 19% said they were not at all confident. Most respondents never (41%) or rarely (49%) changed their irrigation timer with the remaining 10% indicating that they often changed it. The most common reasons given for changing the timer was to turn the system off when it rained for prolonged periods, or to shorten or lengthen the watering cycle. Some people admitted that since they were only permitted to water once a week they tried to water as long as possible. Approximately 52% of respondents said that their watering schedule stayed the same throughout the year, 23% said that it stays pretty much the same and 25% of respondents varied their watering schedule. Many people expressed that they did not have control over their timers even if they did know how to use it, especially in the maintenance free areas. One respondent indicated that when he turned off the sprinkler system because it rained, he got a letter from the association telling him that "it must be on at all times".

Landscape Perceptions

This section covers general landscape perceptions as well as opinions of Florida-friendly landscaping. Before we asked residents about adopting Florida-friendly Landscaping, we attempted to understand the likelihood that people would change their yard at all. Responses to questions asked about what homeowners liked and didn't like about their homes' landscapes revealed a myriad of aesthetic preferences and practical considerations. When asked what they would change, homeowners' personal preferences were very diverse. Some like more grass, others less grass; some like trees, others didn't. When asked what might prevent them from making these changes, things like time, money or knowledge, one universal theme emerged - the homeowners association and its Architectural Review Committee approval process was a huge barrier to making changes to the landscape.

When asked about their current landscape and their likelihood to change their landscapes, a large majority of the telephone survey respondents (n = 72) were somewhat or very satisfied with their current landscaping (80%). About one third (n = 26 respondents) indicated that they were somewhat or very likely to make major changes to their yard in the next three years. Sixty-five percent of those who wanted to make changes indicated that something prevented them from doing so (n = 17 respondents) and of these, most reported it was the HOA (65% or 11 of the 17 respondents). Respondents likely to make changes to their yard were asked what changes they were considering and their responses were recorded open-ended and recoded into categories. Of those likely to make changes to their yard (n=26), most wanted to add plants like shrubs or bushes (19%), trees (11%), or flower beds (11%). Some wanted to add turf grass (8%) or food plants (4%). A surprising number however, (15%), indicated an interest in removing all of their turfgrass and an additional 4% of respondents wanted to decrease the area of the yard covered by turfgrass. Just over 15% of respondents offered that they intended to change to Florida-friendly landscaping. The reasons why homeowners wanted to change their yard (Figure 4) are important for programs and practitioners interested in encouraging more sustainable landscaping. These are in essence the motivators that people in this community have for adopting something different.

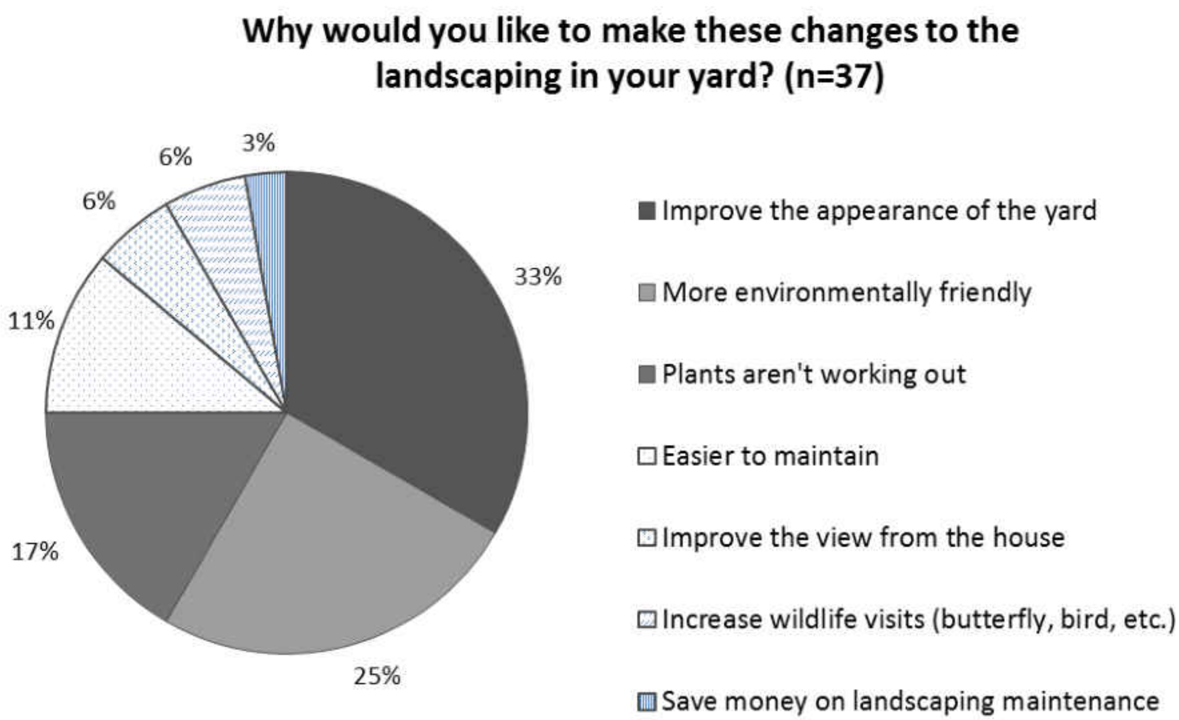


Figure 4: Reasons Homeowners Wanted to Change their Homes Landscape

The most popular answer, “Improving appearance” requires further exploration. People’s aesthetic preferences are diverse, and would be better explored using visual aids such as images, color palettes, or actual plants. We learned more about people's preferences during the landscape design workshops, where it was evident that the participating homeowners were interested in color and flowering plants, while at the same time expressing a desire for low maintenance. These two preferences, unfortunately, do not work in concert. Flowering plants require that dead flowers be removed; they generate seed heads; and they often disperse seeds into areas of the yard where flowers are unwanted. Colorful, flowering plants require regular upkeep and maintenance. Interviews conducted door to door attempted to fill in some of the qualitative descriptions of homeowners preferences.

> **What do you like most about your home's existing landscape?**
>
> *It's green. It isn't something I give much thought to other than its clean and neat and does not stick out as different or bad in the neighborhood.*
>
> *I would say it's clean looking*
>
> *I happen to like a well-manicured lawn.*
>
> *…shrubs, manicured look, ornamental and the variety of color*
>
> *It is a variety of mostly Florida resident type plants.*
>
> *I like flowers and greenery and I like that it's just around the house and not on the borders, you know on the lot line so that you have sort of a minimum amount of work.*
>
> *The community and the fact that all the lawns were being maintained very well.*
>
> **What do you like least about it?**
>
> *The landscape…it needs color, let's put it that way.*

All I know is what we have here currently is all one color, green and she wants to throw in multi-colored plants.

I made some poor decisions because I was picking out plants myself and I made some major mistakes.

If you could, what changes would you like to make in your home's landscape?

I would take out that cement patio and have all that green out there. Because I think the dog would have more fun playing in the grass.

… different plants, more flowers and flowering plants.

Want to get rid of more grass

More drought tolerant lawn. So it looks neat.

I would like to have better grass and better irrigation

Remove more grass

Get rid of the junipers and plant more grass and plant more magnolias and gardenias.

I replaced it with ninety percent grass

Why would you like to make these changes?

The better the outside looks is an indicator of how well the inside will look.

For the beautification of my home and for the value of it.

Why, just aesthetically…Flowers make everything beautiful.

I think that a yard should express care and aesthetics and if you want to have a wild area it should be contained and surrounded by a maintained lawn that is providing an island of separation.

I find this last quote most interesting. The respondent suggested that an individual who desires to plant a landscape with native plants, flowers, trees, shrubberies, and have a “wild area” should be permitted to do so as long as this area is an island in the lawn. The control feature that links the individual “wild area” with the community norm is the maintained lawn.

Understanding the barriers to homeowners changing their landscapes is also important. When we asked the respondents interested in changing their yard what was preventing them from doing so, the large majority (76%) said it was the Homeowners Association (HOA), followed by the cost (18%) and the time it would take (12%). It is apparent how big a deterrent the HOA is when you see how cost and time, two barriers to doing just about anything, pale in comparison. This is evident in the door-to-door interviews as well.

> **What prevents you from making these changes?**
>
> *We are prevented by certain rules of the board and the bylaws that prevent us from doing things that weren’t originally deemed necessary and the autocratic ruling of the landscaping committee puts certain restrictions…based on what they feel their tastes are…which sometimes are not my tastes.*
>
> *Well we have an architectural review committee. Not that its preventing me but it makes it just a little bit more difficult because you have to have it all planned out and have the architectural review committee approve it.*
>
> *The association has decreed that we are going to use this grass.*
>
> *I can’t because of the maintenance free rules and the HOA.*
>
> *The landscape that we have now was here but it has been greatly diminished into some things that the gardening committee wanted. They wanted things cut back. They wanted things cut down to which sometimes we agree and sometimes we do not agree.*
>
> *I will say that one of the things that stopped me from doing things is they require that you submit a survey. The house did not come with a survey. It is five hundred dollars just to get a survey in order for me to then hire a landscaper to tell me*

> *what to put there. Then you have to submit it to the association and they have to approve it. It was too complicated and too expensive of a process.*

Respondents felt that the HOA controlled everything from the number of fruit trees and the types of plants permitted to how high the grass is before it should be cut. While this distressed many people, others really liked this about their community because they did not have to worry about their yard. While not expressly stated, some people seemed to fall back on the association rules as an excuse for not doing "the right thing" with regard to the environment. More on the conflict between individual beliefs and community mandates is evident in the following section that asks respondents specifically about their perceptions about and likelihood to adopt FFL.

<u>Florida-friendly Landscaping Perceptions and Practices</u>

The telephone survey investigated respondents' knowledge and practice of Florida-friendly landscaping (n=73). Most telephone respondents (62%) were aware of Florida-friendly landscaping and this awareness was even higher among the door-to-door respondents (74%), although the difference may be because homeowners wanted to appear knowledgeable when speaking with an interviewer face-to-face. Regardless, awareness of Florida-friendly landscaping was very high in the study subdivision compared to 18% of residents in Central Florida who were asked a similar question (UCF Green Business Survey, 2005). It is important to remember that it is very likely that the homeowner's in the study site had direct contact with the Florida-friendly landscaped subdivision located next door. In fact, one of the entrances to the study subdivision was through the Florida-friendly landscaped subdivision and we would expect people to be aware of their adjoining neighborhood. When asked if they heard of Florida-friendly landscaping before moving into their current subdivision, 22% of telephone respondents indicated that they had, which was still slightly higher than Central Florida residents.

To better evaluate subdivision residents understanding and opinions of Florida-friendly landscaping on the telephone survey, eight questions asked respondents their beliefs about Florida-friendly landscaping, starting with the statement "Florida friendly landscapes…" and followed by eight different statements. Respondents were asked to agree with the statements on a scale from 1-5, using a Likert scale response set that ranged from strongly disagree to strongly agree, anchored at "Neither agree or disagree" in the middle. Figure 5 summarizes the percentage of respondents who agreed and strongly agreed with the statements.

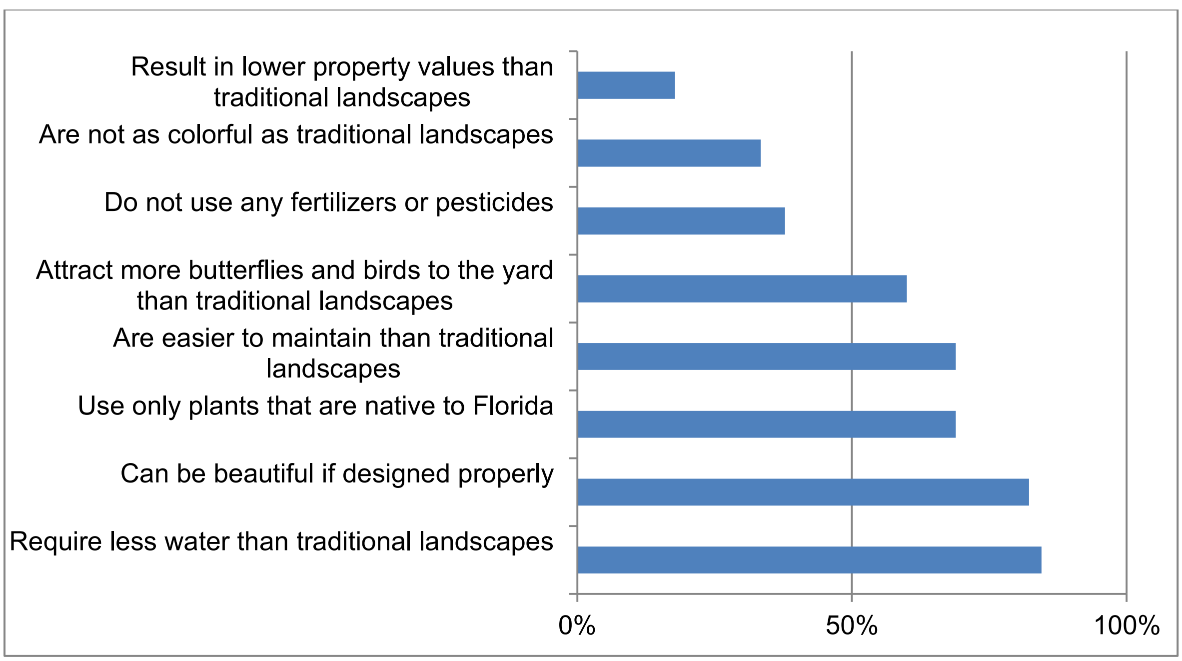


Figure 5: Homeowners Beliefs about Florida-friendly Landscaping (n=45)

Homeowners' beliefs help inform messages that will resonate with them and their peers. This response set is encouraging in that respondents believe that Florida-friendly landscaping can be beautiful and colorful, it attracts birds and butterflies and helps save water resources. These are the same reasons provided by homeowners for wanting to change their landscapes. Communications should consider using these or similar words to encourage adoption of Florida-friendly landscaping among those motivated to act.

Respondents also believed that Florida-friendly landscapes use only native plants and are easier to maintain, although neither statement is necessarily accurate. Florida-friendly landscaping requires a different kind of maintenance, not necessarily easier maintenance. And native plants are not the only types of plants that are utilized when designing Florida-friendly landscapes. Florida-friendly landscaping focuses on putting the right plant in the right place in the yard, which may not necessarily be a native plant. Furthermore, respondents' understanding of native plants is questionable. In a few door-to-door interviews, respondents interchanged the words native and tropical when describing the types of plants used.

On the other end of the chart, it is encouraging that only 18% of respondents agreed or strongly agreed that Florida-friendly landscaping lowers property values, a factor assumed to be a significant deterrent to people not adopting Florida-friendly landscaping. Communications should test the message that Florida-friendly doesn't lower property values and statewide research should be conducted to better understand how pervasive this belief is.

In the telephone survey, a large majority of respondents (82%) strongly agreed that Florida-friendly could be beautiful if designed properly and nobody (0%) strongly disagreed with that statement. This suggests that there is a very small segment of the audience that would be ultimately deterred from Florida-friendly landscaping on the basis of aesthetics alone. In the door-to-door interviews, homeowners who didn't believe they were beautiful expressed a desire for more turfgrass and a more manicured appearance. Future research should attempt to identify audiences based on their preference for turfgrass or flower beds.

The telephone and door-to-door surveys also investigated subdivision resident's current practices and intentions to perform specific Florida-friendly landscaping practices. The interviewers asked people questions about their current landscape practices and the likelihood that they would adopt Florida-friendly practices. In some cases, the nine Florida-friendly principles were simplified to more understandable terms so that homeowners could articulate a response rather than spend time and energy explaining what is meant. For example, rainwater harvesting was simplified to "collecting rainwater for later use" and the hard to explain "right plant, right place" was simplified to a series of questions that asked if they "Choose native plants that are best for the soil, light, and water conditions in your yard" and "Choose low-maintenance plants that don't require frequent pruning, watering or fertilizing."

Summarized responses to the question "Please indicate whether each of these is something you currently do in your landscape, something you aren't currently doing but may do in the future, or something you never see yourself doing in your landscaping" are provided in Figure 6. The responses suggest that subdivision homeowners believe they are already practicing many Florida-friendly landscaping principles. The largest number of respondents (81%) already swept lawn clippings and fertilizer spills off of impervious surfaces and back onto the landscape. This is consistent with the response to a similar question in the Land-water Connection (LWC) data set where 84% of homeowners reporting sweeping spilled fertilizer back onto the lawn or landscaping.

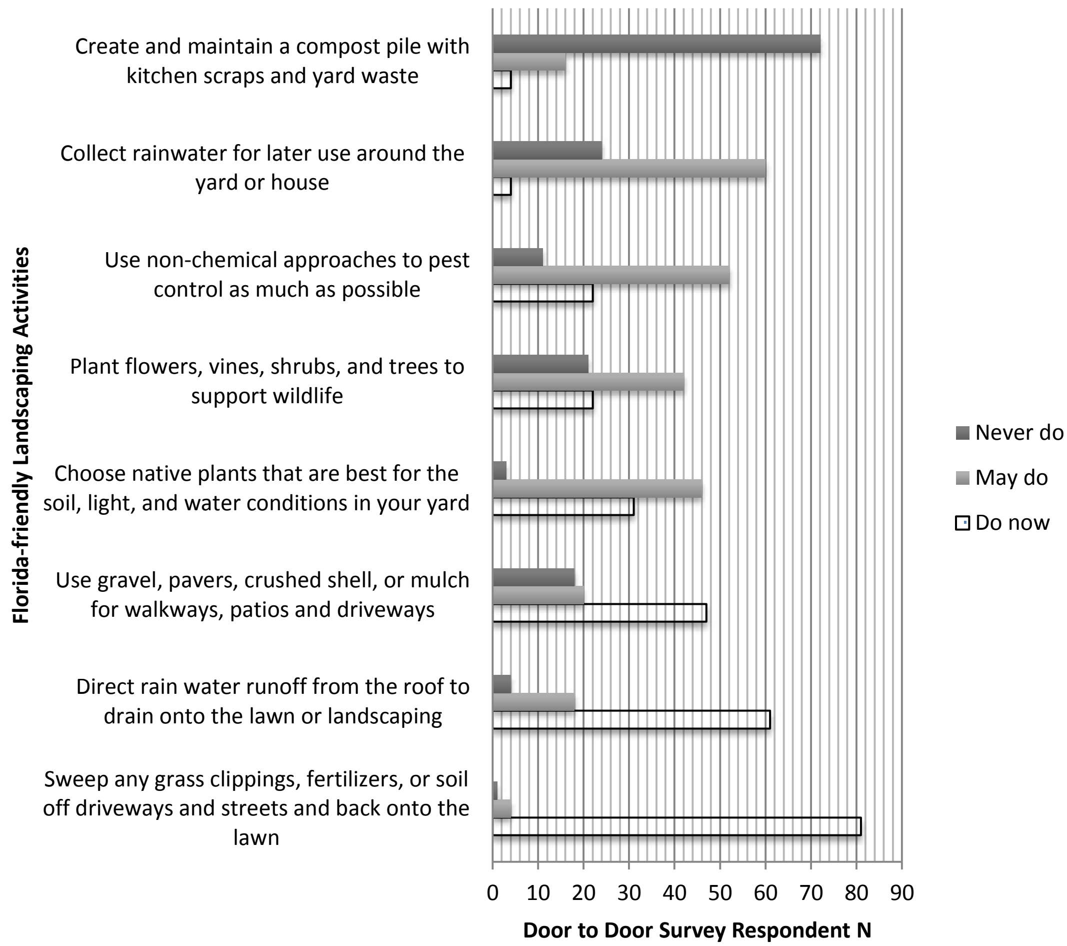


Figure 6: Homeowner's Florida-friendly Landcaping Practices (n=100)

Although a small percentage of homeowners do nothing to remove fertilizer or grass clippings from impervious surfaces, this activity is worthy of further investigation because of its potential input of nutrients to receiving waters.

The following information from the door-to-door interviews provides additional insight to why some homeowners may not practice specific Florida-friendly practices mentioned in the survey. In some cases, these barriers were outside the control of respondents such as structural features like gutters, others were associated with respondents perceptions of community intolerance, and other reasons were more personal, like it would cost too much money or take too much time. This qualitative information can help program implementers meet the needs of audiences by addressing specific barriers individually. The following summarizes the qualitative information collected during the homeowner interviews that specifically asked people what it would take for them to implement each of the described Florida-friendly landscaping principles. Each principle is listed with summarized information under each heading and interview quotes listed in *italics* within each section.

Direct Rainwater Runoff from the Roof to Drain onto the Lawn or Landscape

Residents who had no gutters felt that they couldn't direct rain anywhere. When asked what they would need to adopt this practice, they suggested they would need help installing or moving gutters and information on how to contour the landscape to accept the water. A few homeowners expressed concern about compromising the structural foundation of the house by directing water toward the house where it could erode the soil.

Use Gravel, Pavers, Crushed Shell, or Mulch for Walkways, Patios and Driveways

Residents expressed concerns about the mess, constant cost of replacing the mulch, weed control, and the possibility of mulch attracting bugs and snakes. Some respondents thought that the homeowner's association would not allow them to use mulch in the front yard, but they used it in the back yard.

> *No because it wouldn't be stable enough for walking if they put in anything else but concrete.*
>
> *Maintenance and just the dirt issue. If I was in a more rural setting perhaps but I am not in a rural setting.*
>
> *I think it would make a significant change. I see that in an old Florida neighborhood. I don't see that in this neighborhood. The problem with pavers is you get weeds in between them and then you are spraying chemicals for weeds and things like that although they look nice if they are maintained but I would say no.*
>
> *Yeah as far as mulch goes, we would really like to put in lava rocks but I don't think that we would be allowed to. We haven't asked because our next door neighbors had a go round with them because she put in something that they do not like. They ended up approving it but I don't want to jeopardize what she was trying to do by asking for something similar.*

Choose Plants that are Native to Florida

Some homeowners believed that any plant that could survive Florida conditions was a Florida native plant. Others were unsure and expressed an interest in learning more about them. The most common response when asked if people would consider putting in plants native to Florida was to refer back to the fact that their "homeowner's association would not let them" or that they would need permission from their HOA.

> *Everything is native to Florida isn't it? What do we have that is not native to Florida?*
>
> *Honestly to know which ones are native and which ones aren't? Whatever looks the best. We talked to the people you know at Home Depot or whatever garden place we go and find out which ones will work and which ones don't. We try to*

make like a… we have sea grapes out there and bird of paradise and gardenias. I mean a lot of things don't mix well together but it looks pretty.

Just to be native to Florida? Probably not.

I think the lawn is the most ecological way to go. I understand that a lawn is un-ecological but the value aesthetically can't be ignored.

Our community association has a rule that no matter whether you are fortunate enough to have a well or not you still have to follow county guidelines. The other thing too, you know the association took out all the native grasses in the parks this year and last and put in St. Augustine.

Use Non-chemical Approaches to Pest Control as Much as Possible

Respondents provided a variety of home remedies for insect treatment including soap, oil and hot sauce that they had used as well as biological controls such as lady bugs. Most respondents said that they would try chemical-free methods if they knew it would work. Others believed that the pest control applied to the lawn was already safe and looked to the interviewer to confirm that this was true. Most people said they would need information or help in some way to know what to put down, but the most important thing was that it needed to work. Others felt that pest control was out of their control because they hired a professional service.

From what I understand, the pest control is safe for the animals, so I don't know if it is completely chemical free but it is supposed to be safe for the animals.

If it works. Like I told you for me it didn't work.

We don't really do our own pest control.

I do that now okay, but … I use pesticides very seldom and I try. One of the reasons that I use them very seldom is because a lot of what is killed off, when you use pesticides that we consider to be pests are actually not pests. They are part of the ecosystem that controls other pests.

Plant Flowers, Vines, Shrubs, and Trees to Support Wildlife

Many residents didn't know what plants to plant and they needed more information, education, or other assistance. They wanted plant selection and installation to be easy and convenient to find. Some wanted a service that could install and maintain the plants for them. There were different opinions on wildlife respondents wanted to attract. Some thought of big wildlife like deer, raccoons, wild cats, etc…which were unwanted.

> *Probably not. I want the wildlife to stay in the park.*
>
> *Well, something comes over and turns my trash can over every now and then. It scatters that all over my driveway. I don't appreciate that.*
>
> *Do I want to attract critters to my house? I have to say that it is not something that I am necessarily dying to do.*
>
> *No, but I am thinking of putting out bird feeders in the back because I love the sound of the birds and I love the birds. The only thing is that I am afraid of is the raccoons and if I left them out at night there might be raccoons out there and squirrels. I don't mind the squirrels. I like squirrels. I like critters I just don't want any critters that are going to hurt the dogs.*
>
> *If it became a hassle you know… If every time we walked outside there were bees chasing us around that would be a problem.*
>
> *I like to watch the butterflies but the birds; I stopped feeding the birds because I don't think that was a good thing. I love watching them, but the raccoons came and one thing led to another and the cats might catch a bird so I stopped doing that. The garden is strictly to see the flowers, to enjoy the flowers and to work in the garden.*

Create and Maintain a Compost Pile with Kitchen Scraps and Yard Waste

The most common responses from residents regarding why they would never have a compost pile was because it was dirty, it attracted unwanted animals, there was inadequate room on the property, and their homeowner's association would not allow it. One homeowner said that he kept a compost pile up north, but in Florida, it's too hot and there are too many bugs which make it harder to maintain. He also made a point of saying the he had a large property and the compost was in the far corner, near the vegetable garden. In his perception, his small Florida property wasn't spread out enough and the compost pile would be too close to his living area.

Collect Rainwater for Later Use around the Yard or House

Most respondents were open to the idea of rainwater harvesting. When asked what it would take for them to adopt this practice, residents wanted more information on how to do it, they wanted money to buy a rain barrel and they thought they would need to get permission from the HOA. Those homeowners who said they would never collect rainwater feared it would attract bugs, they believed that rain barrel containers were unsightly and that there was not adequate space for a container, and again, they thought the HOA would not permit it.

> *Too much trouble, I am too lazy.*
>
> *Well I think it would attract mosquitoes and it probably would not be allowed here.*
>
> *I suppose I would need approval to have some sort of structure like that.*
>
> *Honestly, something like that would have to be unsightly. If we could find some place to put it where it was out of sight, then yes.*

> *This community would never allow me to have rain barrels sitting out there…That would never happen. This is a community where people don't want to plant a tree by the lake.*

When targeting suburban residents, messages could focus specifically on the practices that a large percentage of people may do, like directing rain water runoff from the roof to the lawn or landscape or harvesting rainwater, using a normative motivator to encourage socially acceptable behavior. Where an area or an audience demonstrates a high commitment to the behavior, normative messages can be effective to motivate non-adopters to change.

Encouraging the use of Florida-friendly plants can be challenging, however, because people's knowledge of plants is limited. Before asking people to purchase Florida-friendly plants, they need to know which plants are low maintenance, which ones are native, and which ones attract butterflies. The more area-specific plant recommendations are to the community, the better the chances are for accommodating homeowners' desires for low-maintenance, resource efficient plants that attract wildlife.

The qualitative information collected from this study helped clarify the possible motivations and deterrents for subdivision homeowners in southwest Florida to adopt Florida-friendly landscaping practices. A major challenge faced by homeowners seeking to change their landscape design is the overwhelming nature of the task at hand, which requires skills, abilities, knowledge, and artistic talent that may not be within their grasp. The task can be very daunting, especially considering the risk of community backlash if one fails (Dorsey 2010). The negatively associated social norms or neighborhood expectation can easily outweigh motivations when the homeowner is faced with complicated questions like, “What plants should I use and where do I find them? How do I remove the grass areas of my yard? How do I change the irrigation system? What should the new landscape design look like? How do I maintain the new plants?” And perhaps more influential: “Will my homeowners association permit me to make these changes?” “What will my neighbors think?” and “How much is this going to cost?”

Ethnographic Study

In the Landscape Exchange project, the impact of perceived behavioral controls were reduced by working within existing HOA mandates to install Florida-friendly yards in a neighborhood that exhibited high conformity to high-maintenance landscaping. We worked with a small group of these homeowners to investigate further which practices were implementable within the confines of their homeowners’ association rules and which ones were not. We recruited motivated homeowners who expressed an interest in participating in the project and worked with them to overcome the challenges associated with the community normative pressure, the HOA mandates, and the perceived behavioral and ability controls described in the previous section. By providing the design and installation of the yards, we began to understand the impact that individual and neighborhood beliefs have on changing landscape design independent of the situational impacts that impede behavior change. We also saw just how much of a deterrent the HOA and pressure of community norms could be.

Over three years, the Landscape Exchange Project collected ethnographic evidence from eleven research participants while their yards were designed, approved, installed, and maintained. All the participants were responsible for their own landscape maintenance except one who lived in a maintenance-free part of the community, where the HOA hired and paid for the maintenance of everyone's yard using dues collected from the residents. All research participants needed to be trained to effectively select plants and maintain the newly installed yards. They needed to understand plant growth, shape, dormancy, and sensitivity to cold as well as landscape design elements like texture, color, light, shape, and micro-climate. The study site attained its first freezing temperatures in fifty years during the project, killing many plants and confounding the project (as well as its participants). The brown plants were unacceptable to the HOA, regardless of whether they would grow back, they needed to be replaced immediately or else action would be taken. This additional challenge extended the timeframe and tightened the budget.

During the ethnographic study, important qualitative information was collected about the pressure of change, the power of conformity, the challenges of plant selection and maintenance, and the motivation needed to overcome all of these barriers. Participants were motivated for different reasons. Some wanted to enhance visitation of birds and butterflies by adding more native species, others wanted to reduce maintenance costs, others to expand their garden, and others to improve the appearance of their front yard. They also wanted to improve water quality in their community's lakes. By covering the costs to address the requirements of the HOA, homeowners were able to install a more Florida-friendly landscaped yard.

Yard Installation

During the three years of the study, the HOA President changed numerous times while landscaping issues of the community were disputed. Homeowners assembled to dispute tree removal, butterfly garden removal, and shoreline planting removal in the common areas, and to a lesser extent, the replacement of residents' front yards done as part of the project. During the project timeframe, the Florida legislature passed Senate Bill 2080 to promote the use of Florida-friendly landscaping among homeowners association (HOA) governed communities as a means to protect the state's water resources. The law states that "covenants, restrictions, and ordinances may not prohibit Florida-Friendly Landscaping practices" (FDEP, FDACS, Frequently Asked Questions, n.d.). The law provided leverage for homeowners seeking an environmentally-friendly landscape when they approached the governing board of their HOA to request changes. We had the opportunity to see how the community would interpret this new ruling. In response, the Architectural Review Committee, the oversight board responsible for dictating landscape rules and approving yard changes, drafted language to guide the interpretation of SB 2080 into their mandates. Their rules required a strip of turfgrass long the sidewalk or street depending on which fronted the house. It also required that landscape designs and a plant list be submitted to the committee for review and approval prior to making any changes. All of the designs we provided to the participating homeowners retained a strip of turfgrass along the front of the property. Although this strip of turfgrass provided a link of uniformity between the Florida-friendly front yards and adjoining properties, it also placed turfgrass close to impervious surfaces, where irrigation, pesticide, and fertilizer over-spray is more likely to impact water quality and where any runoff goes directly to the storm drain.

The project hired a landscape architect and engaged homeowners in workshops to facilitate plant selection and yard design. The landscape designs paid for by the project varied in cost from between $500-1000/yard and yard installation cost ranged from $500-2000/yard depending on the service provider. These costs would have likely prevented the study participants from proceeding with a yard change if the project hadn't covered them. Once the plans were presented to the Architectural Review Committee, they were approved with only two exceptions. One yard required the addition of the required strip of turfgrass along the street and one homeowner was not permitted to have a trellis to support a climbing vine in the front yard.

Yard installation proved to be challenging and had to be implemented in two phases due to contract timing. The first six yards were installed in 2009 and five more yards were installed in 2010. There were discrepancies in the design plants and the actual plants used, the quality of the installation work, and the quality of the plants. Existing irrigation systems needed to be retrofitted to meet water efficiency needs of the new plants while still providing adequate water for the remaining turfgrass areas. Homeowners were concerned about variations in the irrigation system pressure that would cause pump problems. At least two irrigation lines were broken, in one case flooding the street with heavily sedimented water. Installation requires regular watering of the new plant beds, some of which had to be done by hand. This can be labor intensive for the homeowner if their irrigation system doesn't cover the entire bed area. Even with all of the challenges, homeowners were generally pleased with the installation process, although they expressed some concerns. The following quotes were taken from interviews with project participants after their front yards were installed.

> *Neighbors complained when the original installation occurred. Comments were that the yard was too stark and ugly.*

> *I picked plants that looked better on paper than they did in my yard. In the workshop I picked plants that were very similar in texture that looked overwhelming once in the ground. I think that I would have fared better if it had been pointed out that different textures and heights needed to be incorporated into the yard to provide more visual interest. Unfortunately, those changes were made once the plants were in the ground.*

> *Different plants arrived at different times, as [the installer] bought plants from a number of nurseries. Most plants were in good condition, but a few were not - mostly gaillardia. The [installation crew] piled mulch up around the plants, causing some of them to die. Last week we finally received replacement plants for those that died. One bird-of-paradise is dying.*

> *[Installer's] cuts did not match the landscaped area on the plan, so some changes were needed. [Architect] was there for the planting and made some adjustments due to not having enough plants to fill certain areas. We collectively improved upon the appearance of the yard as the planting took place. Everyone worked well together, and we were all happy with the final result. We recommend more careful measurement of the yard prior to making the plan and also prior to spraying or cutting the yard's borders. Irrigation should be modified or a plan made to modify in advance.*

> *From a time spent on the yard standpoint, it would have been less hand watering if all the plants were installed at the same time. Most new plants require daily watering for the first week or two and then watering every few days for a few*

more weeks. This would have been easier if all plants had been planted at the same time, we could have used the sprinkler system in that area.

They replaced Yellow Walking Iris with African Iris. I have no idea why they were changed. Unfortunately the African Iris and the Dwarf Agapanthus are NOT Florida Natives and they are the plants that are dying or dead, making my yard look terrible.

<u>Yard Maintenance</u>

The project also paid for weekly maintenance of the newly installed yards while also training homeowners to care for their new plants at a series of "Garden Party" workshops. Maintenance records collected from homeowners and the maintenance companies hired to assist them documented the maintenance needs of the new front yards. Generally, the largest dedication of maintenance time was involved with weed control in the newly installed beds. Plants required replacement, especially after the freeze of 2010, when many plants declined or died. Specific fertilizers were applied to trees and plants as needed in the spring and a few plant diseases were treated.   The cost of bed weed control, pruning, and maintenance ranged from $140-375/yard/month, which varied according to yard and service provider.

Exit interviews of homeowners were conducted to understand their satisfaction with their new yard design and maintenance. Fourteen statements were presented on the exit interview and participants were asked to respond on a scale of 1-5 the extent that they agree with the statements. Additional open-ended questions were also asked to capture participants' thoughts about their yards. Table 5 summarizes the average agreement responses to statements measured on a scale from 1-5. They are listed with the one agreed with most strongly (4.88) at the top and the on least strongly (3.00) at the bottom.

Table 5: Project Participants' Statements about their New Yards (Scale of 1-5)

Overall, I am pleased with my new front yard	4.88
I seek native plants more frequently for the yard than I did before	4.75
My new front yard is very different from the one I had before the project	4.63
The way I maintain my front yard has changed	4.50
I am pleased with my new front yard design	4.50
I notice more butterflies in my new front yard	4.50
Neighbors approve of my new front yard	4.43
My connection to my yard has been enhanced due to this study	4.38
I have a good selection of plants in my new front yard	4.38
Less fertilizer is needed in my new front yard	4.38
My friends approve of my new front yard	4.38
I use less water on my new front yard	4.00
I will contact other participants for landscaping advice or plant swapping	3.88
It is harder to maintain my new front yard	3.00

N=9 Final Interviews

Overall, participants were pleased with their yards and they admitted that their relationship with their yard changed, particularly the way they maintained it. A few more people agreed than disagreed that maintenance of the new yard was harder. Most agreed that they seek more native plants than they had before, that they noticed more butterflies, and that their connection to their yard had been enhanced. They agreed that they used less fertilizer and less water. Most agreed that their neighbors approved of the front yard.

Communications should highlight the pleasure that many people experience in a Florida-friendly yard as a motivator for others to adopt similar yards. From the experience in this study, Florida-friendly yards should not be touted as "low-maintenance" but should be touted as providing a more pleasurable experience, and one that will connect people with nature and put them back in the garden.

The outcomes of this research project suggested that although the HOA was perceived by homeowners to be a powerful barrier to changing their yards, once the landscape design was submitted, the review process actually proved to be pretty simple. It is hard to say whether this would have been the same case if the project wasn't so well supported by credible and talented architects and horticulturalists.

The qualitative discourse gathered in the project established a foundation of terms, concepts, perceptions, motivators and deterrents that were used to develop a statewide survey to understand the strength of individual and community level influences that influence homeowners' landscape design choices and maintenance practices. The internal and external conflict associated with people changing their front yard landscapes, their motivations for change, and their expectations of the yard were clarified.

Environmental Research Methods and Analysis

To better understand the fertilizer and plant requirements for the study site, soil and irrigation water samples were taken and analyzed. In this dissertation, I will present only a small portion of that research, since it was primarily the focus of the University of

Florida research team hired by the Landscape Exchange project. My role in the Landscape Exchange environmental study research was recruiting homeowners for soil sampling, assisting with field sampling efforts, reviewing data sheets, conducting significance tests, and interpreting results.

In June 2010, UF/IFAS researchers collected composite soil samples from the front yards of forty-eight (48) homes in the study subdivision at two locations in each yard, (turfgrass and ornamental plant beds), providing a total of 96 samples. Four additional composite background samples were collected from the natural area adjacent to the study subdivision to provide a baseline to compare physical, biological and chemical properties of soils collected from residential areas. Approximately 10-15 soil cores (75-100 g of soil) were randomly sampled using a soil probe per vegetative area at each residence and in the natural areas. Composite soil samples were air-dried and sieved to pass a 2-mm screen. Organic matter, pH, and electrical conductivity (EC) using the standard methods of the University of Florida/IFAS extension soil testing laboratory (Mylavarapu, 2009). Soils were extracted with 0.01*M* KCl and soil ammonium-N (NH4-N) and nitrate (+nitrite)-N (NO3-N) were determined using standard EPA methods (Methods 305.1 and 323.2, respectively). Soils were digested and analyzed for total Kjeldahl N based on standard methods (Mylavarapu, 2009).

Environmental Research Results

In one of the yards (Case #751), the concentrations of NH4-N (77.96 mg/kg) and nitrate NO3-N (77.52 mg/kg) in ornamental bed soils were much higher than the concentrations found in other yards. In fact, the NH4-N concentration was over fifteen times higher than the next highest concentration (4.6 mg/kg). Removing these two data from the sample greatly reduced the NH4-N and NO3-N variances. The NH4-N standard deviation went from 7.05 to .86 mg/kg and for NO3-N from 10.26 to 7.38 mg/kg. The unusually high ornamental soil NO3-N and NH4-N samples from this case were coded as outliers. All other data were retained in the data set (n=100).

There were significant differences in N concentrations in soils in turfgrass areas of residential yards, the ornamental bed areas of the yards, and nearby natural areas. Analysis of variance was used to test significant differences at 95% confidence. All variables exhibited equal variances.

Total Kjeldahl nitrogen (TKN) measures the sum of organic nitrogen, ammonia, and ammonium. In the residential yard soil samples, TKN ranged from 308-1667 mg/kg in ornamental beds and from 321-1965 mg/kg in turf areas. Background samples taken in the adjacent natural area ranged from 502-804 mg/kg TKN.

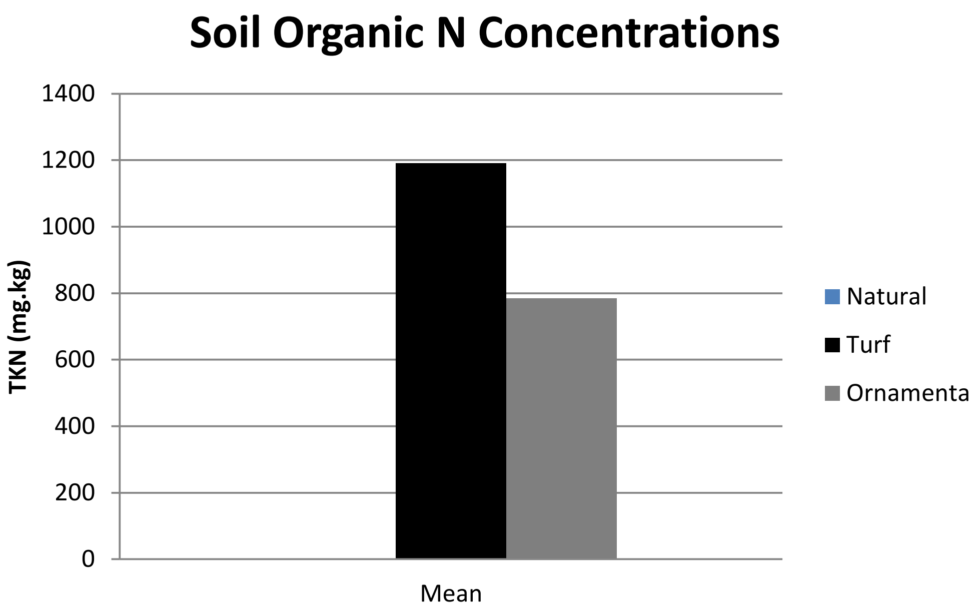


Figure 7: Soil Mean TKN Concentrations (n=100)

ANOVA revealed that TKN concentrations significantly varied between groups ($F = 23.11$, $p < .001$). Turf grass soils had significantly higher TKN concentrations than those in ornamental bed soils ($p < .01$) and soils in natural areas ($p < .001$).

A similar comparison was done of nitrate (NO_3^-) concentrations between the three groups, which ranged from 0.18 - 0.20 mg/kg in natural soils, from 0.89 – 15.16 mg/kg in ornamental soils and from 1.17 – 54.16 mg/kg in turf soils. There was a significant difference in soil NO_3^- concentrations in flower beds, turf, and natural areas of the landscape, $F = 10.84$, $p < .001$, $n = 96$ (Figure 8). Turf grass areas had soil NO_3 concentrations significantly higher than natural areas ($p < .05$) and ornamental beds ($p < .001$).

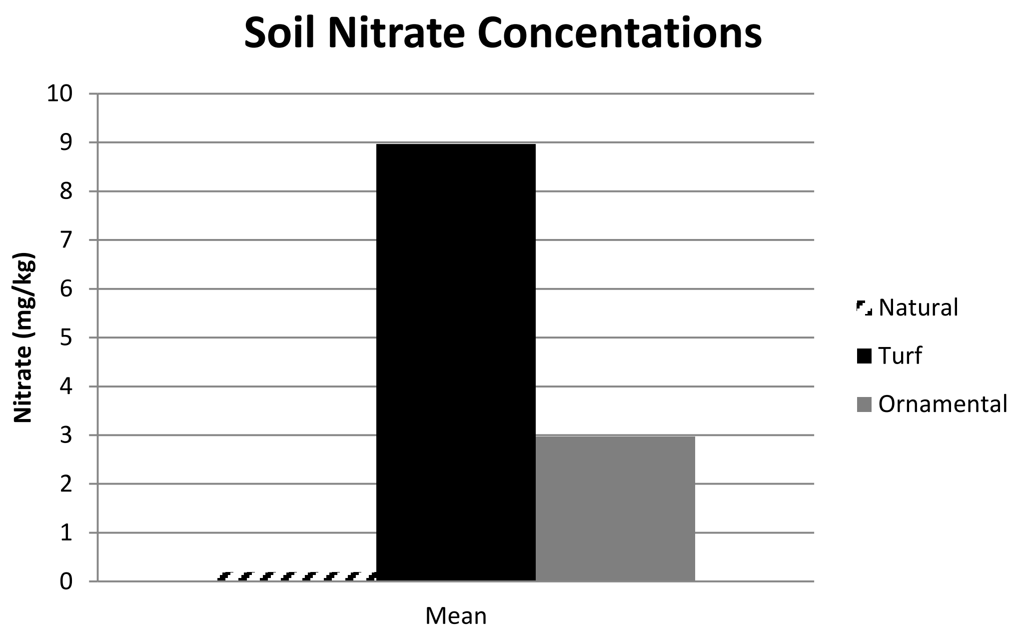


Figure 8: Soil Mean Nitrate Concentrations (n = 99)

Soil ammonium concentrations ranged from 2.67-3.53 mg/kg in natural areas, from 0.72 – 4.6 mg/kg in ornamental beds and from 0.58 to 4.46 mg/kg in lawn areas. ANOVA confirmed significant differences between NH4-N concentrations of the three groups ($F = 11.75$, $p < .001$). There was not a significant difference between natural areas and turf mean soil concentrations, but ornamental beds has NH4-N concentrations that were significantly lower than natural areas ($p < .01$) and turf areas ($p < .001$).

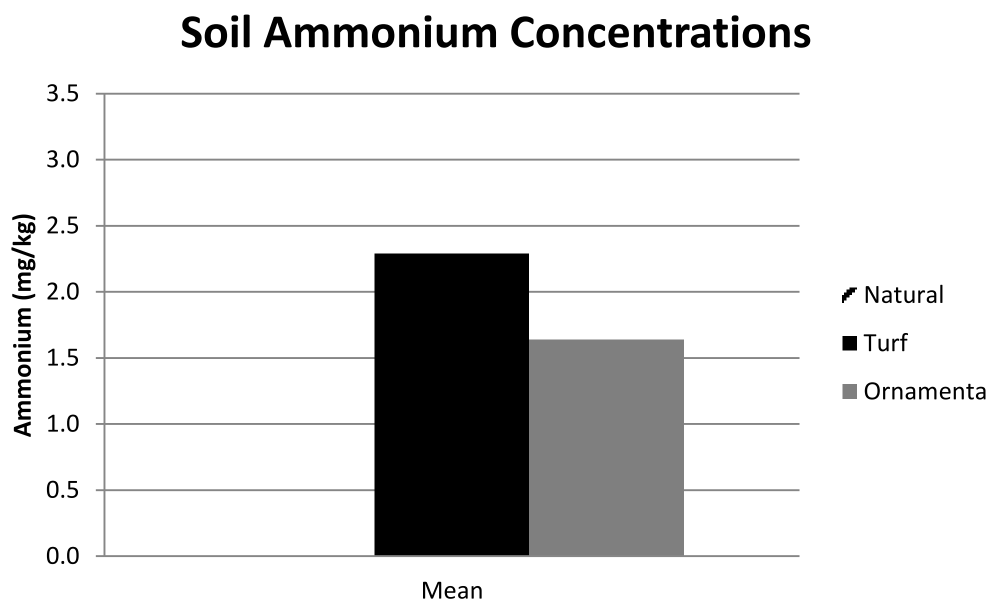


Figure 9: Soil Mean Ammonium Concentrations (n = 99)

Total nitrogen was computed from the amount of organic nitrogen measured as TKN and the concentration of nitrate (NO_3^-). Mean Total N concentrations are shown in Figure 10. Turf areas of the yard had the highest mean Total N concentration (1,200 mg/kg), which was significantly higher than the Total N concentration in natural areas ($p < .01$) and in yard ornamental beds ($p < .001$). The Total N concentrations in the soils of natural areas and ornamental beds did not significantly differ (Figure 10).

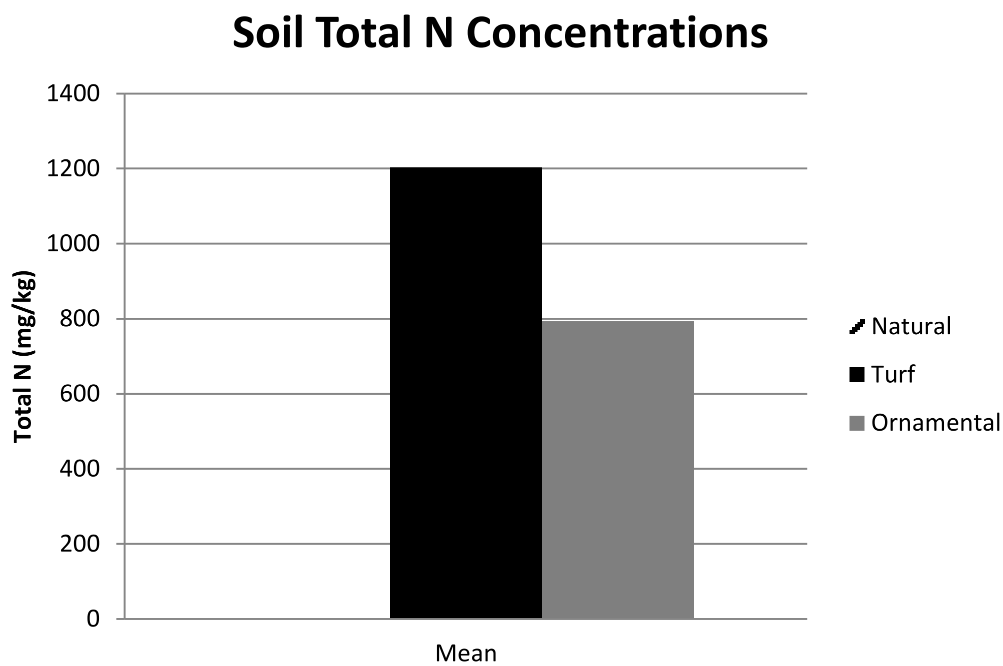


Figure 10: Soil Mean Total Nitrogen Concentrations (n=100)

Discussion and Contributions

The Landscape Exchange project provided valuable foundational information to build upon with additional research. From a socio-behavioral perspective, it provided the discourse and rationality to operationalize quantitative measures in standardized surveys. It was evident from the experience working with the people in the study subdivision that they had powerful influences presenting challenges and opportunities to changing their landscaping practice. Some of the influences were personal aesthetic preferences and desires for natural preservation. Others were oriented toward community conformity and wanted to please the neighbors. In this study, the ever-present oversight by the HOA governing board was pervasive.

From the environmental study, I found that mean soil nitrogen concentrations in turfgrass areas of the yard were significantly higher than those of ornamental bed areas and natural areas. This could be due to mineralization of N in turf clippings or from the inputs of N from turf fertilization. The soils were collected in June, 2010, a time of the year when nitrogenous fertilizer should not have been applied to the yard. Considering this, the nitrate concentrations were quite high in the residential yards relative to the background concentrations.

To better understand the pattern of yard nitrogen concentrations and homeowner fertilizer behaviors, fertilizer frequency and N concentrations were spatially analyzed using interpolation techniques. With the interpolation analysis, data points of known concentrations were linked through a spatial curvilinear regression. Areas of higher Total N concentrations are shaded in darker shades of gray in Figure 11.

Mapping the reported number of times that fertilizer was applied to the lawn with the interpolated Total Nitrogen concentrations in turf soils revealed a pattern of frequency and concentrations that do not appear to relate. This may be because the soil nitrogen concentrations had little to do with fertilizer application. It may also be due to the vague fertilizer frequency responses, which were recorded as monthly, quarterly, semi-annually, etc... or it may be due to the large number of missing (other) data in the fertilizer frequency data set. The analysis will be repeated after recoding the fertilizer frequency data to integrate the “other” category.

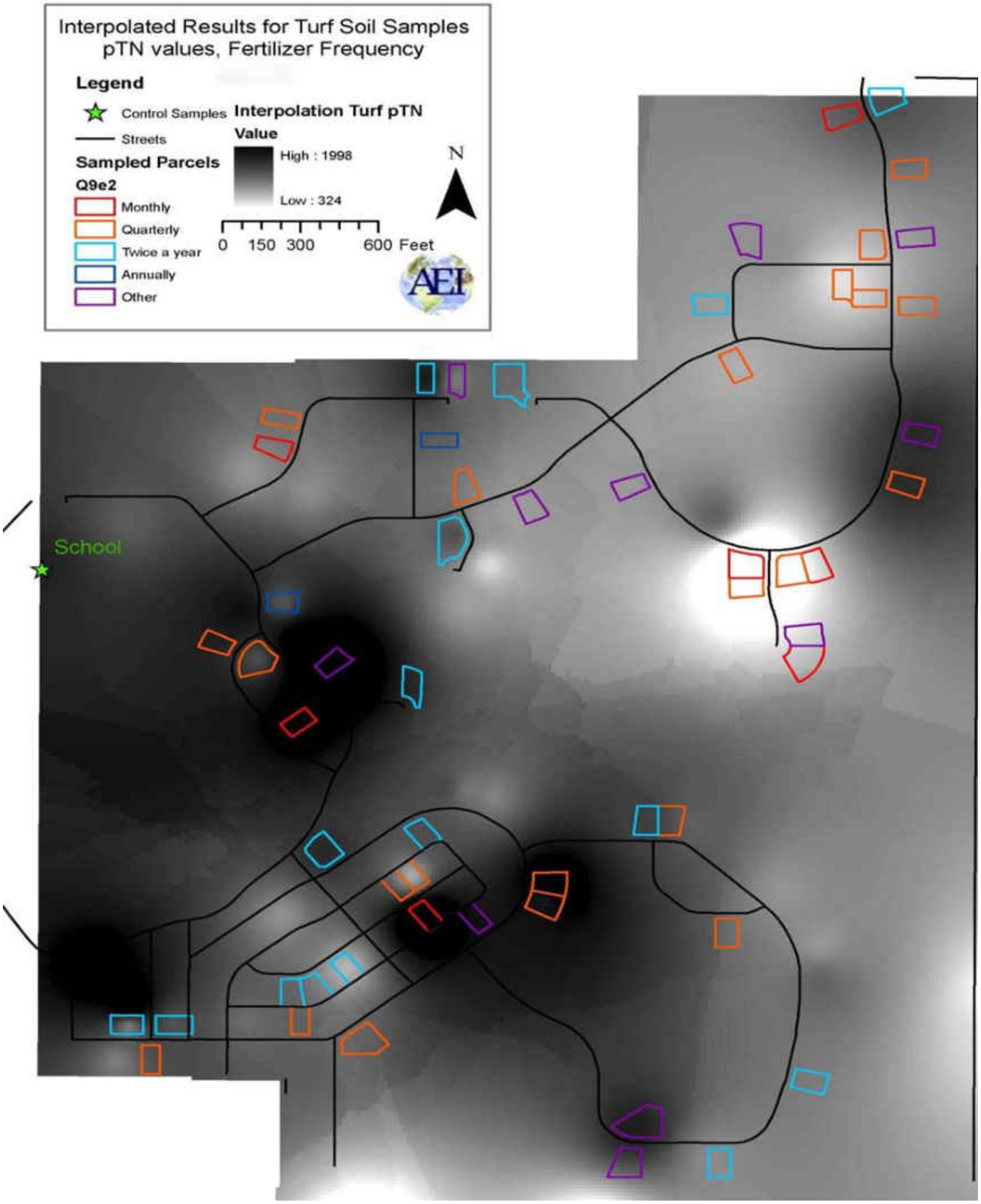


Figure 11: Interpolated Soil Total N Concentrations and Fertilizer Frequency

There was a lapse in time between when the soil samples were taken (June 2010) and when the fertilizer frequency data were collected. (July 2009). Future research should attempt to collect soil data and fertilizer frequency data as close together as possible and to focus on collecting data during the spring and fall months when most homeowners apply fertilizers to the yard. A more evident relationship between soil Total N concentrations and fertilizer application may emerge if the timing of application and sampling is coordinated.

This method provided us the opportunity to test out the use of spatial analysis and interpolation mathematics as a way to link behavioral and environmental data. One important lesson learned from this effort was that correlating environmental quality and behavioral data requires that the data be as proximal in time and space as possible. The findings and methods of the LEP were further advanced in the Land-Water Connection Project that followed.

CHAPTER FOUR: THE LAND-WATER CONNECTION – WEKIVA RESIDENTIAL LANDSCAPE STUDY

Figure 12: Wekiva (a.k.a Wekiwa) photo by Matt Bledsoe

Introduction

The Land-Water Connection (LWC) project related residential fertilizer inputs with socio-economic and environmental information to identify hotspots of human inputs and community level N loading potential. Building on the assumption that virtually all soil systems have nitrogen (N) losses that mimic N inputs (Amundson *et al* 2003), the LWC project measured residential landscape N inputs as an indicator of nitrogen load potential that can negatively impact the environment. Other research demonstrated that lawn age, lawn management practices, soil-disturbance history, soil compaction, soil type, and seasonal timing of nitrogen inputs were integral determinants of nitrogen loss (Raciti *et al* 2008). LWC examined these variables and others as they related to fertilizer application rates and furthermore, it spatially analyzed variables to correlate residential yard N inputs and surface water quality. Spatial analysis of behavioral and environmental data was described by Kaye *et al* (2006), who suggested that residential landscape N inputs should be associated with environmental outputs using models that link social and geophysical functions. The LWC project attempted to address this need by using geo-spatial models and spatial regression analysis to understand N dynamics in a small watershed. In doing so, LWC made an important contribution to urban ecology, socio-environmental science and the integrative methods needed for actionable, science-based decision-making.

The research took place within the legislatively defined Wekiva Study Area (WSA) covering 473 mi^2 (122,620 ha), including sections of 2 counties, 4 cities and 20 census tracts. The WSA population density was 1.28 people/acre based on the 2000 Census. In 2004, the land use in the Wekiva Study Area was 54% forest and open space, 24% residential, 13% agriculture, 5% commercial, industrial, or institutional, 2% golf course, and 2% transportation with the majority of change from agriculture to residential in the previous decade. The Wekiva Parkway and Protection Act of 2004 (Chapter 369, Part III, FS) simultaneously established the WSA and the “Wekiva Parkway,” a limited-access expressway across the Wekiva River Basin in parts of Seminole, Orange and Lake counties. The law required local land use and stormwater management planning to protect the Wekiva River ecosystem. The continued health and function of the Wekiva River was contingent on the potential for land use changes associated with the new parkway.

The law directed the Florida Department of Environmental Protection to study the efficacy of standards developed to achieve N reductions in the Wekiva system. Additional legislation passed in 2006 authorized funds for the "Identification and Quantification of Nitrogen Sources in the Wekiva River Basin Area". This became the source of funds for the initial Phase I study titled Wekiva River Basin Nitrate Sourcing Study (MACTEC 2007) as well as the Phase II Study (MACTEC 2009) to which the LWC project contributed.

The Wekiva is a 25.3 km (15.7 mi) long river originating from two separate freshwater springs, Red Rock Spring and Wekiva Spring, and terminating at the St. John’s River. Located about 24.1 km (15 miles) north of Orlando, the Wekiva was a well-loved and protected river with a loyal “Friends” group that has been actively advocating on its behalf for thirty years. The Wekiva River has been designated a Florida Outstanding Waterway, a Florida Canoe Trail, and both a State and National Wild and Scenic River. Wekiwa Springs State Park was established in 1969 to protect 7,000 acres

(28 km^2) of the Wekiva Spring headwaters and surrounding forest uplands. Figure 13 details the Wekiva Study Area as well as the watershed and springshed boundaries, the two spring heads (Wekiwa and Rock Springs) and the 36 mi^2 LWC Survey Area where homeowner behavioral and water quality data were collected during the project.

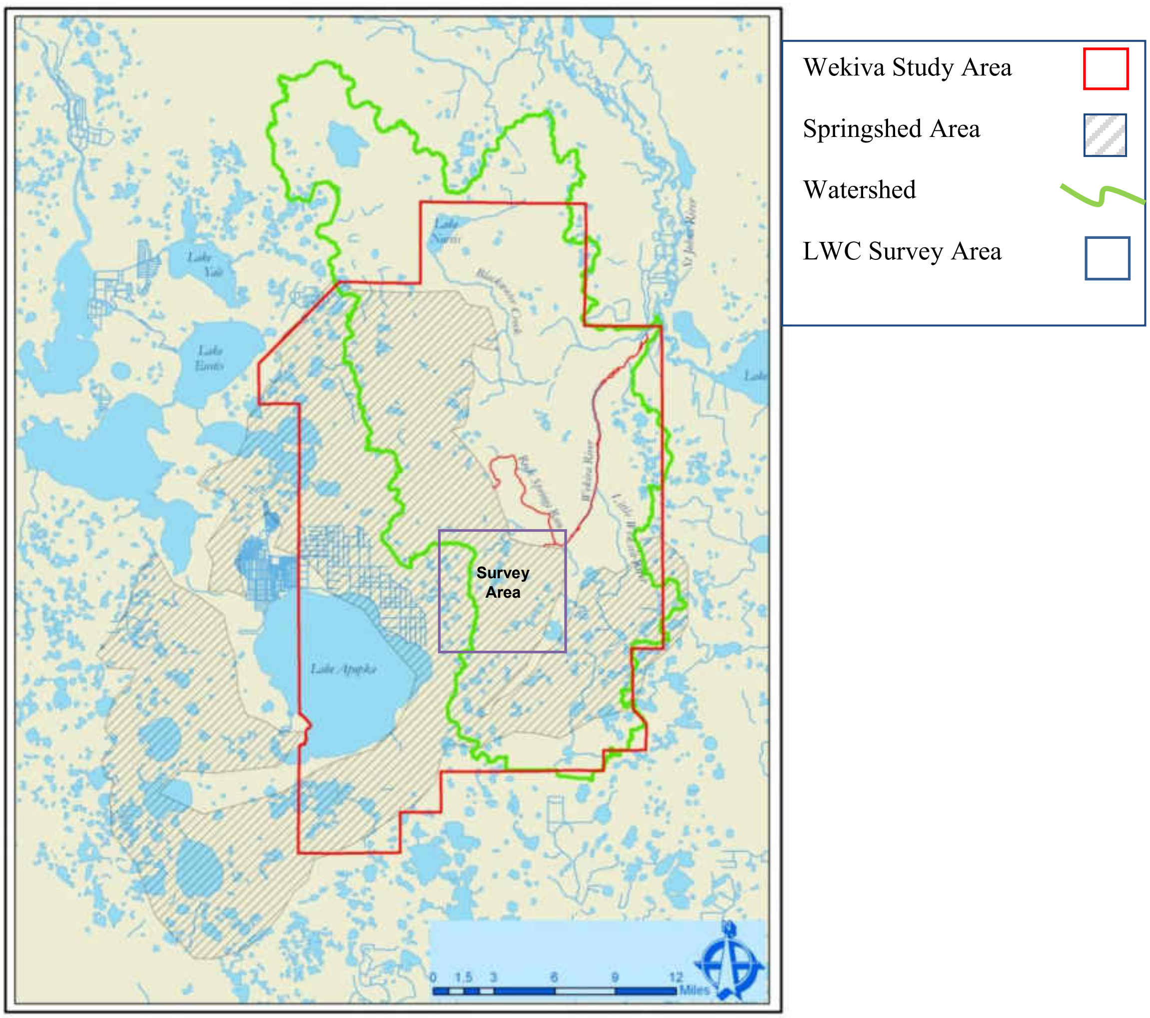


Figure 13: Wekiva Study Area, Survey Area, Springshed and Watershed

Research initiated by St. Johns River Water Management District (SJRWMD) examined available data on sources of nitrogen (N) to the Wekiva River and the Floridan aquifer system that is the spring source. The goals of the research were to estimate relative N source contributions and identify data needs for research directives. The SJRWMD focused on sources of nitrate (NO_3^-), a priority pollutant in the Wekiva River basin. The resulting Phase I Report: Wekiva River Basin Nitrate Sourcing Study (MACTEC 2007) summarized N inputs and loads by source and land use types. The report estimated that 42% of NO3- inputs to the Wekiva came from residential fertilizers (Figure 14). This estimate was based on record reviews and assumptions about homeowner fertilizer practices and was consistent with the findings of others.

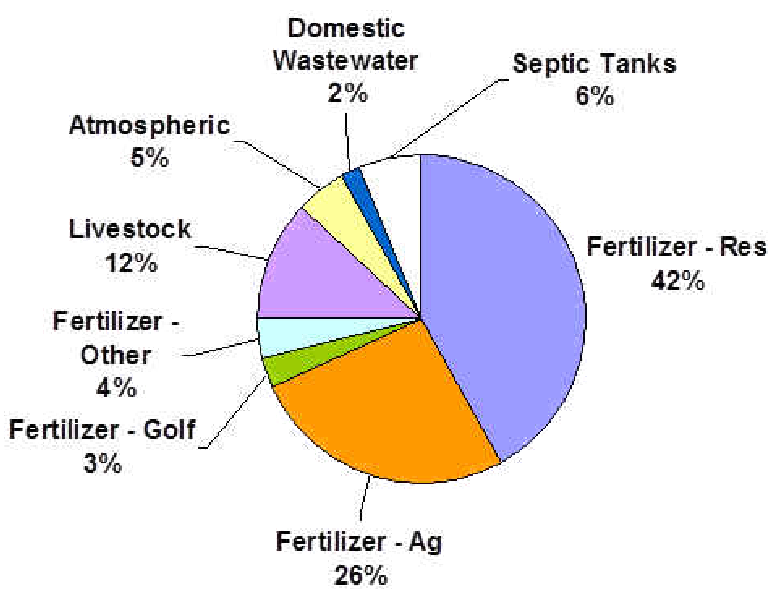


Figure 14: Nitrogen Inputs to the Wekiva River by Source: 9,400 Metric Tons/Year (MACTEC 2007)

At the national scale, estimates of nitrogen loads from fertilizer use ranged from 20% to 25% (Howarth *et al* 2002). Control turfgrass plot studies showed N losses ranging from 25% (Frank *et al* 2006) to 33% (Engelsjord 2004) with similar losses (25-37%) reported across varying citrus fertilizer treatments in a control study (Quinones *et al* 2007). In Florida, a Lake Tarpon study estimated that fertilizer contributed 79% to the total nitrogen load, (Leggette, Brashears and Graham, Inc. 2004). With these differences in load estimates varying at scales, one of the goals of the Phase II research was to better understand the residential fertilizer source contribution to the Wekiva.

Understanding N inputs contributed by residential landscape managers was key to refining source and load estimates in the Wekiva Basin. The Land-Water Connection (LWC) Study was funded by the FDEP to provide valuable information to the Phase II research that would address the assumptions uses to calculate load estimates in the Phase I report. By examining homeowner landscape management practices, we were able to better understand residential landscape fertilizer inputs and potential N loads. In the LWC research, landscape manager self-reported behaviors were related to groundwater and surface water data to link human activities with the watershed. Landscape management data were also spatially analyzed to visualize patterns of fertilizer management types and potential sources based on fertilizer input hotspots.

Methods and Analysis

The Land-Water Connection (LWC) project examined socio-environmental data to spatially relate human N inputs with receiving waters. Using a multi-method research approach, LWC conducted a comprehensive investigation of human inputs of nitrogen associated with landscape management practices. A representative telephone survey of homeowners was conducted to collect information about landscape maintenance responsibilities, fertilization and irrigation frequency, fertilizer inputs, and landscape influences. Data from the telephone survey were geocoded and analyzed along with environmental quality data to better understand the organization of individual, community, and environmental systems. The LWC survey research addressed the following hypotheses:

H1 – Landscape managers significantly differ in the average amount of fertilizer applied to their home's lawn annually.

H2 – Communities significantly differ in the average amount of fertilizer applied by the homeowners within the community.

H3 – Housing age is a significant predictor of fertilizer input intensity (H3A). There is a negative correlation between the two (H3B).

To better characterize neighborhoods based on lawn fertilizer habits, an observational study and homeowner interviews were conducted. Forty-two door-to-door interviews were completed, contributing important qualitative information about why and how homeowners fertilize the lawn while recruiting homeowners to participate in the research. A review of regional HOA mandates was also conducted to clarify community level mandates and norms influencing high fertilizer use. Environmental data collected by MACTEC and long-term surface water quality databases (STORET, SJRWMD) were geocoded and transpolated with behavioral data to relate the behavioral and environmental quality data.   More details on these three data collection methods are provided in the following sections.

Telephone Survey

A fifteen-minute long telephone survey of homeowners in the Wekiva Survey Area was used to collect information on homeowners lawn fertilizing and irrigation practices as well as landscape attitudes and influences. Recognizing that fertilizer sales are high in the spring, the survey was completed from April 18 – May 7, 2008 when people were more likely to recall what they had applied. The survey included prompted questions to facilitate homeowner recollection of fertilizer application, asking the number of times fertilizer was applied since the beginning of the year and over the last twelve months and questions about the number of bags purchased, the size of the bags and the nutrient content. A total of 740 respondents completed the telephone survey.

The University of Central Florida Institute for Social and Behavioral Science was employed to conduct the telephone survey. Interviewers were properly CITI trained to collect human subject data and Institutional Review Board review and approval were completed (Appendix D). A survey sampling frame of 7,000 telephone numbers was procured based on a list of census tracts that geographically overlapped the study area by 70% and those whose major population centers were within the 36 mi^2 survey area even though the entire tract was not. Although accurate, the survey sampling frame extended slightly beyond the Wekiva survey area (Figure 13). Telephone numbers were randomly called between the hours of 3:00 pm and 9:00 pm during weekdays and 12:00 pm and 9:00 pm on weekends. A Computer Assisted Interviewing Techniques (CATI) system allowed automated scripting and response coding. The CATI system was efficient and reliable and reduced coding error. All telephone interviewers were trained in advance and received IRB certification. The survey objectives were: (1) To refine nitrogen source and load estimates by collecting data on homeowner fertilizer practices; (2) to recruit homeowners to participate in the research by having a groundwater monitoring well installed on their property and (3) to understand socio-demographic, community, and individual influences on homeowner residential landscape behaviors.

The telephone survey questionnaire collected general information on homeowners fertilizing and irrigating behaviors and screened respondents for the criteria needed for well installation. The survey was also measured fertilizer application rates by asking a specific series of questions about the three numbers that designate the fertilizer formula on the bag, the bag weight, and the number of bags applied with each application. One important objective of the LWC telephone survey was to calculate an average application rate of N (kg/ha/yr) for regional homeowner landscape managers (HLM) based on the pounds of fertilizer applied annually and the estimated lawn area. Building on the application rate calculation method described by Law *et al* (2004), an average N input per household was calculated. A copy of the survey marginal frequencies is provided in **Appendix B.**

Homeowner Recruitment

Twenty-four groundwater monitoring wells were installed in homeowners' yards in the Wekiva Study Area as a result of recruitment. Fifteen wells were installed in the yards of residents recruited through door-to-door interviews. The remaining wells were installed in the yards of homeowners recruited through the telephone survey.

Homeowner recruitment initiated with the telephone survey, during which the interviewer asked if the respondent would be willing to participate further in the research. Respondents who agreed were asked for their home address and four screening questions to determine if they met selection criteria. Participants were screened to ensure they owned the house and had an established lawn for at least five years, they were connected to the central sewer service (no septic tank), and they lived in a community without any reclaimed water. Ideally, participants lived in a neighborhood with uniform lawn management practices as predetermined by an observational study. Thereafter, interviewers personally visited potential participants to inform them about the project, about the sampling equipment, and about their rights as a research participant. During the telephone survey, 239 persons indicated that they would be willing to participate further in the research, but of these, only 76 provided a home address and of these, twenty-nine agreed to well installation, and of those, nine wells were installed. An additional fifteen wells were installed in yards of homeowners recruited through door to door interviews in targeted communities.

Communities were targeted if they met the selection criteria and exhibited landscape uniformity, which is described in more detail in the following section on the observational study. During the door-to-door recruitment, teams of two to three researchers approached potential participants within targeted uniform neighborhoods. Homes were randomly selected to participate in the research by having a well installed on their property. Potential participants not at home were left a recruiting brochure with a postage paid return registration forms. No registration forms were received through the mail. The characterization of neighborhoods according to uniformity is explained in more detail in the following section.

Observational Study

Observational studies conducted from January to March 2008 identified communities based on their lawn greenness as an indication of community-level landscape maintenance uniformity. The observational study was conducted during a dry and dormant time of the year, when grass was not typically green unless it is irrigated and fertilized regularly. Researchers drove through the Wekiva Survey Area and ranked neighborhood uniformity based on the variation of lawn greenness among homeowner landscapes at the block level. Neighborhood uniformity was noted by the percentage of homes on each block with lush green lawns during the dormant season.

Observed neighborhoods were divided into those where houses appeared to have uniformly green lawns, those that appeared to have uniformly less green lawns, and those that appeared to have both (not uniform). Observations were mapped and recorded to assist the recruiters select neighborhoods with uniform practices.

Homeowners Association Research

A majority of Wekiva Survey Area residents (68%) lived in communities governed by a Homeowner's Association (HOA). Although few of these HOAs (3%) are responsible for maintaining the landscapes themselves, the rules and covenants they enforce are a strong influence on homeowner behaviors (Martin *et al* 2004). At the neighborhood scale, homeowners associations and their mandates act as a measure of lifestyle behaviors and social status. During the LWC research, a thorough investigation of homeowner's association covenants was conducted to understand their influence on lifestyle behaviors.

Thirty-one different HOA covenants and deed restriction documents were collected, examined, and summarized by other members of the research team (Milch and Ritner, unpublished data, 2008). The documents were reviewed to assess their effect on residents landscaping design and maintenance practices. Using the Florida-Friendly Landscaping Covenants, Conditions and Restrictions model covenant language (University of Florida 2009), Milch and Ritner evaluated the HOA covenants to measure the extent that HOA rules addressed environmentally-friendly landscaping ideals. They also evaluated the extent that mandates limited homeowner landscape options, for example by specifying allowable plant species or a type or required coverage of turfgrass. Lastly, they looked at the oversight HOA committee review requirements for requesting landscape changes to evaluate the process burden on the homeowner. They found that among the reviewed 31 HOA covenants, the greatest similarity overlapped the UF model conservation covenant language by 11%. Those with the least amount of coverage overlapped the model by about 2%. The most common feature from the model found in existing covenants was that they had a committee to review landscape changes. Nearly a fifth (17%) of the 31 HOA covenants had a turf grass requirement.

Groundwater Sampling

MACTEC Inc. was responsible for installing twenty-four monitoring wells in residential yards unaffected by septic systems within Wekiva Study Area. Two shallow wells were installed on undeveloped natural areas on state lands (Wekiwa Springs State Park and Rock Springs Run State Reserve).

Well installation took place between October 1, 2008 and October 16, 2008. All wells were installed as 1.5-inch inside diameter (ID) pre-packed micro wells using direct push technology. The depth to groundwater varied greatly across the study area from as shallow as 1.0 ft bls in monitoring well BW-2 to 37.6 ft bls in monitoring well MW-4. The deepest well is monitoring well MW-4 with a total depth of 48 ft bls and the shallowest well is MW-12 with a total depth of 10 ft bls. Wells were completed to a depth of approximately 5 to 10 ft below the water table. In most wells, the screen length is 10 ft with the exception of MW-12 with a 5-foot screen length and monitoring wells MW-2, MW-3, MW-4, MW-10 and MW-15 with 15-foot screen lengths. A complete description of monitoring well construction details including screen interval and depth to groundwater is provided in Table 6.

Each micro well was constructed of 1.5-inch ID schedule 40 Polyvinyl Chloride with a pre-packed 20/30 sand filter pack to 2 ft. above the screen and then sealed with a fine sand seal to 2 ft. above the filter pack. The remainder of the well annulus was grouted to near the surface with cement grout. Because most wells were installed within residential locations a 7-inch flush mounted plastic manhole cover was used for surface completion. The plastic manhole was placed over the well for aesthetic purposes (MACTEC 2009).

Table 6: Monitoring well construction details

Well ID	Screen Interval (ft)	DTW (ft)
BW-1	4-14	2
BW-2	2-12	1
MW-1	4-14	3
MW-2	10-25	18
MW-3	30-45	36
MW-4	13-48	38
MW-5	5-15	6
MW-6	10-20	12
MW-7	10-20	11
MW-8	2-12	3
MW-9	5-15	7
MW-10	17-32	24
MW-11	20-30	21
MW-12	5-10	4
MW-13	4-14	6
MW-14	5-15	6
MW-15	17-32	23
MW-16	5-15	8
MW-17	20-30	7
MW-18	5-15	7
MW-19	5-15	8
MW-20	10-20	10
MW-21	6-16	8
MW-22	17-27	18
MW-23	5-15	4
MW-24	5-15	8

DTW = Depth to groundwater

MACTEC sampled most of the wells and the main vent of Wekiva Springs four times between October 2008 and July 2009, and samples were analyzed for nutrient constituents of residential fertilizer and other water quality parameters. Two existing Floridan aquifer wells within the study area were sampled one time.

Four sampling events were scheduled over a year: Event #1: October 2008 (wet season); Event #2: March 2009 (dry season); Event #3: June 2009 (wet season); and Event #4: July 2009 (wet season). All 24 wells were sampled during the first wet season event (October 2008), but some of these wells were not sampled in subsequent events. For budgetary reasons, sampling of six residential wells (12, 18, 19, 22, 23, and 24) was discontinued after the first wet season sampling event. Two reference wells installed in natural areas were sampled and analyzed during all four sampling events. Two existing Floridan aquifer monitor wells were sampled during the first event. Finally Wekiwa Springs was sampled during each of the four events.

All water samples collected were analyzed for Ammonia as nitrogen (NH3-N), Nitrate plus Nitrite as nitrogen (NOX-N), and Total Kjeldahl Nitrogen (TKN). The groundwater wells with the highest nitrate concentrations were also analyzed for $\delta\ ^{15}N - NO_3^-$ and $^{18}O - NO_3^-$ to further characterize the source of nitrate. These parameters were also analyzed in each sample collected from Wekiva Springs.

Geospatial Analysis Methods

Geospatial data that included parcel layers, census data, soil maps, lawn cover, and land use were preprocessed to the necessary format for geospatial and statistical analyses. Likewise, all behavioral and environmental data were quality assured and converted to spatial layers. All variables of interest (dependent and independent) were mapped and examined spatially across the study area. Patterns of household to community level fertilizer inputs were mapped and extrapolated to county land use. Dr. Claudia Listopad supported the LWC project by providing the spatial and interpolation analysis and maps. Dr. Listopad also co-authored the paper submitted to *Landscape and Urban Planning* as part of this dissertation and co-presented a poster at the Socio-environment Synchronization Center in Annapolis (July 2012).

Grove *et al* (2006) demonstrated a method to segment the landscape to the block level into thematic categories based on the Claritas PRIZM (potential rating index for zipcode markets) categorization system. TWC developed its own rating index that included the significant predictors in previous literature to identify target markets based on their polluting potential. Like Grove *et al* (2006), the LWC project assumed that landscape management decisions and expenditures on landscape maintenance services were motivated by group identity and perceptions of the associated social status of the community lifestyle. We plotted individual behavioral data to identify spatial patterns indicative of community commitment to high maintenance intensity and high N inputs.

Results

This section summarizes the socio-demographic and spatial analysis results and provides maps and outcomes in tabular formats.

Telephone Survey

Table 7 summarizes the demographic characteristics of the 740 people who responded to the Wekiva Telephone Survey. Respondents were middle aged (mean=53 years); white (83%); female (60%); year-round residents (98%); who had lived in Florida an average of thirteen years. Respondents were more highly educated than Floridians in general (2010 Census), with nearly all graduating high school (98%) and a third completing a college degree.

Table 7: Demographics of Wekiva Telephone Survey Respondents (n=740)

	Wekiva	Florida
Female	60%	51%[1]
Caucasian	83%	78%[1]
B.S. degree or higher	33%	26%[1]
Employed	59%	52%[1]
Homeowners Association	68%	47%[2]
Full-time residents	98%	94%[2]
Fertilize their lawn	84%	71%[2]
Irrigate their lawn	92%	86%[2]
Sanitary sewer	61%	*
Reclaimed Irrigation	10%	*
Avg. Lawn percentage	58%	*
Avg. Lot size (Square feet)	21,927	*
Average age	53	*
Average years in Florida	29	*
Average years in current residence	13	*

1. US Census 2010 (n=59,000) 2. UCF Predicting Maintenance Intensity Survey 2011 (n=939). * Not available

Landscape Management Practices

Nearly three-quarters (71%) of surveyed residents indicated that they did the majority of their home's landscape maintenance themselves. Those who hired a landscape maintenance company (23%) varied greatly in the extent that they directed the company's practices. Twenty-two percent indicated that they did not direct the landscaping practices at all, thirty-one said they directed them a little bit, twenty-two percent said they directed them somewhat and twenty-five percent direct their landscape company a lot. LWC research found significant differences in the people who hired landscape companies to apply fertilizer (professional landscape managers or PLM) and those who applied fertilizer themselves (homeowner landscape managers or HLM).

Irrigation Practices

Ninety-two percent of respondents irrigated their lawn, a large majority (78%) used an in-ground, automatic irrigation system to do so, and roughly half of those left the irrigation system on automatic all the time (51%). Almost half (49%) responded that their irrigation system had a rain sensor on it with nearly all (84%) believing it worked correctly.

By far, the majority of respondents (92%) irrigated the lawn no more than two days a week, probably in response to a long-standing public education and regulatory program that limited watering to twice a week. When asked which season they typically water the lawn the most, most respondents indicated they watered the lawn most in the summer (55%). Responses to a similar question regarding when they watered the least indicated that most respondents watered the lawn the least in the winter (61%). This is a surprising finding, considering Florida receives most of its annual rainfall during the summer months. I assumed people irrigated the lawn more frequently during the dry winter months.

<u>Fertilizer Application Rates and N Inputs</u>

Eighty-four percent of homeowners in the Wekiva Survey Area fertilized their lawn. Of those, over half (59%) applied it themselves (Homeowner Landscape Managers), another third (36%) hired a landscape company (Professional Landscape Managers), four percent (4%) had a HOA or landlord that hired a landscape company and 2% had a friend, neighbor, or other apply the fertilizer. About half applied fertilizer on a regular schedule and the other applied fertilizer as needed.

A question that asked homeowners how many times fertilizer was applied to the lawn in the past 12 months was used as a measure of annual lawn fertilizer application. Reported fertilizer application rates ranged from 0-80 times per year, but for the purposes of computing fertilizer input amounts, the two highest data points (50 and 80 times per year) were removed as outliers. One hundred twenty (120) respondents never fertilized the lawn and these were added as zeros to the fertilizer frequency variable. Fertilizer was applied to residential yards in the Wekiva Survey Area 2.86 times/year on average.

Law *et al* (2004) calculated fertilizer application rates at three spatial scales using land-use cover and landscape manager's responses on the type and amount of fertilizer, the frequency of application and lawn area. They used a weighted average application rate multiplied by the lawn area within each watershed to calculate a total mass input of N applied to lawns in the watershed.

A similar method was used in the LWC project to calculate N inputs from fertilizers applied by homeowner landscape managers (HLM). Unfortunately, information on the application rates of professional landscape managers (PLM) was not accessible and as a result, the input data associated with this portion of the response set could not be included in the calculation of N inputs.

Homeowner Landscape Managers (HLMs) applied an average 1.21 bags of lawn fertilizer with an average weight of 22.82 pounds. The data were investigated further to understand the relationship between fertilizer bag size and weight to determine whether mean or medians should be used. The median reported bag size was 20 and the average was 23 pounds, a negligible difference. This was also true of the number of bags of fertilizer applied which had a median of 1 bag and an average of 1.2 bags. In both cases, the median and mean values were comparable, so the mean was used in the calculation.

A limited number of respondents (n=71) knew the three numbers listed on the fertilizer bag that depicted the fertilizer formula. HLMs reported the most commonly used lawn fertilizer formula was 06-06-06 (27%) which is consistent with statewide fertilizer sales data (Florida Department of Agriculture and Consumer Services, 2012). The average amount of nitrogen (N) in the lawn formulas reported was 16%, but for the purposes of computing fertilizer application rates, the more conservative popular formula amount of 6% N was used. Table 8 summarizes the variables used to compute fertilizer N inputs.

Table 8: Computing Fertilizer Inputs by Homeowner Landscape Managers (lbs/yr)

Variable	Question	N	Mean	SD	Range
Homeowner Fertilizer Frequency (Q18)	How many times was fertilizer applied in the past twelve months?	339	2.84	2.1	0-12
Number of fertilizer bags applied (Q23)	How many bags of fertilizer are applied to the lawn at each application?	285	1.21	0.85	0.25-5
Fertilizer bag size (Q24)	How large are the bags of fertilizer you purchase for the lawn? (Lbs)	250	22.8	13.85	5-50
Fertilizer Pounds	Q18 * Q23 * Q24	227	80.6	112.6	0-600

Based on this calculation, homeowners applied 80.58 lbs (36.55 kg) of fertilizer to their lawns the previous year. Homeowners applied an average of 28 pounds of fertilizer at each application, an average of 2.84 times a year. The data did not show that fertilizer amounts decreased with application frequency, suggesting that homeowners who applied fertilizer more frequently were not on average applying less fertilizer with each application. HLMs applied an average of 4.83 lbs (2.19 kg) of N to their lawn annually.

Understanding the amount of fertilizer applied does not inform the concentration of N unless the area is considered. In the LWC project, lot pervious area was imputed by C. Listopad using automated GIS mapping feature extraction with Feature Analyst ® for impervious surfaces. Analysis included batch processing of supervised classification for road and building features using 2008 high resolution 1-ft aerials and vector post-processing. From this, lot-level pervious area was imputed so that an estimate of fertilizer pounds per unit lot area was calculated.

Homeowner Landscape Managers applied an average 12.23 lbs fertilizer/1000 ft^2/yr (597 kg/ha). Using the N amount in the most common fertilizer blend sold (6%) resulted in average input of 0.7339 lbs N/1000 ft^2/yr (36 kg N/ha/yr). Using highest reported N in lawn fertilizer blend (29%) resulted in average input of 3.55 lbs N/1000 ft^2/yr (173 kg N/ha/yr). Both are low compared to the recommended fertilizer rate of 3-5 lbs N/1000 ft^2/yr (195 – 292 kg N/ha/yr). Because fertilizer amounts and formula weren't available for the professional landscape managers, these inputs weren't computed.

Segmenting Audiences

There are several important considerations for practitioners developing programs to reduce residential landscape N inputs. Using the theoretical framework and methods of social marketing audience segmentation and product placement, research should collect data to clarify who is the primary polluter, what influencing forces motivate and prevent actions, what strategies or products are needed to overcome or encourage those forces, and how can success be evaluated in terms of environmental changes. Different strategies are needed to reach landscape managers who differ in their attitudes, influences, barriers, motivations and locations. For example, different types of interventions are needed to reach homeowners who apply fertilizer themselves and those who rely on a professional. It would also be interesting to understand if homeowners who don't apply fertilizer differ from those who do and if homeowners in HOA governed communities differ from those who do not. In this section on audience segmentation, differences in homeowner groups are investigated statistically and spatially as they relate to fertilizer frequency.

The analyses involved several predictors and the nominal measure of four conditions: households where fertilizer is applied by the homeowner (HLM); households where fertilizer was applied by a professional (PLM); households where no fertilizer is applied, and households within HOA governed subdivisions (HOA). Various statistics were used to explore relationships and seek significant group differences that test the following hypotheses.

In the Wekiva Study Area, I tested if there were alternatives to there being no difference between groups of homeowners in terms of key attitudinal, behavioral and socio-demographic criteria. The first hypothesis $H1_0$ will examine differences between homeowners who apply fertilizers themselves (HLMs) and those who hire professional landscape managers to apply fertilizer (PLM). The second hypothesis ($H2_0$) determines if no differences exist between groups of homeowners who don't fertilize the lawn and those that do and the third hypothesis ($H3_0$) examines differences in homeowners living in HOA governed communities and those that do not. The following paragraphs summarize predictor variables that measure landscape management practices, socio-demographics, and attitudes and beliefs were compared between the groups.

Landscape management practices includes such things as annual fertilizer frequency, weekly irrigation frequency, the amount of time spent working in the yard, whether fertilizer is applied on a regular schedule or only as needed, whether they have an automatic in-ground irrigation system as primary means to water the lawn, and whether they set their irrigation system on automatic all the time or change it occasionally.

Socio-demographic and structural information will also be considered such as homeowner age, race, gender, house tenure years living in house, property value, house size, and whether they in a Homeowners Association governed community.

Homeowners attitudes and beliefs about the landscape and normative influences on their practices such as whether the look of the neighbor's yard influences their yard maintenance practices, if they believe a lawn should consist of a single type of grass, that a home's landscape is important to the community, that landscape practices can have a negative effect on water quality, that it is important to have the nicest lawn on the block and that it is important what the neighbors think about their yard and if it doesn't bother them if their grass turns a bit brown during the winter months.

I build on the original hypothesis to better understand the difference between home owners and the influences on their landscape management practices. The original hypothesis is below with additional alternative s hypotheses added to clarify the audience segmentation groups.

H1) – Landscape managers significantly differ in the average amount of fertilizer applied to their home's lawn annually.

H1a) Homeowners who fertilize the lawn themselves spend more time working in the yard and be more likely to apply fertilizer and irrigation as needed compared to those who hire professional to apply fertilizer. Homeowners who apply fertilizer themselves will have lower socio-economic status, be older and have lived in their homes for longer. They will be less concerned with community norms and expectations.

H1b) Homeowners who don't apply fertilizer to the yard spend less time maintaining the yard, they will live in older and less expensive homes, are less likely to live in a HOA governed community, and are more aware of environmental consequences and believe less about community importance and yard status compared to people who fertilize

H1c) Homeowners in HOA communities live in newer, more expensive homes, they are more likely to hire a professional landscape manager to fertilize the lawn, and they believe more strongly about community importance and yard status and that a lawn should be weed-free and green all year compared to those who don't live in HOAs.

The following section focuses on H1a and summarizes the results of the analyses that examine differences in homeowners who apply fertilizer to the lawn themselves (HLMs) and those who hire professionals for this purpose (PLMs).

<u>Homeowner and Professional Landscape Managers (HLMs and PLMs)</u>

Thirty-six percent of homeowners in the Wekiva Study Area relied on professional landscape managers (PLMs) to apply lawn fertilizer. This section reports the results of independent samples tests for significant differences between the two groups (PLMs and HLMs) with respect to their fertilizer frequency, their socio-demographics, and their attitudes. The previous section demonstrated that PLMs apply fertilizer more frequently than HLMs. Other interesting differences between these two groups of homeowners were also discovered that are summarized and tabulated in this section.

Significance tests were conducted to compare each of the two category groups with the twenty-one predictor variables using various statistics. An independent samples t-test was used to investigate if significant differences between groups measured on a continuous or ordinal scale. In addition to fertilizer frequency, Table 9 shows that homeowners who hire professionals live in significantly larger, newer and concomitantly, more expensive houses. They spend significantly less time working in the yard and they are significantly more likely to believe the landscape is important to the community and that the lawn should consist of a single type of grass, two of the normative beliefs that could be associated with perceptions of community expectations. Contrary to my hypotheses, respondent age was not significantly related to the likelihood of hiring a professional landscape manager in the Wekiva Study Area.

Table 9: Mean Differences in Homeowner and Professional Landscape Managers

Predictor Variable	HLM	PLM	t value
Fertilizer Frequency (Annual)	2.84	4.76	-8.85****
Irrigation Frequency	1.96	2.05	-1.34
House size (ft^2)	2027.17	2439.94	-6.10****
House age	30.11	24.77	5.25****
Years in house	13.68	11.69	2.21*
Property value ($1000)	129.93	172.54	-6.00****
Days working in yard	7.24	4.96	3.77****
Respondents age	52.37	54.81	-1.88
A home's landscape is important to the community	3.43	3.55	-2.31*
A lawn should consist of a single type of grass	2.67	2.87	-2.68**
Landscape practices can have a negative effect on water quality	3.23	3.22	.09
It doesn't bother me if my grass turns a bit brown during the winter months	2.84	2.74	1.33
It is important for me to have the nicest lawn on the block	2.06	2.18	-1.71
It is important to me what the neighbors think about my yard	2.46	2.59	-1.69

HLM = Homeowner applied fertilizer themselves PLM = Homeowner hires professional to apply fertilizer

Attitudinal variables measured on Likert scale from 1-4

Independent samples t-test reported * = $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$ (n=740)

Predictor variables that were nominal measurements were examined using a Pearson Chi-square test for independence. For all tests except race, the more precise Fisher's Exact Test was reported. This analysis revealed significant differences between HLM and PLM (Table 10).

Table 10: Differences in Homeowner and Professional Landscape Managers

Predictor Variable (Yes)	HLM	PLM	Chi-Square
Fertilizer applied on regular schedule	32%	84%	143.595****
Have automatic irrigation system	74%	95%	38.187****
Irrigation system on automatic all the time	55%	70%	8.793**
Watering schedule vary throughout the year	53%	51%	.059
Would vacation or trip out of town influence your irrigation schedule	38%	25%	9.886**
Has drought caused you to change yard maintenance	41%	35%	1.988
Does look of neighbor's yard influence your yard maintenance	32%	25%	3.765[a]
Race (White)	82%	86%	2.133
Gender (Female)	57%	66%	4.939*

Chi-square Test of Independence. * $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$. (n=740)
a = approaching significance ($p = .059$)

The fertilizer frequency of PLMs and HLMs was related to the attitudinal measures to understand the relationships between them. Since the Likert scale is an ordinal ranking measure, the more conservative Spearman rho was used to relate HLM and PLM fertilizer frequency with the six attitudinal measures reported in Table 11.

Table 11: Spearman Correlations Relating Homeowner and Professional Landscape Manager Fertilizer Frequency and Attitudinal Measures

Attitude Measure	PLM Fertilizer Frequency	HLM Fertilizer Frequency
A home's landscape is important to the community	-.022	.121*
A lawn should consist of a single type of grass	.061	.200***
Landscape practices can negatively affect water quality	-.218**	-.075
It doesn't bother me if my grass turns a bit brown in winter	-.207**	-.122*
It is important for me to have the nicest lawn on the block	.100	.162**
It is important what the neighbors think about my yard	.097	.196***

Number of times professional (PLM) or homeowner (HLM) landscape manager applied fertilizer to the lawn in last 12 months
Spearman rho reported * = $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

Table 11 shows that the number of times that fertilizer was applied to the lawn was significantly related to different attitudes. PLM fertilizer frequency was significantly related with only two attitudinal measures, the awareness of consequences measure that landscape practices can have negative effects on water quality and the belief that the lawn turning brown in winter is o.k. HLM fertilizer frequency was significantly related to five of the six attitudinal measures. Interestingly, the attitudinal measure of environmental impact, “Homeowner landscape practices can have a negative effect on water quality” was the only variable that didn’t predict HLM fertilizer frequency but was a strong, negative predictor of PLM fertilizer frequency. The only significant negative predictor of both HLM and PLM fertilizer frequency was their attitude regarding grass turning brown in the winter. This attitude was a stronger negative predictor of fertilizer frequency among PLMs than among HLMs. The more strongly they agreed that it was o.k. for grass to turn brown in the winter, the less frequently they fertilized.

I proposed several alternative hypotheses to the null hypotheses that there was no difference between homeowners who hire professional landscape managers and those that do their own landscape management.

The first is that homeowners who fertilize the lawn themselves will spend more time working in the yard and be more likely to apply fertilizer and irrigation as needed compared to those who hire professional to apply fertilizer. Results from this research support these alternative hypotheses. Homeowners who applied fertilizer to the lawn themselves worked significantly more days in the yard than those who hired professionals. They applied significantly less fertilizer to the lawn annually and they were significantly more likely to add fertilizer as needed rather than on a regular schedule. Homeowners who fertilized the lawn themselves were significantly less likely to have an automatic irrigation system, but those who did were more likely to turn it on as needed rather than leave it on automatic all the time. This suggests that homeowners who fertilize the lawn themselves are more actively managing their homes landscape and may be more knowledgeable about maintenance in general. Homeowner landscape managers may enjoy gardening more or be more in touch with the nature in their yard.

The second alternative hypothesis was that homeowners who apply fertilizer themselves will have lower socio-economic status, be older, and have lived in their homes for longer. The findings confirm that homeowners who apply fertilizer themselves live in significantly older and smaller homes with significantly lower property values, both indicators of lower socio-economic status. They also lived significantly longer in their current home than homeowners who hired professionals to fertilize the lawn. This finding is consistent with the finding of Law *et al* (2004), who found that housing tenure was negatively related to fertilizer frequency, just as it was in the LWC project ($r = -.184$, n = 644, $p < .0001$). Respondent age was not significantly different between the two groups.

The third alternative hypothesis was that homeowners who applied fertilizer themselves will be less concerned with community norms and expectations. This was partially supported by results that showed that homeowners who applied fertilizer themselves were significantly less likely to agree that the home's lawn was important to the community. However they were significantly more likely to say that the look of their neighbor's yard influenced their yard maintenance, another indication of community influences. It may be that the yard maintenance that is influenced by the neighbor is not necessarily fertilizer application. I suspect that lawn mowing is more influenced by the neighbors mowing practices. Furthermore, homeowners who hire professionals are less likely to rely on their neighbors to inform or influence their landscape maintenance; they rely on a professional instead. There may be a subtle difference in the community level scale of influence on homeowners who apply fertilizer themselves relative to those who hire professionals. I suspect that homeowners who do their own management may be more influenced by their adjacent properties and those who hire professionals by the expectations of the community at large.

Contrary to what I expected, the fertilizer frequency of homeowners who hired professionals was not significantly related to their community normative beliefs however the fertilizer frequency of homeowners who applied fertilizer themselves was significantly correlated to community beliefs. For example, the annual fertilizer frequency of homeowners who applied fertilizer themselves was significantly positively related to their beliefs about the home's landscape being important to the community and them having the nicest lawn on the block. It is an indication that homeowner fertilizer frequency is more influenced by personal norms and block level influences than the frequency of fertilizer application by professionals.

Understanding the use of fertilizer relative to non-use can be explored by comparing homeowners who don't apply fertilizer at all with those who do. The next section seeks to better understand those who don't fertilize through the same predictor variables used to compare homeowners who apply fertilizer themselves with those who hire professionals.

Homeowners Who Don't Fertilize the Lawn

Sixteen percent of homeowners in the Wekiva Study Area and nearly thirty percent (29%) statewide do not apply fertilizer to their lawn. How do these non-fertilizers differ from homeowners who apply fertilizers in terms of their attitudes, beliefs, and socio-economics? I posed the following alternative hypotheses about this group:

H1b) Homeowners who don't apply fertilizer to the yard spend less time maintaining the yard, they live in older and less expensive homes, are less likely to live in a HOA governed community, and are more aware of environmental consequences and believe less about community importance and yard status compared to people who fertilize.

The next section tabulates the results of tests that compare homeowners in the Wekiva Study Area who fertilized their lawn with those who did not using all of the same predictor variables presented in the previous section with the exception of the measures associated with fertilizer application, which is not applicable to the group of homeowners who do not fertilize. The same statistics were used to compare the two homeowner groups (Fertilizers and Non-fertilizers) as the ones used in the previous section. An independent sample t-test with a 95% confidence interval was used to examine differences between homeowners among variables measured on a continuous scale. Results are summarized in Table 12.

Chi-square tests were used to compare differences among variables measured on a nominal scale are summarized in Table 13. For all tests except Race, the Fisher's Exact Test is reported.

Table 12: Mean Differences in Homeowners Who Don't Fertilize and Those Who Do

Predictor Variable	Don't fertilize	Fertilize	t value
Irrigation Frequency	1.73	2.01	-2.27*
House size (1000 ft^2)	1.89	2.19	-3.62****
House age	35.92	27.84	5.02****
Number of years in house	15.98	12.95	2.54*
Property value ($1000)	102.61	145.34	-5.25****
Number of days spent working in the yard (April)	6.06	6.16	-0.13
Pervious lot cover (1000 ft^2)	20.67	11.71	2.28*
Respondents age	51.30	53.79	-1.55
A home's landscape is important to the community	3.15	3.47	-5.20****
A lawn should consist of a single type of grass	2.54	2.75	-2.29*
Homeowner landscape practices can have a negative effect on water quality	3.11	3.22	-1.44
It doesn't bother me if my grass turns a bit brown during the winter months	3.07	2.80	3.14**
It is important for me to have the nicest lawn on the block	1.78	2.11	-3.93****
It is important to me what the neighbors think about my yard	2.17	2.52	-3.92****

* = $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$
Attitudinal variables are Likert scale from 1-4
Independent Samples t-test report. n = 740

Table 13: Differences between Homeowners Who Don't Fertilize and Those Who Do

Predictor Variable (Yes)	Don't fertilize	Fertilize	Chi-Square
Have in-ground automatic irrigation system	41%	83%	67.47****
Irrigation system on automatic all the time	58%	62%	0.16
Watering schedule vary throughout the year	59%	51%	1.49
Trip out of town would influence irrigation schedule	23%	32%	3.57
Has drought caused you to change yard maintenance	29%	39%	3.57
Look of neighbor's yard influences yard maintenance	19%	29%	4.76*
Race (White)	80%	83%	2.34
Gender (Female)	59%	60%	0.03
Live in HOA governed community	35%	75%	37.41****

Chi-square test reported. * = $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

Table 12 shows that homeowners who do not fertilize differ from those who do in their irrigation frequency, their house size, and the length of time spent in the house as well as the six attitudinal variables. The first alternative hypothesis offered regarding these two groups was that homeowners who didn't apply fertilizer to the yard would spend less time maintaining the yard compared to those who applied fertilizer.

Homeowners who don't apply fertilizer to the yard will live in older and less expensive homes and be less likely to live in a HOA governed community. Evidence that supports this alternative hypothesis demonstrates that homeowners who don't fertilize the lawn live in significantly older, smaller, and less expensive homes and that they have lived in their homes significantly longer than homeowners who apply fertilizer. Homeowners who don't fertilizer were significantly less likely to live in a HOA governed community. These variables are collinear and it would worthy of further exploration to see which is more predictive of fertilizer use, HOA presence or house age. There was a vast difference in the number of lawn fertilizers who lived in HOA governed communities compared to non-fertilizers. Nearly ¾ of the fertilized lawns in the Wekiva Survey Area are within HOA governed communities. This finding and others suggest that further investigation of HOA governed homeowners is warranted.

The final series of alternative hypotheses suggested that homeowners who fertilizer will have different awareness, attitudes, and beliefs form those who do. I suggested that those who don't fertilize would be more aware of environmental consequences and believe less about community importance and yard status compared to people who fertilize. Results partially support these alternative hypotheses. Contrary to what I suggested, there was no significant difference in awareness of consequences between homeowners who fertilized the lawn and those that didn't. However, these two groups differed significantly on their agreement with other belief statements. Homeowners who fertilize the lawn were significantly more like to believe that the home's landscape was important to the community, the lawn should be a single type of grass, it is important to have the nicest lawn on the block, and it is important what the neighbors think about their yard. Clearly these are indications of community norms that influencing fertilizer use. Those who do not fertilizer were significantly less likely to be bothered by the grass turning a bit brown in the winter.

Homeowners Who Live in HOAs

About two-thirds of Wekiva Study Area residents lived in communities managed by a Homeowner's Association (HOA). This section compares homeowners who live in HOAs with those who don't on the same predictors with the exception of the HOA predictor variable, which in this case is the criterion variable. The following alternative hypotheses were outlined.

> H1c) Homeowners in HOA communities live in newer, more expensive homes, they are more likely to hire a professional landscape manager to fertilize the lawn, and they believe more strongly about community importance and yard status and that a lawn should be weed-free and green all year compared to those who don't live in HOAs.

Similar statistics were used to compare the two homeowner groups (No-HOA and HOA) as the ones used in the previous section. An independent sample t-test with a 95% confidence interval was used to examine differences between homeowners among variables measured on a continuous scale and chi-square tests were used to compare differences among variables measured on a nominal scale. Where Levene's test indicated unequal variances, adjusted degrees of freedom were reported. T-test results are summarized in Table 14. Similarly, chi-square analyses presented in Table 15 show significant differences in landscape management practices of homeowners in HOA governed communities and those who are not.

Table 14: Mean Differences in Non-HOA and HOA Residents

Predictor Variable	Non-HOA	HOA	t-value
Fertilizer Frequency	1.83	3.40	-7.66****
Irrigation Frequency	1.90	1.98	-.90
House size (1000 ft^2)	1.83	2.26	-6.98****
House age	39.55	24.47	14.06****
Number of years in house	18.02	11.33	6.86****
Number of days spent working in your garden or lawn in April	7.16	5.64	2.39*
Property value ($1000)	92.10	159.42	12.13****
Respondents age	53.30	53.71	-.33
A home's landscape is important to the community	3.23	3.51	-5.81****
A lawn should consist of a single type of grass	2.60	2.76	-2.34*
Landscape practices can have a negative effect on water quality	3.07	3.27	-3.27**
It doesn't bother me if my grass turns a bit brown during the winter months	3.03	2.75	4.11****
It is important for me to have the nicest lawn on the block	1.93	2.11	-2.72**
It is important to me what the neighbors think about my yard	2.22	2.56	-4.92****

HOA = Homeowners Association Governed Community

Attitudinal variables are Likert scale (1-4)

Independent Samples t-test (n=740) * $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

Table 15: Differences in Non-HOA and HOA Residents

Predictor Variable (Yes)	Non-HOA	HOA	Chi-Square
Hire Professional (PLM)	35%	65%	37.45****
Fertilize the lawn	66%	92%	74.86****
Have in-ground automatic irrigation system	52%	88%	100.03****
Irrigation system on automatic all the time	44%	65%	12.02**
Change seasonal irrigation patterns	87%	77%	8.34**
Watering schedule vary throughout the year	57%	49%	3.06*
Trip out of town influence your irrigation schedule	30%	31%	.06
Has drought caused you to change yard maintenance	37%	38%	.13
Look of neighbor's yard influences yard maintenance	20%	31%	9.66**
Race (White)	79%	85%	10.28*
Gender (Female)	57%	62%	1.88
Hires professional (Yes)	17%	45%	37.41****

Chi-square test of independence (n=740). * $p < .05$, ** $p < .01$, *** $p < .001$, **** $p < .0001$

As hypothesized, homeowners who to live in a HOA governed communities have higher socio-economic status as indicated by them living in significantly newer, larger, and more expensive homes. This relates to the significant finding that they are more likely to hire a professional landscape manager to apply fertilizer to the lawn. Regarding landscape management, since HOA residents hire professionals they like the PLM group, they share the same characteristics about landscape management. HOA residents spend significantly less time working in the yard, they are significantly more likely to apply fertilizer, and they apply fertilizer at a significantly higher annual frequency than residents who don't live in HOAs. They are more likely to have an in-ground irrigation system and to keep it on automatic all the time. Non-HOA residents who had irrigation systems were significantly more likely to vary their irrigation schedule throughout the year and significantly more likely to modify the watering schedule seasonally. This may be related to the HOA requirements to keep the irrigation system on at all times, which was described by homeowners interviewed during the Landscape Exchange project.

There were many significant differences between HOA residents and non-HOA residents in terms of their attitudes and beliefs. HOA residents were significantly more likely to agree that a home's landscape is important to the community, that the lawn should be a single type of grass, that it is important to have the nicest lawn on the block and that it is important what the neighbors think about their yard. In contrast, HOA residents were significantly less likely to be bothered by the grass turning a bit brown in the winter.

From the Landscape Exchange project, it was evident that many homeowners deferred the responsibility of meeting HOA landscape expectations to a professional, thereby assuring compliance. This may be what is revealed in the Wekiva data as well. It may be that homeowners living in HOA communities were more likely to hire a professional, more likely to keep their irrigation system on automatic and never change it, and likely to fertilize more frequency because they don't want to risk HOA repercussions for landscape related infractions.

The only landscape maintenance practices that people who live in HOA communities had in common with those who did not was irrigation frequency and their willing to change the maintenance scheduled when on vacation or during a drought. They were also the same age and gender. The two groups significantly differed in all other predictor variables, suggesting that people who don't live in HOA communities are very different from those who do. This is even evident in HOA racial composition. Interestingly, the only significant racial difference among all of the group comparisons was the significant difference in the number of non-whites living in HOAs relative to the number living outside of HOAs. An interesting visual schematic of the racial and socio-demographic composition of the Wekiva Study Area can be found in the additional maps in Appendix B.

Water Quality

The results of the monitoring well sampling are presented. The wells that exhibited the lowest nutrient concentrations after the first sampling event were not sampled subsequently. Unfortunately, the first sampling event occurred in October, a month when lawn fertilizing activities are typically not high in this part of the state. In addition to the twenty-four residential monitoring wells, two artesian wells were also sampled (OR-0548 and OR-0893) as well as the Wekiva Spring itself. Groundwater quality results from the four sampling events the summarize nitrogen compounds, N^{15} and O^{18} concentrations are presented in the following tables.

Table 16: Groundwater Sampling Event #1

Sample	Date Collected	DTW (ft)	NOX-N (mg/L)	NH3-N (mg/L)	TKN-N (mg/L)	Total N (mg/L)
BW-01	10/10/08	2.01	.19	.150	.700	.89
BW-02	10/10/08	.98	.62	.600	1.100	1.72
MW-01	10/9/08	3.44	.02	1.200	1.500	1.52
MW-02	10/9/08	17.61	5.50	.020	.048	5.55
MW-03	10/21/08	33.70	.01	.025	.500	.51
MW-04	10/21/08	38.37	12.00	.025	.500	12.50
MW-05	10/9/08	5.82	3.80	0.100	2.000	5.80
MW-06	10/9/08	12.24	.36	0.020	.048	.41
MW-07	10/9/08	10.60	1.70	0.067	.048	1.75
MW-08	10/10/08	2.50	.04	0.410	1.300	1.34
MW-09	10/9/08	7.12	.47	0.050	.048	.52
MW-10	10/20/08	23.58	3.10	.025	.048	3.15
MW-11	10/10/08	21.02	4.60	.074	.048	4.65
MW-12*	10/9/08	4.15	.00	.320	.680	.68
MW-13	10/9/08	5.73	.38	.140	1.700	2.08
MW-14	10/9/08	6.11	4.20	.025	.048	4.25
MW-15	10/10/08	23.05	4.10	2.200	1.000	5.10
MW-16	10/10/08	7.92	4.10	.025	.048	4.15
MW-17	10/20/08	6.98	3.50	.160	.048	3.55
MW-18*	10/10/08	6.84	.24	.025	.048	.29
MW-19*	10/10/08	7.55	.09	.230	1.300	1.39
MW-20	10/10/08	10.25	2.80	.130	.048	2.85
MW-21	10/10/08	8.09	.18	.380	1.600	1.78
MW-22	10/10/08	18.18	.19	.051	.048	.24
MW-23	10/20/08	3.91	1.90	.310	.760	2.66
MW-24	10/20/08	7.88	.26	.098	.048	.31
OR-0548*	10/21/08		.01	.052	.500	.51
OR-0893*	10/21/08	15.08	.03	1.800	2.000	2.03
Wekiwa	10/10/08		1.40	.020	.048	1.45

*Only sampled once

Table 17: Groundwater Sampling Event #2

Sample	Date Collected	DTW (ft)	NOX-N (mg/L)	NH3-N (mg/L)	TKN-N (mg/L)	Total N (mg/L)	$\delta^{15}N$	$\delta^{18}O$
BW-01	3/24/09	8.32	.04	<.025	.095	.14		
BW-02	3/24/09	3.07	.02	.690	1.200	1.22		
MW-01	3/22/09	4.71	.01	2.000	1.900	1.91		
MW-02	3/23/09	22.95	2.00	<.025	.095	2.10	12.95	
MW-03	3/23/09	35.32	.06	<.025	.095	.15		
MW-04	3/23/09	39.94	14.00	<.025	.095	14.10	3.18	
MW-04D	3/23/09		14.00	<.025	.095	14.10	2.95	
MW-05	3/23/09	8.66	1.40	<.025	1.100	2.50	8.49	
MW-06	3/22/09	15.44	1.60	<.025	.095	1.70		
MW-07	3/22/09	14.05	4.70	<.025	.095	4.80		
MW-08	3/24/09	3.54	.10	.420	1.400	1.50		
MW-09	3/22/09	10.09	.10	<.025	.095	.19		
MW-10	3/23/09	27.02	5.80	<.025	.095	5.90		
MW-10D	3/23/09		5.90	<.025	.095	6.00		
MW-11	3/23/09	26.37	4.60	<.025	.095	4.70	5.66	
MW-13	3/24/09	8.35	.33	.085	.910	1.24		
MW-14	3/24/09	8.07	2.20	<.025	.095	2.30	2.60	
MW-15	3/23/09	26.33	3.40	2.600	1.400	4.80	13.25	
MW-16	3/24/09	11.34	.14	.500	.990	1.13	29.35	
MW-17	3/23/09	8.78	1.50	.062	.095	1.60	10.27	
MW-20	3/22/09	13.09	3.60	<.025	.095	3.70		
MW-21	3/22/09	11.93	1.70	<.025	1.200	2.90		
MW-22	3/24/09	20.53	6.40	<.025	.095	6.50		
Wekiwa	3/23/09		.97	<.025	.095	1.07	14.64	

Table 18: Groundwater Sampling Event #3

Sample	Date Collected	DTW (ft)	NOX-N (mg/L)	NH3-N (mg/L)	TKN-N (mg/L)	Total N (mg/L)	$\delta^{15}N$	$\delta^{18}O$
BW-01	6/4/09	4.35	.87	.085	.580	1.45		
BW-02	6/4/09	.21	.01	.590	1.100	1.11		
MW-01	6/2/09	2.58	.01	1.700	1.900	1.91		
MW-02	6/2/09	19.29	4.10	.025	.095	4.20		
MW-03	6/4/09	35.35	.01	.025	.095	.11		
MW-04	6/3/09	36.11	2.70	.010	.095	2.80	3.13	3.29
MW-05	6/4/09	6.07	.54	.025	.780	1.32		
MW-06	6/2/09	12.22	.52	.025	.095	.62		
MW-07	6/3/09	9.87	5.70	.010	.520	6.22	2.08	4.35
MW-08	6/4/09	1.83	.05	1.100	1.900	1.95		
MW-09	6/2/09	7.40	.20	.058	.095	.30		
MW-10	6/3/09	25.04	2.30	.010	.095	2.40	2.75	2.40
MW-11	6/3/09	22.98	3.30	.010	.095	3.40	3.97	3.15
MW-13	6/4/09	5.07	5.90	.025	2.300	8.20		
MW-14	6/4/09	5.92	1.60	.025	.095	1.70		
MW-15	6/3/09	22.50	4.40	2.000	.760	5.16	11.97	6.25
MW-16	6/4/09	8.28	.28	.280	.940	1.22		
MW-17	6/2/09	5.45	3.00	.850	.095	3.10		
MW-20	6/3/09	9.35	2.20	.010	.095	2.30		
MW-21	6/2/09	7.70	1.20	.062	1.400	2.60		
MW-22	6/3/09	17.39	3.40	.010	.095	3.50	3.29	3.71
MW-22D	6/3/09		2.50	.010	.095	2.60	3.23	3.65
Wekiwa	6/3/09		1.30	.010	.095	1.40	11.03	9.56

Table 19: Groundwater Sampling Event #4

Sample	Date Collected	DTW (ft)	NOX-N (mg/L)	NH3-N (mg/L)	TKN-N (mg/L)	Total N (mg/L)	$\delta^{15}N$	$\delta^{18}O$
BW-01	7/30/09	2.51	.87	.025	.720	1.59		
BW-02	7/29/09	1.37	.01	.400	1.100	1.11		
MW-01	7/28/09	3.77	.01	2.800	2.900	2.91		
MW-02	7/28/09	18.08	4.40	.025	.095	4.50		
MW-03	7/29/09	34.14	.03	.025	.095	.12		
MW-04	7/29/09	38.72	12.00	.025	.095	12.10	3.92	2.82
MW-05	7/30/09	6.70	2.00	.045	3.400	5.40		
MW-06	7/29/09	12.96	.59	.025	.095	.69		
MW-07	7/29/09	11.19	1.50	.025	.095	1.60	2.73	2.02
MW-08	7/30/09	2.31	.01	.400	1.700	1.71		
MW-09	7/29/09	8.51	.64	.025	.095	.74		
MW-10	7/29/09	24.40	3.60	.025	.095	3.70	5.27	3.08
MW-11	7/29/09	23.57	4.60	.025	.095	4.70		
MW-13	7/29/09	6.29	1.10	.025	1.400	2.50		
MW-14	7/30/09	6.00	3.40	.025	.210	3.61		
MW-15	7/29/09	23.60	3.70	1.800	.620	4.32	9.35	7.33
MW-16	7/30/09	8.85	3.20	.025	1.100	4.30		
MW-17	7/28/09	7.40	2.20	.072	.095	2.30		
MW-20	7/29/09	9.57	2.20	.025	.095	2.30		
MW-21	7/30/09	9.49	.01	.068	1.200	1.21		
MW-22	7/29/09	17.27	3.70	.025	.095	3.80	5.78	5.05
Wekiwa	7/29/09		1.10	.025	.095	1.20	11.03	9.56

Two background wells and the Wekiwa Springhead were sampled to represent background conditions indicative of natural conditions. The results of the sampling of these background conditions demonstrated low Total N concentrations relative to the residential monitoring wells. The mean concentration of Total N in background wells was 1.15 mg/L and in Wekiwa Springs was 1.277 mg/l. The mean concentration of Total N in residential monitoring wells was 3.17 mg/l, and varied greatly. The lowest average residential well Total N concentration was in MW-3 (0.223 mg/l) and the highest was in MW -4 (10.37 mg/l). Figure 15 presents the fluctuations of Total N in the background wells and Wekiwa Springs over nine months during which four samples were taken. The patterns suggests that Total N dropped from October to March in all three samples, and then increased drastically in BW-1, increased somewhat in Wekiwa Springs, and remained about the same in BW-2. The patterns in the residential wells are dramatically different as shown in Figure 16 on the following page.

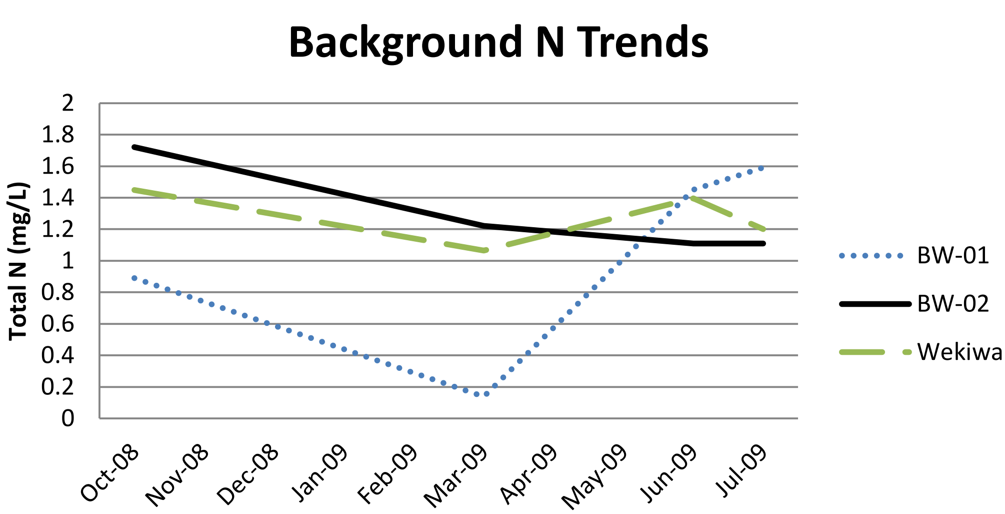


Figure 15: Total N Trends in Background Wells (BW) and Wekiwa Springs (n=4)

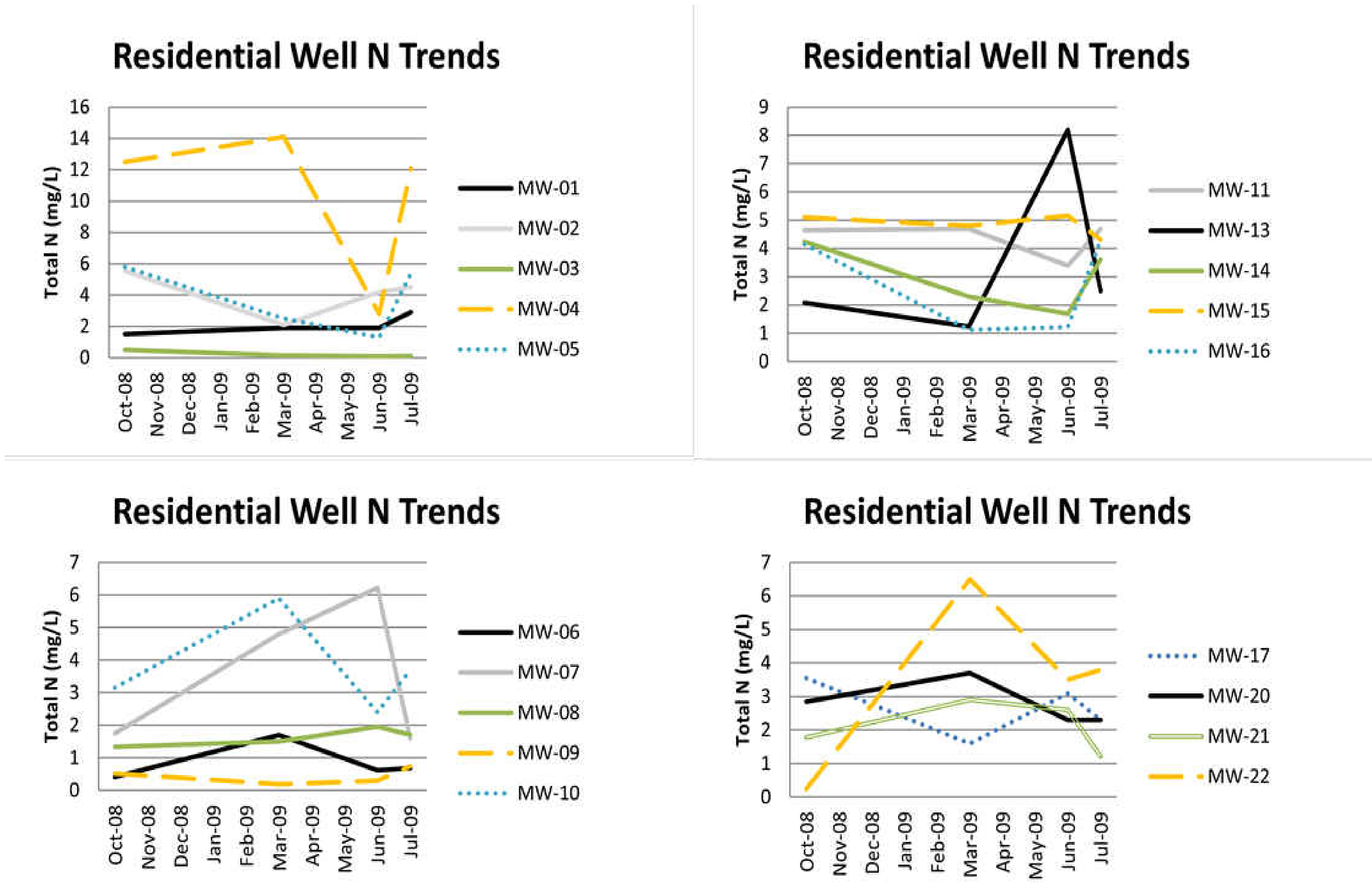


Figure 16: Total N Concentrations in Residential Monitoring Wells

Residential wells exhibited much more variance in Total N concentrations over the nine months during which the four samples were collected. With only four samples, it is not possible to confidently test significant differences in these samples, and they are reported here descriptively as drastic or only slight changes. Figure 16 shows four trend charts, each plotting the Total N concentrations of four or five residential monitoring wells. The wells that were only sampled one time were not plotted (MW-12, MW-19, and MW-20).

From sample October to March, when the most evident decrease in Total N concentrations occurred in the background wells, seven residential monitoring wells showed an increase in Total N concentrations, including two (MW-7 and MW-22) showing drastic increases. The remaining eleven residential monitoring wells had decreasing Total N concentrations in that time period.

From March to June, when two of the three background wells showed increasing Total N concentrations, several residential wells Total N concentrations decreased. Five of the residential wells decreased substantially (MW-4, MW-6, MW-10, MW-20, MW-22) while two (MW-5, MW-11) decreased slightly. During the same timeframe, the Total N concentrations in residential monitoring wells MW-2, MW-6, MW-7, MW-13 and MW-17 increased substantially and increased slightly in MW-8. Total N concentrations in residential wells MW-1, MW-3, MW-9, MW-14, MW-15 and MW-16 remained about the same from March to June. During this time period about the same number of well increased in Total N concentrations as those that decreased and those that stayed about the same.

There were some rapid changes in Total N concentrations from June to July with some residential wells increasing drastically in Total N concentrations (MW-1, MW-5, MW-10, MW-14, and MW-16) and other decreasing drastically during that timeframe (MW-7, and MW-13). Three additional wells increased slightly, one decreased slightly and the remaining three residential wells remained about the same. From June to July, eight wells showed increasing Total N concentrations, four residential wells, showed decreasing Total N concentrations and three stayed about the same. The background Total N concentrations didn't change much from June to July. Background well 1 (BW-1) increased slightly, BW-2 stayed about the same, and Wekiwa Springs decreased slightly.

The isotopic signatures of monitoring wells with the highest Total N concentrations were examined for further evidence about nitrogen sources. Depleted ^{15}N would be expected from atmospherically derived N sources relative to organically derived sources. There were noticeable differences in the mean $\delta^{15}N$ concentrations between monitoring wells that are evident in Table 20, although the concentration of $\delta^{15}N$ did not vary much within each well over the sampling periods. The monitoring wells exhibiting the lowest $\delta^{15}N$ values were MW4, MW-7, MW-11, MW-14 and MW-22. Two of these five wells are located within the fertilizer hot spot in Figure 19 (MW-4 and MW-11).

Table 20: Mean $\delta^{15}N$ Concentrations in Monitoring Wells

Sample Date	Mar-09	Jun-09	Jul-09	Mean $\delta^{15}N$
MW-02	12.95			12.95
MW-04	3.18	3.13	3.92	3.41
MW-04D	2.95			2.95
MW-05	8.49			8.49
MW-07		2.08	2.73	2.41
MW-10		2.75	5.27	4.01
MW-11	5.66	3.97		4.82
MW-14	2.60			2.60
MW-15	13.25	11.97	9.35	11.52
MW-16	29.35			29.35
MW-17	10.27			10.27
MW-22		3.29	5.78	4.54
MW-22D		3.23		3.23
Wekiwa	14.64	11.03	11.03	12.23

Other sources of nitrogen besides those from lawn fertilizers that would be expected in groundwater in the study area include septic tank effluent and drawdown from Lake Apopka by the Wekiva and Rock Springs springshed (Figure 13). Nutrient concentrations would be expected to be confounded by both of these sources, although the isotopic signature of both sources would expect to be enriched in N15 relative to new atmospherically derived fertilizer nitrogen compounds. There are many confounding geo-physical features to considered including the groundwater and surface water flow patterns and hydraulics that are influenced by rainfall, Karst topography, and soil porosity. The lag time between N inputs at the surface and its resulting appearance in the aquifer is difficult to estimate and there were insufficient data to truly understand how fluctuations in nitrogen occurred over time.

Clearly, human inputs of N are playing a role in the Total N concentrations in the residential and background wells, and plotting the wells spatially with the behavioral data can help clarify the connection. C. Listopad (2012) was engaged by the LWC project to assist with the spatial analysis and mapping of the socio-demographic, behavioral, and water quality data. Results of this effort are presented in the following section with additional maps included in Appendix B.

Interpolating Fertilizer Inputs to Identify Hotspots

The audience segmentation analysis found that fertilizer frequency varied between groups of homeowners. Homeowners who hired professionals had the highest average annual fertilizer application frequency (4.76), followed by the average of all homeowners who fertilized (3.51), homeowners who lived in HOAs (3.4), homeowners who applied fertilizer to the lawn themselves (2.84) and homeowners who didn't live in HOAs (1.83). To relate fertilizer inputs spatially, the measure of fertilizer frequency was used as a surrogate for fertilizer inputs calculated in pounds, because the inputs calculated in pounds would only include the information reported by homeowners who applies fertilizer to the lawn themselves and effectively eliminate the homes where professionals applied fertilizer to the lawn. Therefore, using the calculated pounds of fertilizer as the criterion variable would bias and greatly reduce the number of data. Fertilizer inputs calculated in pounds was also strongly correlated with fertilizer frequency ($r = .525$, n=219, $p < .01$), supporting the use of fertilizer frequency as a surrogate measure.

Data from several sources were used in the geospatial analysis. These included fertilizer frequency data from the Wekiva Residential Fertilizer Survey, socio-economic data retrieved from property appraiser and census datasets, groundwater data from MACTEC (2009), and surface water quality data retrieved from the Orange and Seminole County Water Atlas. Variables such as income, race, fertilizer frequency, subdivision boundaries, housing age, mean assessed property value, surface water quality, groundwater quality, and land use were mapped. Housing age was a significant predictor of fertilizer frequency and a significant difference between groups of homeowners in our audience segmentation analysis. In the following section, housing age groups are related to fertilizer hot spots to better understand the land use patterns related to N inputs.

Fertilizer Frequency and Housing Age

Housing built year for each sample unit was downloaded from property appraiser (PA) data from Seminole and Orange Counties. A Spearman correlation revealed a moderate negative relationship between housing age and fertilizer frequency ($r = -.287$, $p < .0001$). To better understand differences between house age groups that may be related to development patterns, a new variable of eight house age groups that differed significantly in their fertilizer frequency was created. Table 21 demonstrates a linear negative relationship between housing age and fertilizer frequency and then an unusual increase in fertilizer frequency among houses 20-34 years old.

Table 21: Mean Differences in Fertilizer Frequency among House Age Groups.

House Age (yrs)	Average Fertilizer Frequency	N
5 – 9	4.72	32
10-14	4.10	59
15 – 19	3.28	46
20 – 24	2.80	81
25 – 29	2.88	104
30 – 34	3.04	127
35 – 49	2.32****	103
> 50	1.51****	76

One-way ANOVA reported, F = 8.731, $p < .001$, n = 626
Significant differences reported from youngest age group **** = $p < .0001$

To better understand how residential development patterns and fertilizer frequency hotspots relate across the landscape, a GiZ score was generated and mapped to show where fertilizer frequency is significantly high and significantly low relative to year house built. The goal was to visualize development patterns that may explain the increase fertilizer frequency noted in the dataset among homeowners living in houses built between 30 and 34 years ago. Reviewing the land use data revealed the presence of several golf courses in the area which were plotted in bright green on the map.

In Figure 17, it is evident that the large fertilizer frequency hotspot in the center top portion of the map exists in an area of homes built between the years of 1974-1989 that are adjacent to two large golf courses. This suggests that the golf course may be an influential predictor of fertilizer frequency that is moderating the effect of house age. Further geospatial analysis revealed that the closer a house gets to a golf course, the higher the fertilizer frequency rate. This may be explained by the likelihood that golf course communities are HOA governed communities where homeowners are more likely to hire professional landscape managers. Both of these variables positively related to fertilizer frequency. It may also be indicative of an additional descriptive normative influence presented by the green of the golf course. The visual reinforcement of green turf on the course may influence homeowners to seek a similarly green lawn. Mapping the fertilizer frequency hotspots relative to the year built and golf course allowed the visualization of landscape patterns not revealed in other analyses.

From the map, it is also evident that a third golf course near the NW corner of the map has some homeowners in proximity who are applying significantly more fertilizer and some that are applying an average amount of fertilizer. It would be interesting to visit this community to better understand the difference between those people loving on the east side of the golf course who fertilizer more than those living on the west side of the golf course. It may be the case that the gated subdivision contains those on the east and not those on the west, or it may be the normative influence of the neighbors at the block level, sharing information about their lawn maintenance practices.

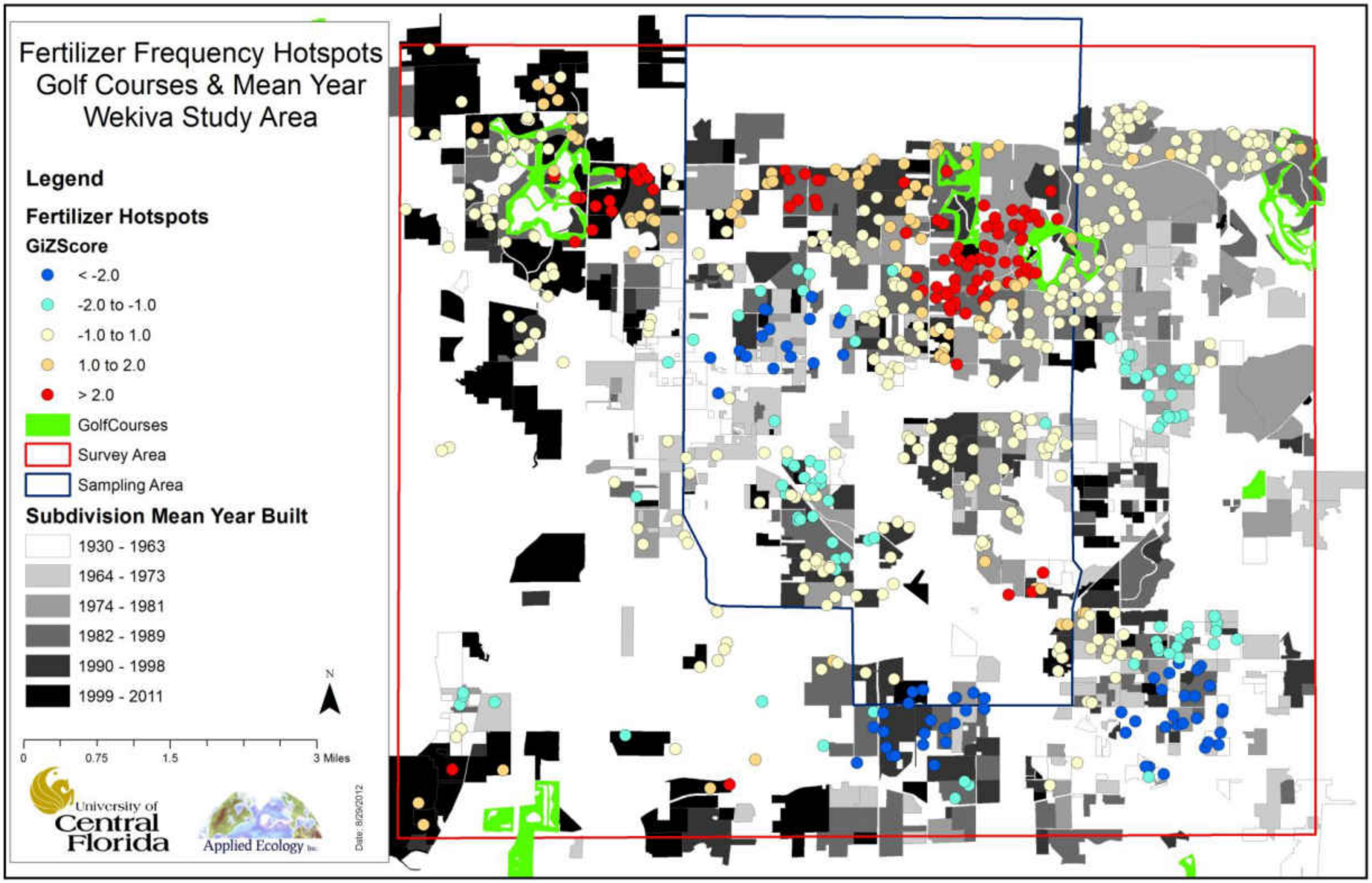


Figure 17: Fertilizer Frequency Hotspots and Subdivision Mean Year Built

Fertilizer Frequency and Property Value

To better understand the influence of house value on fertilizer frequency, a similar hotspot method was employed to map and spatially analyze the relationship between fertilizer frequencies and mean assessed property value (Figure 18). An interesting finding of this spatial analysis was that a threshold emerged in property value at about $325,000 after which fertilizer frequency decreased. This may be a manifestation of increasing property sizes, since lot pervious area was a weak significant negative predictor of fertilizer frequency ($r=-.082$, $n=627$, $p < .05$). It could be the case that pervious lot area relates to fertilizer frequency up to a size where fertilizing is not feasible which could explain why fertilizer frequency decreased in property values higher than $325,000. It may also be that higher income households are not as normatively influenced as middle class households. Larsen and Harlan (2006) found that of numerous socio-economic variables such as income, length of residency, degree of environmental concern, and engagement in outdoor recreational activities, the only significant predictor of resource efficient front yard designs preference was income. Lower-income homeowners preferred lawn, middle income residents preferred ecological landscaping, and higher income residents were divided between the two. This may be an indication that certain income brackets are associated with more normatively influenced landscape practices. In Wekiva, it may be that the middle class is more normatively influenced than the higher income residents.

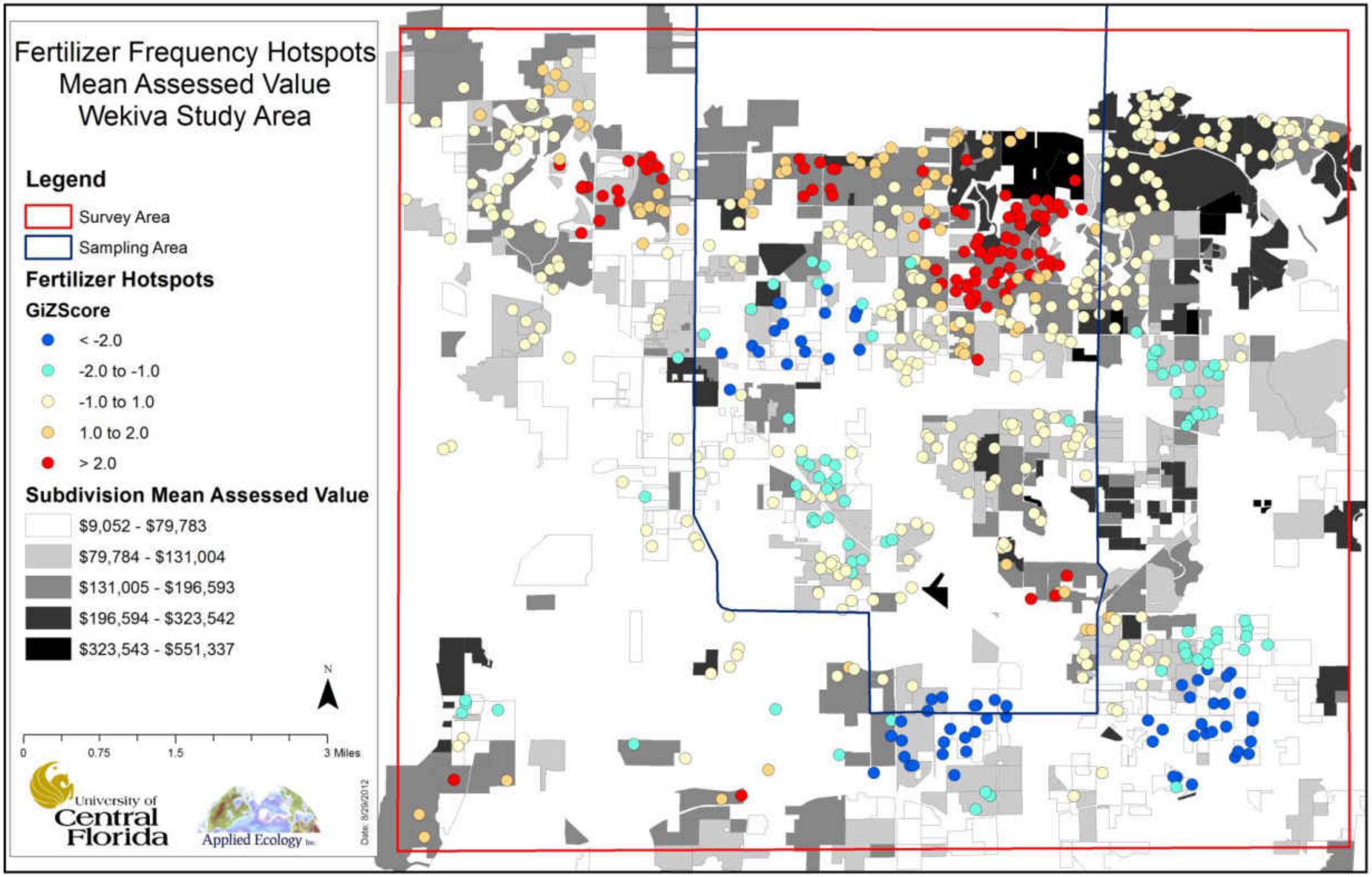


Figure 18: Hot Spot Analysis of Fertilizer Frequency and Property Value

Fertilizer Frequency and Water Quality

Hot spot analysis was also used to relate fertilizer frequency with ground and surface water quality. Surface water quality data were downloaded from the Seminole and Orange County Water Atlas websites for thirty-seven (37) surface waters within the study area that had at least 12 months of available data. Total N mean concentrations for the period of record were included in the analysis. The summarized surface water quality data in Table 22 shows little variation of nitrogen concentrations between surface water bodies, with NOX ranging from 0.0055 to 1.05 mg/l, TKN ranging from 0.25 to 2.72 mg/l and Total N concentrations in surface water ranging from 0.47 to 2.84 mg/l across the area.

Figure 19 shows the map of the fertilizer frequency hot spot analysis, with surface and groundwater mean Total N concentrations plotted. Fertilizer frequency is interpolated to link data points into areas of significantly higher inputs in red and those significantly lower in blue. Concentrations of Total N in surface water data noted as triangles and monitoring well noted as stars are color coded with lowest concentrations in green and highest in red. Two artesian wells (OR-0893, Lake Prevett, and OR-0548, Wekiwa Springs) were sampled once and are also included on the map. has one well out of four that does not exhibit elevated Total Nitrogen level (MW-18).

One obvious pattern of high ground water total N concentrations was evident in Figure 19 proximal to the bright red fertilizer frequency hotspot. Five groundwater monitoring wells (MW-23, MW-5, MW-11, MW-16, and MW-4) had high total N concentrations, including the residential monitoring well with the highest concentration of all (MW-4, mean 10.37 mg/L). However, these monitoring wells had varying depths and screen intervals, and thus samples were retrieved from different depths of the aquifer, further confounding this study. There was one well in this red hot spot area that was measured below detection limits (MW-18), but it was only sampled one time during the study. The nitrogen concentrations appear to be lower in surface water bodies to the south and east of the Wekiva Study Area.

Table 22: Surface Water Sampling Data Downloaded from Seminole and Orange County Water Atlas Websites.

STATIONID	STATIONNAME	SOURCE	NOX (in mg/l)				TKN (in mg/l)				TN (in mg/l)			
			No_Samples	Mean	Stdev	Max	No_Samples	Mean	Stdev	Max	No_Samples	Mean	Stdev	Max
73483	RSR-WR	Orange	65	0.5234	0.3601	1.1300	90	0.7649	0.5999	2.9800	45	1.3642	0.4332	2.9910
02234635	WEKIVA RIVER NR APOPKA, FLA.	Orange	3	1.0500	0.1323	1.2000	7	0.2514	0.0552	0.3000	3	1.3000	0.1732	1.5000
02234635	WEKIVA RIVER NR APOPKA, FLA.	Orange	3	1.0500	0.1323	1.2000	7	0.2514	0.0552	0.3000	3	1.3000	0.0000	1.5000
20010280	Lake Brantley at center	Seminole	4	0.0055	0.0017	0.0080	5	0.4600	0.0962	0.5700	5	0.4652	0.0000	0.5740
20010321	LK LOVELY N.W. ORLANDO / SOUTH-EAST / ST JOHNS	Orange	7	0.0934	0.1217	0.3430	8	2.7225	1.8409	6.7700	7	2.8377	1.9929	6.9310
20010321	LK LOVELY N.W. ORLANDO	Orange	7	0.0934	0.1217	0.3430	8	2.7225	1.8409	6.7700	7	2.8377	1.9929	6.9310
20010342	Rock Springs Run 50 meters upstream of Wekiva River	Seminole	8	0.9550	0.0689	1.1000	9	0.7133	1.0975	3.5000	8	1.3200	0.3643	1.9700
A25	Marshall	Orange	27	0.0108	0.0104	0.0510	26	1.5615	0.4771	2.5900	26	1.5800	0.4902	2.6000
A51	Dream	Added	22	0.0319	0.0547	0.1810	23	0.8530	0.1970	1.1500	23	0.8813	0.2216	1.3300
ASH	Lake Asher	Seminole	82	0.0425	0.0368	0.1722	609	0.6704	0.1645	1.7000	51	0.7670	0.0000	1.7560
ASH	Lake Asher	Seminole	82	0.0425	0.0368	0.1722	609	0.6704	0.1645	1.7000	51	0.7670	0.0000	1.7560
BER	Bear Lake	Seminole	85	0.0421	0.0420	0.2340	615	0.5770	0.1386	1.3000	52	0.6541	0.0000	1.3610
BER	Bear Lake	Seminole	85	0.0421	0.0420	0.2340	615	0.5770	0.1386	1.3000	52	0.6541	0.0000	1.3610
BRA	Lake Brantley	Seminole	83	0.0434	0.0491	0.3840	613	0.5002	0.1352	1.1000	81	0.5763	0.0000	1.1592
BRA	Lake Brantley	Seminole	83	0.0434	0.0491	0.3840	613	0.5002	0.1352	1.1000	81	0.5763	0.0000	1.1592
BW41	McCoy	Orange	23	0.0207	0.0449	0.2050	23	1.0391	0.6562	2.9200	23	1.0460	0.6756	2.9300
BW47	Page	Orange	12	0.0108	0.0075	0.0200	12	0.9667	0.4820	1.8700	9	0.9703	0.4059	1.8730
BW51	Pleasant	Orange	30	0.0133	0.0230	0.1140	29	0.7597	0.2799	1.5700	30	0.7641	0.2803	1.5700
BW52	Prevatt	Orange	20	0.0136	0.0255	0.1200	20	1.3890	0.4778	2.9100	19	1.4304	0.4757	2.9200
CUB	Cub Lake	Seminole	51	0.0547	0.0454	0.2240	578	0.6043	0.0953	1.4000	49	0.7093	0.0000	1.4052
CUB	Cub Lake	Seminole	51	0.0547	0.0454	0.2240	578	0.6043	0.0953	1.4000	49	0.7093	0.0000	1.4052
HAR	Lake Harriet	Seminole	46	0.0545	0.0364	0.1222	542	0.3924	0.1211	1.6000	46	0.5062	0.0000	1.7222
HAR	Lake Harriet	Seminole	46	0.0545	0.0364	0.1222	542	0.3924	0.1211	1.6000	46	0.5062	0.0000	1.7222
LBR	Little Bear Lake	Seminole	51	0.0576	0.0401	0.1340	578	0.7293	0.1590	1.6000	49	0.8186	0.0000	1.6052
LBR	Little Bear Lake	Seminole	51	0.0576	0.0401	0.1340	578	0.7293	0.1590	1.6000	49	0.8186	0.0000	1.6052
LW17	Shadow	Orange	41	0.0101	0.0080	0.0440	41	0.6339	0.2097	1.2000	39	0.6498	0.2144	1.2150
LW20	Weston	Orange	53	0.0122	0.0112	0.0570	54	0.8717	0.2675	2.2000	56	0.9165	0.3208	2.2150
LW40	Lovely	Added	29	0.0076	0.0062	0.0200	29	0.9003	0.2643	1.4700	27	0.9257	0.2669	1.4700
LW7	Gandy	Orange	53	0.0304	0.0375	0.1530	55	0.7284	0.2129	1.2100	72	0.7535	0.2240	1.2100
LW9	Hill	Orange	29	0.0125	0.0089	0.0470	32	0.7503	0.1387	1.0600	32	0.7612	0.1431	1.0700
LWB	Little Wekiva B (North O.B.T.)	Orange	55	0.0808	0.0708	0.2930	57	0.9823	0.3188	2.2100	52	1.0821	0.3162	2.2200
LWD	Little Wekiva D (Oranole Rd.)	Orange	68	0.3249	0.2301	0.9610	84	0.7640	0.3605	2.1400	79	1.1006	0.4174	2.1850
LWEK2	Little Wekiva River at S.R. 414	Seminole	60	0.3223	0.1015	0.6480	525	0.7652	0.4065	2.2000	28	1.0713	0.3900	2.8480
MIR	Mirror Lake	Seminole	53	0.0571	0.0434	0.1500	581	1.1324	0.5646	2.3000	51	0.9920	0.0000	2.4040
MIR	Mirror Lake	Seminole	53	0.0571	0.0434	0.1500	581	1.1324	0.5646	2.3000	51	0.9920	0.0000	2.4040
WET	Little Wekiva	Seminole	47	0.4602	0.7808	4.3440	574	0.8023	0.1355	1.3000	44	1.3395	0.0000	5.3440
WET	Little Wekiva	Seminole	47	0.4602	0.7808	4.3440	574	0.8023	0.1355	1.3000	44	1.3395	0.0000	5.3440

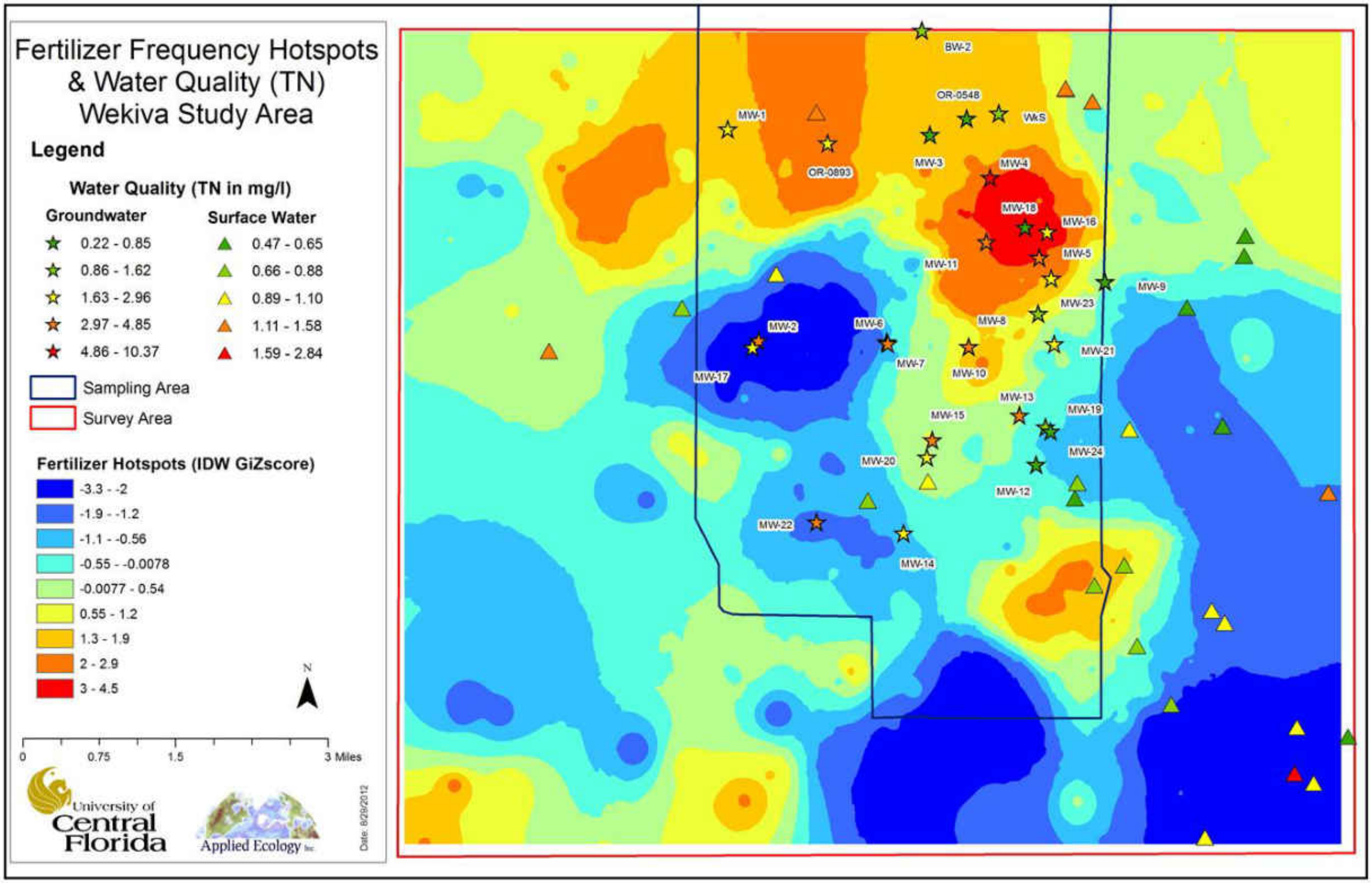


Figure 19: Fertilizer Frequency Hot Spots and Environmental Quality

Conclusion and Future Research Directions

The following general hypotheses were posed at the opening of this chapter:

H1 – Landscape managers significantly differ in the average amount of fertilizer applied to their home's lawn annually.

Significant differences in fertilizer frequency were found between landscape managers. The average annual fertilizer frequency applied by homeowner landscape managers was 2.84 times/year which was significantly less than the number of times/year fertilizer was applied by professionally landscape managers (mean = 4.76, t= -8.849, $p < .0001$). This is consistent with finding of Law *et al* (2004) who found that that the application rate reported by professional lawn care companies was higher compared to that calculated for homeowners, but the increased application frequency did not necessarily translate to higher N inputs. In the LWC project, nitrogen inputs by homeowner landscape managers were calculated from their responses to questions about fertilizer bag sizes, quantities, and nutritional content. Using a mean of the most commonly reported N percentage in the lawn fertilizer blends (16%) and the imputed pervious area, homeowner landscape managers are applying an average of 1.96 lbs N/1000 ft^2/yr (95.69 kg N/ha/yr). The most common blend reported by Wekiva respondents and the most commonly sold fertilizer blend contains 6% N. If everyone in Wekiva used this blend, the resulting average input would be reduced to 0.7339 lbs

N/1000 ft^2/yr (36 kg N/ha/yr). Because the fertilizer formulas for the professional landscape managers weren't available, it is assumed that they are applying no more than the recommended fertilizer rate of 3-5 lbs N/1000 ft^2/yr (195 – 292 kg N/ha/yr), which is twice the average annual N input of homeowners.

> H2 – Communities significantly differ in the average amount of fertilizer applied by the homeowners within the community.

The LWC research focused on homeowners association governed communities (HOAs). Significant differences were found in the mean number of times fertilizer was applied to the lawns of houses within HOAs and those not within HOAs, $t = -7.66$, $p < .0001$. This result is likely due in part because houses in HOAs are significantly more likely to be managed by a professional landscape manager, chi-sq = 37.41, $p < .0001$. Homes in HOA communities were also found to be significantly younger than homes not within HOAs, $t = 14.063$, $p < .0001$ and there is a relationship between house age and fertilizer frequency that is described in more detail below.

> H3 – Housing age is a significant predictor of fertilizer input intensity (H3A). There is a negative correlation between the two (H3B).

Spearman analysis revealed a significant negative relationship between housing age and fertilizer frequency ($r = -.287$, $p < .001$) that was predicted. Further investigation demonstrated that this linear relationship temporarily plateaued and the mean fertilizer frequency increased slightly among houses built 25-34 years ago. Spatial analysis revealed that these houses were located in a golf course community, where a fertilizer frequency hot spot was also evident. Overall, housing age predicts less fertilizer frequency except in the presence of situational influences such as a golf course.

There were many other interesting findings associated with this study that go beyond the investigation of the three hypotheses. The LWC project research results support the claim of Grove *et al* (2006) by demonstrating that behavioral and environmental data collected at the individual, household and neighborhood level can clarify relationships among human and ecological systems and contribute to the development of human ecosystem theory. The results confirmed that relationships exist between fertilizer frequency and N inputs among homeowners who apply fertilizer themselves, supporting the use of fertilizer frequency as a surrogate measure for N inputs. Results also found that land use variables such as housing age, presence of a homeowners association, and presence of a golf course were significant predictors of high fertilizer frequency. LWC research segmented audiences to better understand how homeowners differ in their practices and found that there were many differences between people who apply fertilizer to their yards and those who don't, but one of the few things that they had in common was the amount of time they spent maintaining the yard. The audience segmentation analysis also demonstrated that landscape fertilizer inputs differed between homeowners who applied fertilizers themselves and those who hired professionals, and that these groups differed in terms of their socio-demographics, attitudes, landscape maintenance practices, and residential locations. Homeowners who lived in HOAs were compared to those who do not and there are significant differences in these two groups that are important to consider when developing educational strategies. One of them is the strength of normative influences in HOA communities that significantly relate more to fertilizer among those living in HOAs than those who do not.

The LWC project was able to demonstrate a spatial analysis tool to integrate data at the household level into regional land use patterns, thereby linking spatial scales from the household to the subdivision to the region via land use and housing development. Using geospatial and cluster-based market analyses to examine differences in suburban neighborhoods, the research identified communities with more polluting potential. Social differentiation among suburban neighborhoods was evident and demonstrated that socio-demographic information can be used to predict environmental change as behaviors change over time as suggested by Grove *et al* (2006). Besides contributing to the growing body of evidence that links human and biogeochemical evidences, the project provided important social marketing information useful for developing strategies and other directives to protect the ecosystem and to evaluate program results in terms of behavior change and nutrient loads.

Future research should attempt to link landscape management and water quality data collected closer together in time and space. The more disconnected they are temporally and spatially, the more confounded the results are. A study that focuses at the block or yard level may capture a more direct correlation between behaviors and receiving waters. The LWC project findings guided the creation of questions and protocols for the statewide telephone survey and landscape maintenance prediction model created in the final research project of this dissertation.

CHAPTER FIVE: PREDICTING LANDSCAPE MAINTENANCE INTENSITY

Introduction

The Predicting Landscape Maintenance Intensity (PMI) project conducted a statewide survey of Florida homeowners with measures grounded in social psychology theory to understand the influences on homeowner landscape management preferences and practices. Working at a statewide scale, the project measured social and personal norms, individual beliefs and attitudes, and perceived controls and abilities to predict household landscape maintenance intensity and adoption of environmentally-friendly landscaping. Few studies focus at the individual scale to identify characteristics associated with high intensity landscape managers. In doing so, I strived to expand an understanding of landscape management influences to the individual level so that motivators and deterrents can clarify strategies and predict the likelihood for behavior change.

Results from the two previous studies illuminated the difference in how and why people maintain their front yard. The Landscape Exchange revealed common terms, attitudes, beliefs, and rational decision-making cost and benefits considered by homeowners adopting an environmentally-friendly landscape. From this discourse, a schematic framework of theoretical influences emerged that could be operationalized into questions for empirical data collection. Results from the Land-water Connection (LWC) project demonstrated the socio-demographics and land use variables that influenced landscaping practices. LWC results showed that homeowners could be defined along a gradient of maintenance intensity types, and that those types lived in similar communities. I assumed that the potential for pollution is greater among communities with high residential landscape management intensity.

In the current project, I integrated two tested social-psychology measures to explain the motivators and deterrents to engaging in more environmentally-friendly landscape management. The first is the Theory of Planned Behavior, TPB (Ajzen 1988) which measured the extent subjective norms (community influences), personal beliefs (attitudes) and perceived behavioral controls (abilities) influence intentions. As one of the most influential and well-supported social-psychological theories for predicting human behavior, TPB provided the framework for estimating the influential weight of individual attitudes, subjective norms, and perceived behavioral controls (PBC) within the model.

The second is the Normative Action Theory (Schwartz 1977), which added the measures of personal norms (obligations), abilities, and awareness of consequences to the model. Normative Action Theory (NAT) describes personal norms as a measure of an individual's preferences to perform a certain behavior due to their individual beliefs and values or the related feelings of guilt for not doing so. Together with the NAT measure of awareness of consequences, I investigated the internal conflict termed "lawn anxiety" by Robbins (2007), where individuals are aware that their lawn maintenance practices are harmful, but are compelled to do them anyway. The NAT measures of personal norms and awareness of consequences can illuminate the extent that external pressure from referent groups, mandates, and community norms conflict with individuals' personal preferences and ability to change.

The use of integrated socio-behavioral models has been supported by research that argues the importance of distinguishing influences more precisely. Measures such as personal norms, past behaviors, and self-identity are important predictors of pro-environmental behaviors (Bamberg and Moser 2007, Conner and Armitage 1998, Ouellette and Wood, 1998). Conner and Armitage (1998) reported that including a measure of past behavior as part of the TPB explained an additional 7% of variance in intentions and 13% of variance in behavior on average. In landscape behaviors, fertilizer and irrigation practices are repetitive behaviors that are likely predicted by past behaviors. I examined how existing maintenance behaviors related to the likelihood to adopt environmentally-friendly landscaping (EFL), as an indication of how current behaviors may include likelihood to change.

Research suggests that strong normative influences and weak behavior control play an important role in determining residential landscape behaviors. Several different types of normative influences are described. The subjective norm described in the TPB (Ajzen 1988, pp 117) refers to the individual's perception of social pressure to perform or not to perform a certain behavior as it relates to their attitude about the behavior. Cialdini (2003) refined the subjective norm further by describing injunctive and descriptive norms. Injunctive norms are similar to the subjective norms described in the TPB in that they are motivated by social rewards and punishments. Descriptive norms are unique and describe the influence of the perception that others are doing the same thing. Descriptive norms are perception based, and motivate behaviors by providing evidence that referent groups are behaving similarly. I suspect that landscape behaviors are more motivated by descriptive norms than injunctive ones and survey questions that measure descriptive normative influences asked specifically about homeowners perceptions of what their neighbors were doing.

Wall *et al* (2008) used a combined TPB & NAT model to predict car user transportation influences. In their research, they linked quantitative and qualitative research studies to improve the predictive confidence of the research findings of perceived behavioral control as an important limiting factor. Wall *et al* (2008) collected survey data and examined regression residuals to identify variance effects and then conducted interviews to better understand those effects. They used the quantitative method to guide the qualitative research. In this dissertation, I also used mixed-methods research to predict behavioral intentions based on integrated social-psychology theories. Although the research of Wall *et al* (2008) assisted me to formulate questions and conduct analyses, I applied the methods in a different order. I used the qualitative evidence collected in the Landscape Exchange ethnographic study to develop the quantitative measures in the statewide survey.

Predicting Maintenance Intensity (PMI) research measured landscape management intensity as an indicator of polluting potential. Landscape preferences like design features, plant materials, and maintenance preferences were considered along with current and intended future behavior and potential motivating and discouraging influences. Figure 20 schematically represents the influences on landscape maintenance intensity and adoption of environmentally-friendly landscaping that were investigated for correlations, predictive power, and the direction of relationships. The predictive model represented three scales of influence, linking individual beliefs and attitudes, community norms and expectations, and institutions and perceived behavioral controls. My interest was distinguishing whether individuals or communities differed in the extent that they were influenced externally by community norms and perceived behavioral controls or the extent they acted in accordance with their own personal beliefs. Figure 20 is color coded according to scale, with individual influences shown in blue, community level influences in green and institutional influences in orange.

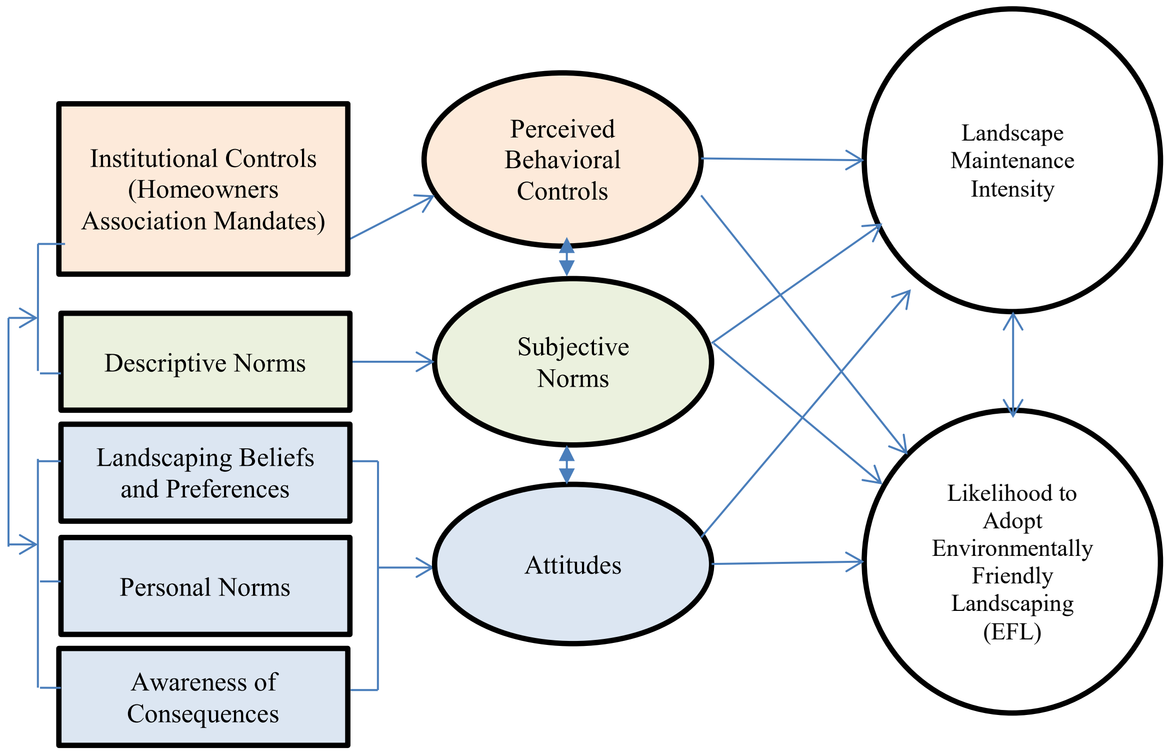


Figure 20: Landscape Maintenance Intensity Prediction Model

The dependent variable associated with landscape maintenance intensity was measured by computing the amount of inputs applied to the lawn in a single year.   The other dependent variable, likelihood to adopt environmentally friendly landscaping, was a nominal question that asked homeowners their current status regarding the behavior. Normative and attitudinal predictors were operationalized within the constructs of the

TPB and the NAT; focusing on descriptive and personal norms, awareness of consequences, perceived behavioral controls, and landscape activities and enjoyment.

The research focused on the research questions described below.

- How do individual beliefs and attitudes affect landscape maintenance intensity?
- How do descriptive and subjective norms influence individual practices?
- How do households differ in terms of their likelihood to adopt more environmentally-friendly landscaping (EFL) practices?
- How do institutional controls such as homeowners associations influence homeowners' ability to adopt environmentally-friendly landscaping practices?
- How do perceived behavioral controls such as expertise, product availability, price, or physical limitations that influence homeowners' ability to adopt environmentally-friendly landscaping.

In this research, I assumed that homeowners who identified with practicing environmentally-friendly landscaping would have lower than average maintenance intensity, higher awareness of consequences, lower normative influences and lower perceived behavioral controls. I also assumed that they would enjoy gardening. Alternative hypotheses were postulated to guide research analysis, discussion, and further investigation.

Methods

A series of testable alternative hypotheses was developed to understand the extent and variation of individual and community level influence on household landscape maintenance intensity (LMI) and likelihood to adopt environmentally-friendly landscape (EFL Adopters).

H1: Landscape maintenance intensity (LMI) will positively relate to community normative pressure (H1a) and homes in HOA communities will have significantly higher LMI scores (H1b). (LMI) will positively relate to income (H1c), education (H1d), and new housing development (H1e). LMI will negatively relate to awareness of consequences and EFL adopters will have significantly lower LMI scores (H1f).

H2: Homeowners who are currently practicing EFL will enjoy gardening (H2a), will have less community normative pressure (H2b) and will score higher on perceived behavioral controls measures (H2c). EFL adopters will be significantly less likely to live in a HOA community (H2d); significantly more likely to be aware of environmental consequences (H2e); and significantly more likely to have studied environmental or ecological topics during their education (H2f). EFL adopters are significantly more likely to have lived in their homes for longer than non-adopters (H2g).

Survey Design

The 68-item survey questionnaire was based on the extensive qualitative information collected in the Landscape Exchange project as well as questions used by other researchers who had operationalized the TPB and NAT measures. Hunecke *et al* (2010) provided a method to measure the TPB influences on individuals' transportation choices and their survey question format was consulted as reference for guidance along with questions of Wall *et al* (2008), whose research addressed a similar topic using an integrated TPB/NAT measure. Questions were designed to measure dependent variables and independent variables as summarized in this section. Additional socio-demographic and structural questions were asked as well. Attitudinal and belief oriented questions had Likert scale responses ranging from 1-6 as follows strongly disagree (1), disagree (2), somewhat disagree (3) somewhat agree (4), agree (5) and strongly agree (6). "Not applicable" and "Don't know" responses were also offered.

The following series of tables details the items that were specifically used to construct the measures in the integrated TPB/NAT model. Table 23 details the items that were asked in the survey that were used to construct three different lawn and garden attitudes. These measures were constructed based on the qualitative information collected in the Landscape Exchange study, which suggested that individuals varied in the extent they saw their yard as a playground for personal enjoyment of the garden and to the other extreme, as a community enforced commitment to hard work motivated externally by community conformity pressure or property market values. The "Garden Safe" attitude measures the extent homeowner's believe their yard is safe for health and the environment.

Table 23: Survey Items Measuring Attitudes & Beliefs

Attitude Measures	Items
Enjoy Gardening	Trying new plants in the yard is pleasurable to me.
	I enjoy watching the plants in my yard change and cycle throughout the year.
	I like working in the garden more than maintaining the lawn
	I enjoy watching butterflies and birds in my yard.
Prefer Yard Order	Having plants other than grass in the yard attracts unwanted wildlife.
	Trees are not safe to have in my front yard.
	I consider any plant other than grass in the lawn to be a weed
	A homes front yard should be almost entirely grass
Garden Safe	The way I currently maintain my lawn is safe for animal and human health
	The way I currently maintain my lawn is safe for the environment
	The way my lawn is currently maintained is not harmful to water quality.
Enjoy mowing grass	I enjoy mowing the grass
Brown in winter o.k.	It doesn't bother me if my grass turns a bit brown in the winter
Rewarding	The way my lawn is currently maintained is very rewarding
Inconvenient	The way my lawn is currently maintained is very inconvenient
Inexpensive	The way my lawn is currently maintained is very inexpensive
Status	People with the most money have the best lawns
Equal lawn and beds	Having 50% lawn and 50% plant beds is a good idea for the front yard
Hard to change	The way my lawn is currently maintained is difficult to change.
	I would have a hard time changing the way I currently maintain my front yard.
Easy	The way my lawn is currently maintained is very easy

Table 24 details the items used to characterize homeowners awareness of consequences and ability to make a difference on the outcome of those consequences. These measures attempt to capture a general sense of landscaping as a source of health or environmental degradation.

Table 24: Survey Items Measuring Awareness of Consequences

Measure	Items
Awareness of Consequences	Most chemicals applied to the lawn are harmful to human health.
	Pesticides applied to the lawn can be harmful to pets and animals.
	People can help improve water quality by not applying fertilizer to the lawn.

Table 25 includes the survey questions that were specifically designed to measure the subjective norm construct, defined as the community pressure on the individual to conform to a socially expected landscape norm. From the Landscape Exchange interviews, people described this normative pressure in terms of their property values, the importance to the community and their obligation to have a perfect lawn for their neighbors.

Table 25: Survey Items Measuring Subjective Norms

Measure	Items
Subjective Norms	I feel obligated to maintain a green weed-free lawn
	The way my lawn is maintained is important to my community
	The way my lawn is currently maintained is important for property values

Table 26 details the items used to measure descriptive norms as the extent that neighborhood landscape visual cues have on the actions of the individual. The questions about descriptive norms specifically ask the homeowner to answer the questions based on what they see in their neighborhood and their perceptions of their neighbors practices and reactions to their own yard.

Table 26: Survey Items Measuring Descriptive Norms

Measure	Item(s)
Descriptive Norms	Most of my neighbors maintain a green lawn all year round.
	Most of my neighbors hire professionals to maintain their yard
	My neighbors typically maintain a weed-free, green lawn.
	Most of my neighbors don't apply chemicals to maintain their yard. (Reversed)
	My neighbors would not care if I removed the lawn in the front yard and planted something else (Reversed)

Personal norms refer to individual feelings of obligation related to their own internal values and beliefs. Questions from others (Wall *et al* 2008, Hunecke *et al* 2010) demonstrated the use of key psychological terms to operationalize this construct. Phrases such as "I would prefer or I would rather…," "I feel obligated to…," I wonder if …" or "I wish I could…" were used to understand individuals personal preferences for a certain behavior based on their individual attitudes. The items in the state survey that measure personal norms are presented in Table 27.

Table 27: Survey Items Measuring Personal Norms

Measure	Item(s)
Personal Norms	I would prefer not to use fertilizer on the lawn
	I feel obligated to conserve water
	I would rather not apply chemical pesticides to the lawn
	I wish I could remove more of the lawn in my front yard and plant something else
	I would like to reduce the amount of water used on the lawn
	Sometimes I wonder whether applying chemicals to the lawn is harmful
	If I knew it were harmful to the environment, I would stop applying fertilizer to the lawn
	I wish didn't have to spend so much time maintaining the yard
	I seek environmentally friendly products to use in my yard

Two dependent variables were constructed as part of the survey. The first measure was designed to capture the maintenance intensity of the household based on the frequency that lawn care products were applied. Applying products to the lawn is a direct measure of landscape inputs that can relate to environmental damage. I assumed that the more individuals applied products to the lawn, the more they were actively engaged in their home's landscape maintenance. The survey items that were used to capture the Landscape Maintenance Intensity Scale (LMI) are listed in Table 28.

Table 28: Landscape Maintenance Intensity Measures

How many times in the last year were the following applied to the lawn?
Fertilizer applied to lawn (times/year)
Weed and Feed, weed killer or herbicide applied to lawn (times/year)
Pesticides or insect killer applied to the lawn (times/year)

A second dependent variable, Likelihood to Adopt EFL, consisted of the single question "Please check one of the following statements that best represents your home's environmentally-friendly landscaping practices" with the following response sets. This is a nominal measure of the homeowners' readiness to adopt environmentally-friendly landscaping.

Table 29: Likelihood to Practice Environmentally-friendly Landscaping

Which statement best represents your home's EFL practices?
I currently practice EFL to the greatest extent possible
I don't intend to ever change anything about the way I maintain the yard
I intend to do more EFL in the future

More details and discussion of the Dependent and Independent Variables creation are included further along in this chapter. The Variable Creation section focuses specifically on how survey items were used to create the indices that measure the psychological constructs and how the two dependent variables were computed. The next section of this chapter describes the data collection such as the survey method and random sampling design and the representativeness of the data.

Data Collection

A web-based survey of homeowners in the state of Florida was conducted by Knowledge Networks, Inc. from June 3 – June 21, 2011. A sample of 1,086 panel members that were pre-identified as living in a single-family detached house, a single-family attached to one or more houses, or a mobile home responded to the survey. Only homeowners were targeted with the survey because I was seeking individuals who were likely to be more knowledgeable about the landscape maintenance practices and more invested in their residence and their neighborhood (Friedrichs & Blasius, 2009).

Respondents screened for the primary yard maintenance decision-maker resulted in 939 qualified respondents completing the survey (n = 939). Seven hundred sixty-three (81%) of respondents were white, non-Hispanic; 3% identified as being black non-Hispanic; 21% identified as mixed race; non-Hispanic and 12% indicated they were Hispanic. Weighting was applied so that survey respondents represent the Florida population that own and live in the types of homes defined above who were the primary yard maintenance decision-makers. Weights were calculated based on the Florida Current Population Survey benchmark variables as follows:

- Gender
- Age (18-34, 35-44, 45-59, 60+)
- Race/Hispanic ethnicity (White/Non-Hispanic, Black, Non-Hispanic, Other non-Hispanic, 2+ races/Non-Hispanic, Hispanic)
- Metropolitan/non-metropolitan status
- Education (High school or less, Some college, Bachelors or higher)

- Internet access at home
- Language proficiency.

The following section describes the sampling methodology used by Knowledge Networks (2011) to collect representative survey data via an online research panel.

Surveys were completed by members of KnowledgePanel®, a randomly selected panel that is representative of the U.S. population. Panel members are randomly recruited by telephone and mail surveys, and households are provided with access to the Internet and hardware if needed. Unlike other Internet research panels which sample only individuals with Internet access who are willing to volunteer for research, KnowledgePanel is based on a more representative and inclusive sampling frame. They recruit panel members from those with listed and unlisted telephone numbers, those without a landline telephone, and those who do not have Internet access or computers. Knowledge Networks does not accept self-selected volunteers, providing a less biased and more representative sample of the population.

Knowledge Networks selects households for KnowledgePanel using random-digit dialing (RDD) or address-based sampling (ABS) techniques. ABS involves probability-based sampling of addresses from the U.S. Postal Service's Delivery Sequence File. Randomly sampled addresses are invited to join KnowledgePanel through a series of mailings and can join the panel by one of several means. Individuals register for the panel by completing and mailing back a paper form in a postage-paid envelope; by calling a toll-free hotline; or by visiting the designated registration website. After initially accepting the invitation to join the panel, respondents are then profiled for demographics and maintained on the panel using the same procedures established for the RDD-recruited research subjects. Respondents sampled from the RDD and ABS frames are provided the same privacy terms and confidentiality protections.

Once a person is recruited to the panel, they are contacted primarily by e-mail (instead of by phone or mail). This permits surveys to be fielded very quickly and economically. In addition, this approach reduces the burden placed on respondents who typically find answering Web questionnaires more interesting and engaging than being questioned by a telephone interviewer. In addition to the above-documented English-based panel recruitment, Knowledge Networks also constructed KnowledgePanel Latino[SM] to provide translation capabilities to conduct representative online surveys with U.S. Hispanic community.

Using this sampling methodology, KN is able to attain a 97% coverage rate of their targeted US household sample and a 93% Latino population coverage rate. This allows for confident interpretation of the results to the larger population (Knowledge Networks 2011).

Variable Creation

Two dependent variables were investigated during the survey. One was a continuous variable that measured the extent that homeowners applied lawn care products. The other is a nominal measure of groups of homeowners differentiated by the extent that they have reported their current or intended environmentally-friendly landscaping practices.

Dependent Variable #1: Landscape Maintenance Intensity Index

A measure of landscape maintenance intensity (LMI) was used to investigate homeowners based on the amount of inputs they added to their lawn. The LMI measure was computed by summing the mean number of times that homeowners reported applying herbicide, pesticide, and fertilizer in a single year as reported in the following three questions.

- About how many times was your lawn fertilized over the last twelve months?
- About how many times was pesticide (insect killer) applied to your lawn over the last twelve month?
- About how many times was herbicide (or weed and feed) applied to your lawn over the last twelve month?

The strong correlation of these three items was tested, Cronbach's alpha = .868. Three outlier data were coded as missing and the average application rate was calculated by dividing each application rate by the number of actual responses to the three questions. Response frequencies for LMI Dependent Variable (n = 756) ranged from 0-12 with a mean of 2.16 and a standard deviation of 2.19 (Table 30). The LMI Dependent Variable has a non-normal distribution due to the large number of zero responses and that nearly three-fourths of homeowners apply products to the lawn three or fewer times a year (Skewness 1.825, Kurtosis 4.916). Attempts to transform the variable using natural logs did not improve the curve and so non-parametric statistics were used.

Table 30: LMI Dependent Variable Response Frequencies

Landscape Maintenance Intensity (LMI) Score	Frequency	Valid Percent	Cumulative Percent
.00	173	22.9	22.9
.33	10	1.3	24.2
.50	4	0.5	24.7
.67	27	3.6	28.3
1.00	81	10.7	39.0
1.33	31	4.1	43.1
1.50	10	1.3	44.4
1.67	34	4.5	48.9
2.00	104	13.8	62.7
2.33	26	3.4	66.1
2.50	6	0.8	66.9
2.67	34	4.5	71.4
3.00	42	5.6	77.0
3.33	19	2.5	79.5
3.67	5	0.7	80.2
4.00	61	8.1	88.2
4.33	4	0.5	88.8
4.67	13	1.7	90.5
5.00	8	1.2	91.5
5.33	7	0.9	92.5
5.67	2	0.3	92.7
6.00	27	3.7	96.3
6.33	1	0.1	96.4
6.50	1	0.1	96.6
6.67	3	0.3	97.0
7.00	2	0.2	97.2
7.33	2	0.2	97.5
7.67	1	0.1	97.6
8.00	3	0.3	98.0
9.00	1	0.1	98.1
10.00	3	0.4	98.5
11.33	1	0.1	98.7
12.00	10	1.3	100.0
Valid Total	756	100.0	
Outliers (35,53,54)	3		
System Missing	180		
Total	939		

Dependent Variable #2: Environmentally-friendly Landscaping Adopters

The extent that a homeowner has adopted or intends to adopt environmentally-friendly landscaping was measured by their selection of the most appropriate response after reading a brief description of environmentally-friendly landscaping. The survey explained that an environmentally friendly landscape was one that used no chemical pesticides or herbicides, applied little to no fertilizer or irrigation water, and included native plants and trees instead of cultivated turfgrass. Some of the prominent state programs were provided as examples such as Florida-friendly landscaping, Florida Yards and Neighborhoods, WaterStar, Xeriscape yards, and WaterWise yards. Respondents were prompted to select one of the following statements that best represented their home's environmentally-friendly landscaping practices and the marginal frequencies are reported (Table 31). The groups who don't intend to change and are currently practicing EFL are not mutually exclusive.

Table 31: Marginal Frequencies of Dependent Variable #2, EFL Adopters[1]

Response Sets	Frequency	Valid Percent
I don't intend to ever change anything about the way I maintain my yard	290	31%
I currently practice environmentally-friendly landscaping to the greatest extent possible	287	31%
I intend to do more environmentally-friendly landscaping practices in the future	348	38%
Valid Total	925	100%
Refused	14	
Total	939	

1. Which statement best represents your homes environmentally-friendly landscaping?

Independent Variables

Summation scales were developed using the guidelines provided by Spector (1992) to measure independent variables. Indices were computed from survey questions designed to measure the psychological constructs of the predictive model such as personal norms, community normative pressure to high maintenance, individual beliefs and attitudes about gardening, and perceived behavioral controls. As previously discussed, the survey questions were designed to measure specific constructs as guided by the discourse that emerged during the qualitative study in the Landscape Exchange (LE) Project. I used Principal Components Analysis (PCA) to confirm that the survey items designed to measure these constructs were effective and to better refine the constructs.

Principal Component Analysis (PCA) with Varimax rotation was conducted on each series of survey questions designed to measure the psychological construct to identify which questions best measured the underlying dimension. Factors with eigenvalues greater than one were retained. Correlation analysis tested the direction and strength of inter-item correlations. Items with the strongest relationships were retained for the scale and reversed coded as needed to represent a uni-directional measure of the psychological construct. The mean of the three variables was computed for those who answered a majority of the items for each index was included in the final computed variable. Internal validity tests were conducted on the computed variable to confirm that Cronbach's alpha was at least .70, an acceptable internal consistency (Nunnally 1978, Pallant 2010). The final independent variable indices are summarized in Table 32.

Table 32: Indices with Items Measured on Likert Scale (1-6)

Variable	Cronbachs alpha	Questions	Mean	SD
Community Norms (n=928)	.82	Most of my neighbors maintain a green lawn all year round. Most of my neighbors hire professionals to maintain their yard My neighbors typically maintain a weed-free, green lawn. Reverse coded – Most of my neighbors don't apply chemicals to maintain their yard. Reverse coded – My neighbors would not care if I removed the lawn in the front yard and planted something else. I feel obligated to maintain a green weed-free lawn The way my lawn is maintained is important to my community The way my lawn is currently maintained is important for property values	4.00	.87
Personal Norms (n=900)	.76	I would prefer not to use fertilizer on the lawn I feel obligated to conserve water I would rather not apply chemical pesticides to the lawn I would like to reduce the amount of water used on the lawn Sometimes I wonder whether applying chemicals to the lawn is harmful If I knew it was harmful to the environment, I would stop applying fertilizer to the lawn I wish I could remove more of the lawn in my front yard and plant something else	4.10	.81

Variable	Cronbachs alpha	Questions	Mean	SD
Awareness of Consequence (n=911)	.72	Most chemicals applied to the lawn are harmful to human health. Pesticides applied to the lawn can be harmful to pets and animals. People can help improve water quality by not applying fertilizer to the lawn.	4.21	.98
Perceived Behavioral Controls (n=861)	.78	While making an environmentally-friendly yard, it would be easy to design it While making an environmentally-friendly yard, it would be easy to decide what plants to use While making an environmentally-friendly yard, it would cost a lot of money to install (Reversed) An environmentally-friendly yard would be easy to maintain With an environmentally-friendly yard, it would be easy to resell the property While making an environmentally-friendly yard, it would be easy to find someone to help While making an environmentally-friendly yard, it would be difficult to find native plants (Reversed) Making an environmentally-friendly yard would be a fun project Having an environmentally-friendly yard would be very rewarding	3.96	.73

Variable	Cronbachs alpha	Questions	Mean	SD
Enjoy Gardening (n=879)	.76	Trying new plants in the yard is pleasurable to me. I enjoy watching the plants in my yard change and cycle throughout the year. I like working in the garden more than maintaining the lawn I enjoy watching butterflies and birds in my yard.	4.56	.94
Garden Safe (n=901)	.82	The way I currently maintain my lawn is safe for animal and human health The way I currently maintain my lawn is safe for the environment The way my lawn is currently maintained is not harmful to water quality.	4.89	.84

The individual variables summarized in Table 33 were also considered. The HOA influence variable was computed from two variables that asked respondents if they lived in a homeowners association (HOA) governed community followed by a question on the extent that the HOA enforced landscaping rules. An ordinal variable was created that ranked respondents based on the extent that the HOA influenced their landscaping practices with 1 meaning the HOA was not present at all (those who answered “No” to the question about if they lived in a HOA governed community), 2 was coded for those who responded that the HOA was not active at enforcing landscaping rules, 3 was coded for those who indicated the HOA was somewhat actively enforcing landscaping rules and 4 was coded for those who indicated the HOA was very actively enforcing landscaping rules.

Table 33: Individual Variables

Construct	Question	Mean	Range	N
Beliefs	I would have a hard time changing the way I currently maintain my front yard	3.84	1-6	857
	I wish I didn't have to spend so much time maintaining the yard.	3.82	1-6	826
	The way my lawn is currently maintained is very inconvenient	2.85	1-6	881
	The way my lawn is currently maintained is very inexpensive	3.72	1-6	911
	The way my lawn is currently maintained is difficult to change	3.47	1-6	831
	The way my lawn is currently maintained is very easy	4.03	1-6	892
	Having plants other than grass in the yard attracts unwanted wildlife	2.54	1-6	853
	Trees are not safe to have in my front yard	2.16	1-6	901
	I consider any plant other than grass in the lawn to be a weed	2.79	1-6	904
	A homes front yard should be almost entirely grass	3.29	1-6	886
	I enjoy mowing the grass	3.15	1-6	785
	It doesn't both me if my grass turns a bit brown in the winter	3.97	1-6	904
	Having 50% lawn and 50% plant beds is a good idea for the front yard	3.94	1-6	815
	People with the most money have the best lawns	3.89	1-6	880
EFL Practice	I seek environmentally friendly products to use in my yard	4.33	1-6	841
HOA Influence	HOA influence on landscaping	2.02	1-4	923
Structures	How big is your home's property (acres)	1.15	.02-10	454
	What year was your house built (recoded)	28.01	1-136	922
	How long have you lived in the house	14.40	1-60	937
	How long have you lived in Florida	28.00	1-82	937
Socio-economic	Household Income ($1000)	65.16	5-175	939
	Years of formal education	14.65	3-21	939
Env Education	Extent environmental topics covered	2.12	1-5	934

Nominal variables such as race, gender, and employment were recoded into dichotomous variables to represent one category compared to a reference group in regression analysis. In this research, I created dummy groups for Hispanic and nonwhite groups compared to the white reference group. I created unemployed and retired/disabled dummy groups compared to the employed group. I created a dummy group for gender, with male as the reference group. During regression analysis, coding dummies in this manner allows the regression coefficients to be interpreted as differences in the dependent variable mean scores between the defined dummy category and the comparison group (Hair *et al* 2006, p. 97).

Groups of homeowners were created as dummy variables so that they could be compared in multiple regression analyses. These included the group of homeowners who applied products to the lawn themselves (HLM), those who hired professionals (PLM) to apply products to the lawn and those who didn't apply anything to the lawn. For the HLM and PLM variables, the respondent was included in the group if at least one product (fertilizer, herbicide, or pesticide) was applied to the lawn. The group (dummy) variables were created by recoding the number of cases where respondent answered the responsible party for applying one of the products. If missing from all three questions, the dummy variable was coded missing. The HLM and PLM groups were made up of those who indicated that the homeowner or professional applied one, two, or all three of the refer the lawn products. This resulted in 51 cases where respondents selected that both homeowners and professionals applied products.

For the group of homeowners who did not apply anything (Not Apply), the missing were individually considered for whether they should be included in the variable as data or coded as missing. I didn't assume that because someone didn't answer that they should be coded as "Not Apply." The breakdown of cases for the landscape manager groups is provided in Table 34.

Table 34: Number of Responses to Landscape Manager Variables

Landscape Manager Variable	Cases	Percentage
Nobody Applied Anything to the Lawn	129	14%
Professional Applied Something	295	32%
Homeowner Applied Something	446	48%
Both Apply Something	51	6%
Total Valid	921	100%
Missing	18	
Total	939	

Results

Bivariate Analyses

A series of correlation analyses were conducted to relate metric and nominal independent variables with each of the dependent variables. The Maintenance Intensity Dependent Variable was markedly non-normal (Skewness = 1.825, Kurtosis = 4.916). Therefore, Spearman correlations were computed to understand the bivariate relationships between it and the independent variables. The Spearman Rank Order correlation test is a non-parametric method to measure the relationship between two variables. It is considered to be a distribution-free test that makes no assumptions about normality of the distribution useful when one or both variables are not normally distributed or one of the variables is ordinal (O'Rourke, Hatcher and Stepanski, 2005, pg 140, Carver and Nash, p. 255).

Results of the bivariate analyses are tabulated on the following pages. Table 35 shows that four of the six indices are significant predictors of the landscape maintenance intensity. As expected, community norms to a high maintenance landscape significantly related to high household landscape maintenance (r = .360, p <.0001). Personal norms to reduce lawn inputs, Awareness of Consequences and to a lesser extent, belief that the garden was safe, were significant negative predictors of landscape maintenance intensity. Surprisingly, joy of gardening was not a significant predictor of landscape maintenance intensity, perhaps this is due to large variability of practices used by people who love to garden. It also shows that several of the indices are strongly correlated with each other, a possible concern for confounding the multiple regression analysis. For example the Personal Norms and the Awareness of Consequences indices are strongly correlated (r = .563, p < .0001) and the perceived behavioral control and garden joy are moderately correlated (r = .368, p = .0001).

Bivariate analyses of the individual variables that were not included in the indices were also related to the Maintenance Intensity Dependent Variable using Spearman correlation analyses. Moderate negative relationships were found between maintenance intensity and beliefs that lawn care was inexpensive (r=-.288, p < .001) and that the lawn turning brown in winter was o.k. (r = -.248, p <. .001). The age of the house (r = -.249, p < .001) and property size (r = -.153, p < .01) were also significant negative predictors. The strongest positive predictor of maintenance intensity was the HOA influence (r = .296, p < .001) and income (r = .246, p < .001).

Table 35: Spearman Correlations between Indices and Maintenance Intensity

	Maint. Intensity	Comm. Norms	Personal Norms	AC	PBC	Garden Joy	Garden Safe
Maintenance Intensity	1.000						
Community Norms	.360****	1.000					
Personal Norms	-.292****	-.119****	1.0000				
Awareness of Consequences (AC)	-.310****	-.148****	.563****	1.0000			
Perceived Behavioral Controls (PBC)	-.064	.002	.259****	.150****	1.0000		
Garden Joy	.048	.053	.249****	.153****	.368****	1.0000	
Garden Safe	-.153***	-.048	.048	-.046	.138****	.146****	1.0000

Spearman's rho reported, 2-tailed significance noted * $p < 0.05$ level ** $p < 0.01$ level ****$p < .0001$.

Table 36: Spearman Correlations of Individual Belief and Attitude Measures and Maintenance Intensity

	Maintenance Intensity	Can't change	Prefer less time	Incon.	Inexp.	Hard to change	Easy	Unwanted wildlife	Trees unsafe
Maintenance Intensity	1.000								
Can't change	.088*	1.000							
Prefer less time	.018	.167**	1.000						
Inconvenient	-.135****	.023	.309****	1.000					
Inexpensive	-.288****	-.079*	-.131****	.015	1.000				
Hard to change	-.093*	.229****	.173****	.256****	.043	1.000			
Easy	-.044	-.021	-.260****	-.247****	.378****	-.150****	1.000		
Unwanted wildlife	.023	.117**	.095**	.215****	.022	.184****	-.050	1.000	
Trees unsafe	-.0080	.048	.071*	.153****	.040	.137****	-.037	.423****	1.000

Spearman's rho reported, 2-tailed significance noted * $p < 0.05$ level ** $p < 0.01$ level ****$p < .0001$.

Table 37: Spearman Correlations of Individual Belief and Attitude Measures and Maintenance Intensity

	Maintenance Intensity	Plant weed	Yard grass	Enjoy mowing	Brown ok	Lawn status	Half lawn	Seek EF prod
Maintenance Intensity	1.000							
Plant weed	-.027	1.000						
Yard grass	.048	.256****	1.000					
Enjoy mowing	.069	.052	.141****	1.000				
Brown ok	-.248****	.034	-.164****	.061	1.000			
Lawn status	-.097**	.136****	.099**	-.042	.029	1.000		
Half lawn	.005	-.106**	-.159****	.072	-.006	.082*	1.000	
Seek EF prod	-.058	-.122****	-.142****	.133****	.042	-.053	.289****	1.000

Spearman's rho reported, 2-tailed significance noted * $p < 0.05$ level ** $p < 0.01$ level ****$p < .0001$.

Table 38: Spearman Correlations of Socio-demographic and Structural Measures and Maintenance Intensity

	Maintenance Intensity	Property acres	House age	Years in house	Years in Fl	HOA Active	Income	Ed	Env Ed
Maintenance Intensity	1.000								
Property acres	-.153**	1.000							
House age	-.249****	.048	1.000						
Years in house	-.069	.192****	.486****	1.000					
Years in Fl	-.102**	.209****	.338****	.533****	1.000				
HOA Influence	.296****	-.284****	-.482****	-.277****	-.272****	1.000			
Income	.246****	-.086	-.177****	-.016	-.068*	-.045	1.000		
Education	.108**	-.182****	-.053	-.008	-.060	.013	.410****	1.000	
Env. Education	.043	.038	.024	-.072*	-.049	.065	-0.016	.114****	1.000

Spearman's rho reported, 2-tailed significance noted * $p < 0.05$ level ** $p < 0.01$ level ****$p < .0001$.

Correlations between independent variables were also evident from the bivariate analysis and were taken into consideration when constructing the multiple regression analysis that will be discussed further in the section. These included the strong positive relationship between HOA influence and house age (r = -.482, p <.0001) and between HOA influence and the community norms index (r = .491, p < .0001) which is not included in the tables. Findings from the LWC project demonstrated the positive relationship between HOA presences and house age that can be explained by the timeframe for HOA development which boomed since 1990.

The second Dependent Variable, Environmentally-friendly Landscaping (EFL) Adopters, was a nominal variable containing three groups summarized in Table 31. The relationships between this Dependent Variable and other nominal-level independent variables were investigated using a chi-square test of independence. The chi-square test of independence compares the frequency of cases found in one categorical variable to the frequency of cases in another to determine if the proportion of cases in the comparison groups differ significantly from predicted values if cases were assigned randomly. Each variable can have two or more categories (Pallant, 2010, p 257). The EFL Adopter dependent variable has three categories. The chi-square test results comparing the EFL Adopters with other groups including those who live in HOA communities, landscape managers, and socio-demographic groups are reported in Table 39. Tests results showed that the only variables that significantly related to EFL Adopters were whether or not one applied anything to the lawn (chi-square = 8.565, p < .05), whether or not the respondent is retired or disabled (chi-square 15.751, p <.0001) or gender (chi-square 13.034, p <.001).

Table 39: Pearson Chi-square of EFL Adopters and Nominal Predictors

Predictor Variable (Yes)	Don't Intend to Change	Currently Practice	Intend to do More	Pearson Chi-Square	N
Live in HOA	52%	43%	47%	4.940	912
Professional Applied	40%	35%	37%	1.767	911
Homeowner Applied	50%	52%	59%	5.561	911
Nobody Applied	16%	17%	10%	8.565*	908
Unemployed	16%	11%	14%	2.391	925
Retired or Disabled	46%	42%	31%	15.751****	925
Race (Non-White)	17%	17%	21%	2.434	925
Gender (Female)	49%	62%	61%	13.034***	925

df = 2, , * $p < 0.05$ level ** $p < 0.01$ level *** $p < 0.001$ level ****$p < .0001$.

A series of ANOVA tests was conducted to determine differences in scores on the metric variables for people in the three groups: 1) those who never intend to change their landscaping practices, 2) those who currently practice environmentally-friendly landscaping to the greatest extent possible, and 3) those who intend to do more environmentally-friendly landscaping practices in the future. One-way between groups analysis of variance (ANOVA) was used to compare the variability within each group using an F statistic. The higher the F statistic, the more variance there is between the groups (Pallant, 2010, p. 186). The one-way ANOVA evaluates whether there are significant differences in the mean scores across the three groups (Table 40).

Table 40: One-way ANOVA Comparison of EFL Adopter Group Means

Variable	Don't Intend to Change	Currently Practice	Intend to do More	sig	N
Indices					
Community Norms	3.94	3.98	4.06		905
Personal Norms	3.69	4.29	4.25	****	893
Awareness of Consequences	4.02	4.28	4.28	***	870
PBC	3.53	4.24	4.05	****	853
Garden Joy	4.20	4.75	4.67	****	872
Garden Safe	4.82	5.11	4.75	****	881
Beliefs					
I can't change	4.00	3.82	3.64	**	852
Prefer less time	3.84	3.75	3.85		821
Inconvenient	3.02	2.77	2.78		873
Inexpensive	3.62	3.91	3.66	*	903
Hard to change	3.55	3.43	3.45		825
Easy	3.99	4.16	3.93		884
Unwanted wildlife	2.81	2.39	2.47	****	847
Trees unsafe	2.29	2.07	2.14	*	892
Plant weed	3.09	2.65	2.67	****	896
Yard grass	3.65	3.08	3.20	****	877
Enjoy mowing	2.88	3.36	3.20	**	777
Brown ok	3.88	4.11	3.93		894
Lawn status	3.92	3.87	3.86		872
Half lawn	3.60	4.05	4.11	****	808
Seek EF prod	3.69	4.78	4.41	****	835
Structures					
Property acres	1.16	1.33	1.01		450
House age	26.09	29.06	28.92		909
Years in house	15.52	14.05	13.72		923
Years in Florida	29.62	28.64	26.21	*	923
HOA Influence	2.13	1.87	2.03	*	909
Socio-economics					
Age (Years)	60.33	58.31	56.39	***	925
Income ($1000)	66.66	62.57	66.11		925
Education	14.44	14.80	14.71		925
Env Education	1.82	2.44	2.14	****	920

One-way ANOVA reported, * $p < 0.05$ level ** $p < 0.01$ level *** $p < 0.001$ level ****$p < .0001$.
Highest means on significant variables are in **bold.**

From the ANOVA results it is clear that individuals who don't ever intend to change their landscape practices differed from those who currently practice EFL or those who intend to do more. Those who didn't intend to ever change their landscape were older and had lived in Florida longer. They were more likely to not want wildlife visiting their yard, to believe that trees were unsafe to have in the yard, and that the lawn should be a weed-free monoculture. They were less likely to agree that having 50% lawn and 50% beds in the yard was a good idea. Those who didn't intend to ever change their landscape maintenance were also more likely to say that they couldn't change their landscape and that their homeowner's association actively enforced landscape rules.

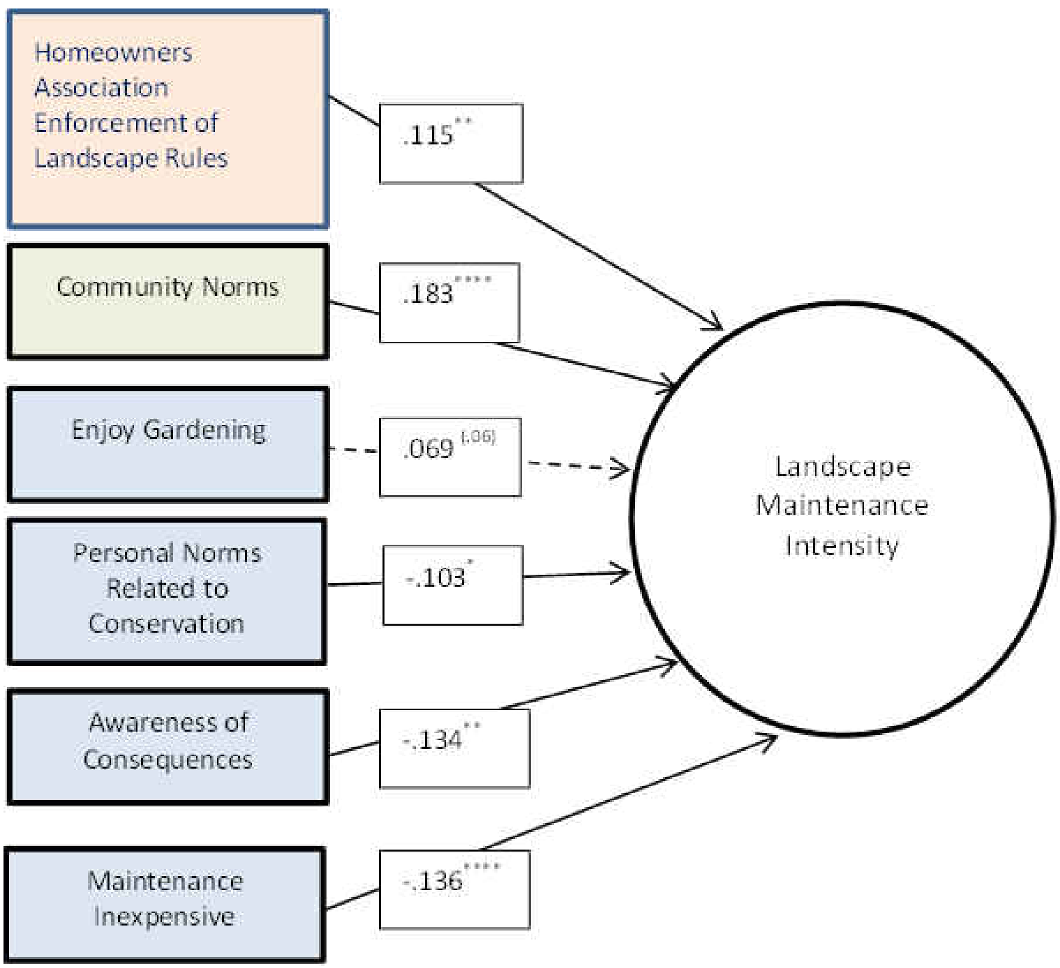
Those who currently practice EFL to the greatest extent possible were also significantly different from the other two groups. They had higher environmental value personal norms, greater awareness of consequences, and they were more likely to purchase environmentally-friendly landscaping products. They enjoyed gardening and mowing the lawn more than the others and they believed that their garden maintenance practices were safe for health and the environment. They were more likely to agree that EFL landscaping was easy, scoring the highest on the Perceived Behavioral Controls index. Although the differences between income and education were not significant, it is interesting to note that current EFL Adopters were in school the longest, but made the lowest income. They were significantly more likely to have studies more environmental and ecological topics during their education than the other two groups.

Multivariate Analyses

Multiple Regression

Multiple regression analysis was used to analyze the relationship between the Landscape Maintenance Intensity (LMI) Dependent Variable and the independent variables with which it most strongly correlated. It provides information about the explanatory power of variables when examining one dependent variables and independent variables measured on a continuous, ratio, or metric level. Regression analysis weighs the contribution of each independent variable and selects the linear combination that best predicts the dependent variable. The regression coefficient (*b)* represents the change in the dependent variable for each unit change in the independent variable. The standardized coefficient (β) reduces the regression coefficient to the number of standard deviations, which allows the comparison of independent variables measured in different ways. A t-value for each variable is calculated by dividing the coefficient with its standard error. It measures the extent that the coefficient is not zero and the probability of obtaining the t-value if the actual coefficient is zero. The Beta coefficient is based on both the degree of association and the scale unit of the independent variable (Hair *et al* 2006 pp. 169-268.) It reflects the unique contribution that the independent variable adds to the model. The model R2 measures the joint-contribution of all of the independent variables. Beta coefficients may underestimate the importance of a variable if the variable makes a strong joint, contribution to explaining the dependent variable but not a strong unique contribution. This is why understanding the bivariate relationship of variables is important.

Entering variables in a specified order allowed me to see how specified variables explained the amount of variance in the independent variable when controlling for the effect of other variables. I was interested in the effects of beliefs and attitudes independent of structural variables and so I conducted an initial regression analysis of just the attitudinal and belief variables to understand the relationships between them and landscape maintenance intensity (Figure 21).



OLS Linear Regression Model R2 = .17, F = 22.19, $p < .0001$, (n= 661)
Standardized Coefficients reported $p < 0.05$ level ** $p < 0.01$ level *** $p < 0.001$ level ****$p < .0001$ Perceived Behavioral Controls detracted from the model ($p = .701$) and was not used .

Figure 21: OLS Linear Regression Beta Coefficients Reported

There was a substantial correlation (r = .502, p < .001, n = 898) between the measure of community norm pressure and the extent that the HOA enforced landscape rules, which can decrease the total variance in the dependent variable (R2) by including both of these variables in the model. The same was true of the personal norms measure of individual preferences to reduce inputs to the yard and the awareness of environmental consequences measure (r = .534, p <.001, n = 854).

In order to understand the extent that psychological variables predicted maintenance intensity relative to structural variables like socio-demographics and landscape management responsibility, I conducted a nested multiple regression analysis. The socio-demographics that related strongly with maintenance intensity included house age and household income. Landscape management responsibility variables were also added, comparing the professional landscape managers and those who didn't apply products to the lawn with the reference group, which was the group of homeowners who applied fertilizer themselves. Table 41 summarizes the results of the regression model. Model 1 included the four psychological measures and Model 2 adds the socio-demographic and responsible party variables.

Table 41: OLS Linear Regression Model Predicting Landcape Maintenance Intensity

	Model 1			Model2		
Coefficients	β	*b*	Std. Error	β	*b*	Std. Error
(Constant)		2.003	.650		1.99	.578
Community Norms	.245****	.611	.093	.065	.163	.086
Awareness of Consequences	-.194****	-.429	.082	-.063	-.138	.073
Enjoy Gardening	.061	.144	.086	.036	.084	.074
Maintenance Inexpensive	-.165****	-.274	.062	-.066*	-.11	.054
House Age (Years)				-.066*	-.008	.004
Household Income ($1000)				.072*	.004	.002
Professional applied				.36*****	1.823	.175
No one applied products				-.281****	-1.691	.205
R2		.16			.39	
F Statistic		31.57****			50.48****	

Two-tailed significance, * *p*< 0.05 level ** *p* < 0.01 level *** *p*< 0.001 level ****$p < .0001$
b = Unstandardized coefficients β= Standardized Coefficients

The full model (n = 646, F = 50.48, p <.001) explained 39% of the variance in landscape maintenance intensity. When the socio-demographic and landscape management variables were added to the regression model, the strength of the socio-psychological variables dropped such that only one, the variable that measured the belief that lawn maintenance was inexpensive, contributed significantly to the model ($p < .05$). Two other variables, the measure of community norms and awareness of consequences, were approaching significance (p =.06). Both of the socio-economic variables (house age and income) significantly contributed to the model, but had opposite relationships.

Whether professionals or no one applied products to the lawn were the two strongest predictors of landscape maintenance intensity.

One interesting outcome of this model is that the landscape manager is the ultimate predictor of landscape maintenance intensity. According to the model, having a professional apply products nearly doubles a household's landscape maintenance intensity score relative to those who apply products themselves. This finding warrants further investigation to understand who hires professionals, how they determine the frequency of professional services and the extent that they direct professional practices.

<u>Multinomial Logistic Regression</u>

Logistic regression calculates the case probability of being in one group or another based on log odds. Coefficients are interpreted as unit changes in the log odds of being in one group or another. By calculating the antilog of the coefficient, the exponentiated coefficient, (Exp) B, allows easier interpretation of the unit change to odds. An exponentiated coefficient equal to 1.0 indicates there is no change in the dependent variable when we change the independent variable. Exponentiated coefficients less than 1.0 reflect a negative relationship between the dependent and independent variables and a decrease in the odds of being in the excluded group. The opposite occurs when the exponentiated value is greater than 1.0, there is a positive relationship, and the odds increase of being in the excluded group. The percentage change in odds is calculated by subtracting 1.0 from the exponentiated coefficient and multiplying that value by 100, (Hair *et al* 2006, pp. 355-368). Model significance values are calculated using a chi-square test on the differences in the log likelihood values which is annotated as -2LL.

The same independent variables used to predict the Landscape Maintenance Intensity dependent variable were investigated using multinomial logistic regression to understand the likelihood for households to adopt environmentally-friendly landscaping. Recall that the EFL Adopter DV#2 had three categories coded as follows: (0) I don't intend to ever change anything about the way I maintain my yard; (1) I currently practice environmentally-friendly landscaping to the greatest extent possible and (2) I intend to do more environmentally-friendly landscaping practices in the future. Logistic regression allowed me to estimate the effects of independent variables on the likelihood that they will appear in each of the three groups defined in the EFL Adopter DV. For this analysis, I used the group that didn't intend to ever change anything about their yard as the reference group. The exponentiated coefficients, (Exp) B, and significance of the independent variables are reported in Table 42.

Table 42: Odds Ratios from the Multinomial Logistic Regression Predicting EFL Adoption[1,2]

	I currently practice environmentally-friendly landscaping to the greatest extent possible	I intend to do more environmentally-friendly landscaping practices in the future
	Exp (B)	Exp (B)
Pro-environmental Personal Norms	3.219****	2.969****
Enjoy Gardening	1.765****	1.544****
High Maintenance Community Norms	1.240	1.340*
Awareness of Consequences	.765*	.960
Maintenance Inexpensive	1.077	.944
Professionals Applied	1.060	.867
No One Applied	1.024	.453*
Income ($1000)	.998	1.000
House age	1.009	1.010

1. Which statement best represents your homes environmentally-friendly landscaping?
2. Reference category is: (0) I don't intend to ever change anything about the way I maintain my yard.
Model Pseudo R2 (Nagelkerke) = .211, -2 Log Likelihood = 1553.51, Chi-square = 162.903, p <.001, n = 760.
* p < 0.05 level ****p < .0001

The logistic regression analysis demonstrated that as possessing pro-environmental personal norms such as preferences to minimize the use of chemicals, fertilizers and water on the lawn, significantly increased the chances of respondents being in the group that currently practices EFL ($p < .0001$) or the group that intends to practice more EFL ($p < .001$) relative to those who never intend to change anything about the way they maintain their yard. For each unit increase in the Personal Norms Index, measured on a scale from 1-6, the chances of being in either the group of people who currently practice EFL or the group who intend to practice more EFL would nearly triple compared to being in the group that doesn't intend to ever change.

The extent that survey respondents enjoyed gardening also had a significant effect on EFL adoption (p <.0001). For each unit increase in enjoying gardening, measured on a scale from 1-6, the odds of currently practicing EFL increased by 76% and the odds of intending to do more EFL practices increased by 54% compared to those who never intended to change, given the other variables in the model are held constant.

Awareness of environmental consequences significantly contributed to EFL adoption, but in a confounding way. Awareness of Consequences played a statistically significant role in differentiating the group that currently practiced EFL from those who didn't intend to change ($p < .05$), but it did not play a significant role in differentiating the group that intended to do more EFL practices from those who didn't intend to change ($p = .97$) when holding the other variables constant.

One-way ANOVA confirmed there were significant differences in the awareness of consequences between both those who currently practiced EFL and those who intended to do more EFL relative to those who didn't intend to change. Those who currently practiced EFL had a mean difference of -.2612 ($p < .01$) and those who intended to do more EFL had a mean difference of -.2646 ($p < .01$) between their Awareness of Consequences score and the mean score of those who didn't intend to change.

Table 43: One Way ANOVA of Awareness of Consequences and EFL Adopters

		Mean Difference	Std. Error	Lower Bound	Upper Bound
Don't Intend to Change	Currently Practice	-.2612*	.0835	-.4573	-.0651
	Intend to Do More	-.2646*	.0804	-.4534	-.0759
Currently Practice EFL	Don't Intend	.2612*	.0835	.0650	.4573
	Intend to Do More	-.0034	.0787	-.1881	.1813
Intend to do More EFL	Don't Intend	.2646*	.0804	.0758	.4533
	Currently Practice	.0034	.0787	-.1813	.1881

* The mean difference is significant at the 0.05 level.
1. Which statement best represents your homes environmentally-friendly landscaping?
$F = 6.701$, $p = .001$, $n = 870$

Perhaps looking at how these three EFL Adopter groups, awareness of consequences and landscape practices may further clarify these three groups. Recall that there was a significant negative relationship between Landscape Maintenance Intensity (LMI) and Awareness of Consequences ($r = -.237$, $p < .0001$), which was predicted. We saw that those who currently practice EFL were just as aware of the environmental consequences of landscape maintenance as those who intended to do more EFL in the future. Now we would like to see which of these groups applies more products to their lawn relative to their awareness. A one-way between groups analysis of variance (ANOVA) was used to compare the variability within each group of EFL Adopters on their mean Landscape Maintenance Intensity. Maintenance Intensity did not significantly vary between groups, with the greatest mean difference (.412, $p = .08$) between those who currently practice EFL and those who intend to do more EFL.

Table 44: EFL Adopter Group Mean Maintenance Intensity and Awareness of Consequences

	Landscape Maintenance Intensity (0-12)		Awareness of Consequences (1-6)	
EFL Adopter Group	Mean	Frequency	Mean	Frequency
Don't Intend to Change	2.04	31%	4.02	30%
Currently Practice EFL as Much as Possible	2.00	31%	4.28	32%
Intend to do More EFL in the Future	2.41	38%	4.28	38%

Landscape Maintenance Intensity ANOVA $F = 2.884$, $p = .059$, $n=751$

Awareness of Consequences ANOVA $F = 6.701$, $p = .001$, $n = 870$

Although those currently practicing EFL and those intending to practice EFL were similarly aware of the environmental consequences of landscape maintenance, the mean amount of fertilizer, herbicide, and pesticides they applied was very different. Those who intend to do more EFL had a mean maintenance intensity score that was much higher than those currently practicing EFL (nearly significant $p = .08$). In fact, those who intend to do more EFL had the highest mean landscape maintenance intensity score of the three groups. This finding supported the concept of lawn anxiety described by Robbins (2007), regarding those who are aware of the environmental consequences still applying lawn care products. My findings show that there are two groups who are aware of the environmental consequences, and one of them applies more products then the other. Further investigation of these two groups is warranted in future research. The group with the lowest Awareness of Consequences was those who never intend to change their landscape maintenance. This group of non-changers applied about as much fertilizer, herbicide, and pesticides to their yard annually as those who currently practice EFL as much as possible. These are not the findings I expected. Perhaps looking at those who apply nothing to the lawn (LMI Score = 0) will help clarify the relationship between EFL Adoption groups and maintenance intensity.

From the logistic regression model, it was apparent that those who did not apply products to the lawn were significantly less likely to be in the group of EFL Intenders relative to those who never intended to change their yard. Not applying anything to the lawn decreased the odds of intending to do more EFL by 55% relative to those who didn't intend to ever change their landscaping. Surprisingly, not applying anything to the lawn did not significantly relate to being in the "I currently practice EFL to the greatest extent possible" group compared to the reference group. Table 45 clarifies that the homeowners who didn't apply fertilizer, herbicide or pesticides to the lawn identified most with the group who currently practice EFL to the greatest extent possible (38%), followed by the group who didn't intend to ever change their maintenance (35%). Pearson chi-square confirmed significant differences in the frequency of three groups ($p < .05$). The fact that the group that intended to do more EFL (27%) had the lowest number of non-adopters may partially explain why this group of EFL had such high maintenance intensity. So if this group intends to do more EFL, and they are currently applying more products then the other two groups, I wonder what is preventing them from adopting more EFL practices. Further investigation of the socio-demographics and landscape management responsibilities of these three groups may clarify.

Table 45: Frequencies EFL Adopters that Don't Apply Products to the Lawn

	Do Not Apply Fertilizer, Herbicide or Pesticides to the Lawn
Don't Intend to Ever Change Yard Maintenance	35%
Currently Practice Environmentally-friendly Landscaping as Much as Possible	38%
Intend to Do More Environmentally-friendly Landscaping	27%

Chi-square 8.565, p <.05 (n = 908)

House age and income were both significant predictors of landscape maintenance intensity (LMI), but they did not significantly relate to EFL Adoption. Likewise, if a professional applied lawn products strongly predicted landscape maintenance intensity. Who applied fertilizer, herbicide or pesticide to the lawn did not have a significant relationship with EFL adoption (Table 46). I would have expected those who had a professional maintain their lawn to identify with those who didn't intend to change anything about the yard relative to the other two groups, and this was the case.

Table 46: EFL Adopters, Homeowner and Professional Applicators (n=780)

	Applied Fertilizer, Herbicide or Pesticides to the Lawn		
EFL Adopter Group	Homeowner	Professional	*p*
Don't Intend to Ever Change Yard Maintenance	52%	48%	.11
Currently Practice Environmentally-friendly Landscaping as Much as Possible	58%	42%	.67
Intend to Do More Environmentally-friendly Landscaping	59%	41%	.26

Pearson Chi-Square Significance Reported

Discussion

This concludes the investigation of landscape maintenance intensity and adoption of environmentally-friendly landscaping adoption for the purposes of this dissertation. Unfortunately, the variables that predicted the landscape maintenance intensity index did not provide a full picture of the relationships between EFL Adopter groups that can help determine the primary target for changing behavior. The analysis did reveal many interesting findings which are summarized in this section by the research questions and hypotheses they address.

My interest was distinguishing whether individuals or communities differed in the extent that they were influenced externally by community norms and perceived behavioral controls or the extent they acted in accordance with their own personal beliefs.

> H1: Landscape maintenance intensity (LMI) will positively relate to community normative pressure (H1a) and homes in HOA communities will have significantly higher LMI scores (H1b). (LMI) will positively relate to income (H1c), education (H1d), and new housing development (H1e). LMI will negatively relate to awareness of consequences and EFL adopters will have significantly lower LMI scores (H1f).

The alternative hypotheses were all significantly related to landscape maintenance intensity and in the predicted direction. Landscape maintenance intensity (LMI) positively related to community norms to have a high maintenance landscape ($r = .360$, $p < .0001$); HOA influence ($r = .296$, $p < .0001$); income ($r = .246$, $p < .0001$); education (r

= .108, *p* <.01); and being in a newer house (r = .249, *p* < .0001). Being in a newer house also significantly correlated with HOA influence (r = .482, *p* < .0001). LMI did negatively relate to awareness of consequences (r = -.310, *p* < .0001). Although those currently practicing environmentally-friendly landscaping did have the lowest LMI score (2.00), it was not significantly lower than the group that had the highest LMI score, although the mean difference between the groups was approaching significance (*p* = .08) using a one-way ANOVA. Because the maintenance intensity index was so non-normal, I ran a Kruskal-Wallis nonparametric, rank-order comparison which found that the difference between Current EFL Adopters and those who intend to do more EFL was significantly different (*p* = .014).

> H2: Homeowners who are currently practicing environmentally-friendly landscaping (EFL) will enjoy gardening (H2a), will have less community normative pressure (H2b) and will have stronger environmentally conscience personal norms (H2c). EFL adopters will be significantly less likely to live in a HOA community (H2d); significantly more likely to be aware of environmental consequences (H2e); and significantly more likely to have studied environmental or ecological topics during their education (H2f). EFL adopters are significantly more likely to have lived in their homes for longer than non-adopters (H2g).

Nearly all of the hypothesized relationships were significant and in the predicted direction. The EFL Adopter group that currently practiced environmentally-friendly landscaping differed significantly from the other two EFL Adopter groups, those who intended to adopt and those who never intended to change. Those currently practicing EFL were more likely to enjoy gardening ($p < .0001$) and mowing the lawn ($p < .01$); they were more likely to believe that EFL landscaping was easy ($p < .0001$); they had significantly higher environmentally conscience personal norms ($p < .001$); were influenced the least by a homeowners association ($p < .05$); were significantly more aware of environmental consequences than those who never intended to adopt EFL ($p < .001$) and studied environmental and ecological topics longer than the other groups ($p < .0001$).

However, contrary to the hypothesized relationship, I did not find that current EFL Adopters were significantly different than the other two groups, nor were they significantly less normatively influenced. Their score on the community norms index, mean = 3.98 on a scale from 1-6, was about the same as those who don't intend to ever change their landscape (3.94) and only slightly less than those who intend to do more environmentally-friendly landscaping (4.06). It is interesting that the pressure of community norms to a high maintenance yard did not significantly relate to respondents associating with any specific group even though the community norm variable was a strong positive predictor of landscape maintenance intensity.

The second alternative hypothesis that was not supported by this research was that those currently adopting environmentally-friendly landscaping would live in older homes. The variables of house age and years living in the house did not contribute significantly to being in any of the EFL adoption groups. Although they did live in homes that were older on average than the other two groups, current EFL adopters lived in their homes about as long as those who intend to do more landscaping (14 yrs) and only slightly less time on average than those who never intend to change their landscape (15 yrs). There is likely a relationship between HOA influence and house age that should be explored further to understand how community mandates continue to influence landscape maintenance over time.

There are many areas for further exploration in this research. In this chapter, I focused on two dependent variables, landscape maintenance intensity and the level of adoption of environmentally-friendly landscaping practices. I compared the variables that predicted one to see how they related to the other. My findings were not what I expected in some cases, particularly that those who adopted EFL practices to the greatest extent possible were equally likely to not apply anything to the lawn as those who didn't intend to ever change their practices. Those who intend to do more EFL were the least likely to not apply anything to their lawn. This was confirmed by comparing the landscape maintenance intensity and awareness of consequences scores among the three EFL adopter groups. Although Landscape Maintenance Intensity is a useful measure of product inputs, it does little to explain individual motivations for applying products.

More investigation of the life-history measures (i.e. age, income, and household characteristics), perceived behavioral controls, and normative influences of the EFL adopter groups is needed. Further investigation will explore the differences in those currently practicing EFL and those who will never change to better understand these two market segments. Also, the group that intends to do more should be investigated further to understand what is preventing them from acting. Further exploration of the perceived behavioral controls measures is needed.

My findings supported the concept of lawn anxiety described by Robbins (2007), regarding those who are aware of the environmental consequences, but still applied lawn care products. It would be interesting to explore the relationships further to understand why those who are environmentally aware are motivated to high maintenance regardless.

It is interesting that the significant influences on EFL Adoption were related more to individual characteristics such as personal norms, attitudes about the garden, and awareness of consequences and that the landscape managers and socio-demographics were weakly related. This is in contrast to what was found in the regression model done on the Landscape Maintenance Intensity (LMI) dependent variable, where structural differences like who was responsible for maintenance and socio-demographics like house age and income were strongly significant. Further investigation of structural versus personal motivators may explain these dynamics.

CHAPTER SIX: CONCLUSIONS AND FUTURE RESEARCH

Conclusions

> "Landscape is a visible and noticeable artifact of often unnoticed and sometimes invisible natural and societal processes. Being visible and communal, the landscape brings different people into a common experience of environmental systems, (Nassauer 2012).

Findings from this dissertation suggested that lawn nitrogen inputs, landscape maintenance intensity, and the likelihood of adopting alternatives may not be contingent on homeowners per se, but on where the homeowner lives. There wasn't a clear link between an individual's personal preferences, awareness of consequences, intentions and practices, but what was clear was that homeowners in this study applied lawn fertilizer at a rate that was much lower than the State of Florida's recommended fertilizer application rates.

The homeowners who did not apply fertilizer to the lawn at all differed significantly from those who did in ways that demonstrate different structural and cultural influences. For example, it is apparent from this research that the age of the house and historical development pattern played a big part in the use of fertilizer. Those who did not fertilize the lawn had significantly older homes with lower property values, but they lived in smaller houses on larger lots. More recently, the suburban development pattern was to build larger houses on smaller lots. Going back to developing homes on larger lots with more vegetation may accommodate the adoption of a more native, sustainable residential landscape.

This negative relationship between house age and fertilizer use is worthy of further investigation. How old does a house have to be before fertilize use stops? Does the need to fertilize the lawn diminish over time due to community influences or biological changes in the soil? Non-fertilizers were less likely to agree to the questions that measured community and normative influences, an indication that they feel less community pressure to fertilize. Perhaps it is also due to the natural succession of the residential landscape that reaches an acceptable point where no fertilizer is needed. It would be helpful to collect field vegetative and soil data to better understand how the landscapes of those who do not fertilize differ biologically from those who do. I suggest that both the social and biological communities relax over time, if they are allowed to. The presence of an HOA can extend the time it takes for the community to relax. Those who did not fertilize were significantly less likely to live in a HOA community.

Findings clarified that homeowners who applied lawn products more frequency lived together in newer, and concomitantly HOA governed, communities. However, those living in HOA communities were also more likely to hire landscape professionals who applied products more frequently. It is difficult to say whether the higher fertilizer frequency among professional resulted in more fertilizer being applied, as professional landscape companies are not required to disclose the blend of fertilizer used on the lawns they serve. If professionals apply fertilizer at the State of Florida recommended annual rates, then they are applying about twice as much fertilizer on average then homeowners who are applying fertilizer themselves. Other areas of the country, like Ann Arbor, Michigan, have taken steps to require that the fertilizer blends used by professionals are sampled so they can calculate nutrient inputs associated with professional landscape management. Without knowing the inputs, it would be difficult to conduct a study of nutrient dynamics at the landscape scale.

Evidence from research participants suggested that part of the reason that homeowners in Homeowners Association (HOA) governed communities hired professionals was to ensure compliance with strict landscape rules enforced by the HOA. The power of HOAs to enforce landscape rules was reinforced by a recent case where a homeowner was sued by her HOA for planting hardier, drought tolerant bahia grass (Spear 2012). The HOA, which was coincidentally located in the Wekiva Study Area, had a covenant in place requiring St. Augustine sod on the yard. The St. Augustine sod needed extensive irrigation, costing the homeowner hundreds of dollars monthly. The homeowner requested the landscape change according to her HOAs guidelines and received no response. The homeowner who proceeded with the requested landscape changes was consequently sued by her HOA, demanding that she "cease violating the homeowners' association rules". This evidence reinforces the claim that HOA governed communities enforce the use of water and fertilizer dependent turfgrass regardless of the Florida Statute that restricts them from prohibiting Florida-friendly landscaping. The HOA as a governing structure has the potential to usher in the new, sustainable landscape or prevent it from being implemented.

The environmental findings in this research were interesting, but not conclusive. Findings also demonstrated that soil nitrate concentrations in residential yards differed in the ornamental bed areas and the turfgrass areas. The fact that the turfgrass soils had much higher Total N and nitrate concentrations could be explained by nitrogen accumulation in thatch materials or that the turfgrass was more fertilized than the ornamental beds. In either case, the higher N concentrations are a nutrient sink that has the potential to be a source as the system matures.

Suburban landscape managers are not using fertilizer to feed themselves or the hungry. Lawns and the fertilizer required to maintain them are a socially constructed and market reinforced paradigm that must change in order to sustain human ecology. Lawn reform not only calls into being different capital accumulation regimes of garden care that are more ecological, but also requires that environmental debates be framed to tip the balance back to environmental preservation. This may require manning decision-making committees with more ecologists and water quality scientists than the industries who gain from continuing the growth of the suburban lawn. Before this on-going trend perpetuates water quality degradation worldwide, a new trend must emerge that promotes sustainable residential landscape designs and practices that link social norms to actions that balance biogeochemical cycles. A resource efficient residential landscape is drought proof, recession proof, provides habitat for pollinators, reduces the use of toxins and fertilizers, and potentially saves money on maintenance while providing social and commercial benefits (Sandberg and Foster 2005, Helfand *et al* 2006).

This dissertation research investigated the natural, societal and communal processes at work in the suburban landscape to understand how they interact. Data were collected at varying spatial scales over five years during three projects to understand homeowners motivators and deterrents to environmentally-friendly landscaping, to identify polluting communities based on their fertilizer inputs, correlate fertilizer inputs with localized environmental quality indicators, and finally to predict landscape maintenance intensity and adoption of environmentally-friendly landscaping based on socio-psychology and socio-economic variables. This research is important to the growing evidence needed to build the discipline of urban ecology which requires more detailed data on residential landscape managers' behaviors and attitudes to clarify behavioral patterns associated with N inputs (Law *et al* 2004).

This research is also important to the program implementers and policy-makers who are working to improve water quality in Florida's rivers and lakes. There is a lot at stake in Florida, for local governments mandated by regulatory requirements to reduce TMDLs, for Florida residents who enjoy aquatic systems for recreational or passive enjoyment, for businesses who rely on fisheries and tourism revenue, and for future generations of Floridians who require clean drinking water. The challenge is to understand the ecosystem adequately to intelligently intervene, since we inevitably will (Nassaur 2012).

Recommendations

Further investigation is needed to inform land use, landscape, and fertilizer regulatory decision-making so that sustainable residential development can be designed to meet the needs of the growing population without compromising the ability of future generations to meet their own needs. Pollutant loads associated with residential fertilizer should be accurately projected to estimate a timeframe for reaching nitrogen reduction goals. Furthermore, the public health and environmental justice issues that surround nitrogen impacts should be addressed. This section describes future research goals and recommendations.

Further research is needed at the landscape scale to fully appreciate the extent that residential lawn fertilizer is impacting water quality. Small-scale turfgrass studies do not take into account human actions and environmental influences. Urban ecology research that integrates the human dimensions of landscape management with the receiving biomass, soils, and waters will better demonstrate the real world environmental impacts of suburban fertilizer use. This will help stakeholders address pollutant reduction goals, prioritize and evaluate regulatory and education programs, and identify source contributions so that interventions can be appropriately applied.

New residential landscapes and ground covers are needed that maintain the purity, conformity, and tidiness of turfgrass acceptable to society (Nassauer 1995), without requiring continuous inputs of chemical fertilizers and pesticides. New ground covers that are easily grown and transported and serve to trap soil and prevent erosion while linking the community in a carpet of communal color. Research should focus on creating a new, sustainable ground covers rather than show the leaching potential of fertilizer dependent turfgrass.

The use of native plants may be accommodated by working with local and regional plant distributors to promote them with special marketing, similar to Florida-friendly plants. Native plants tags could include the bird and butterfly species they support as well as the maintenance requirements, flowering schedule, and planting needs.

Changes in suburban development patterns and land use planning are needed to accommodate a sustainable residential landscape that does not contribute excess nitrogen to aquatic systems, use up freshwater supplies, require chemical inputs manufactured in polluting industries, or eliminate native biota. Going back to development of smaller houses on larger lots may reduce the use of fertilizers and the resulting nitrogen inputs as well as increase biodiversity and improve natural habitat. In both the Wekiva study and the statewide survey, property size was negatively related to inputs of products to the lawn. This presents an alternative argument to conservation subdivision design that encourages high-density cluster development with more houses on smaller lots.

The Homeowners Association as the emerging suburban landscape can potentially lead the societal adoption of a new landscape norm. Laws that encourage and assist Homeowners Associations to accept an alternative, more sustainable landscape design can facilitate acceptance of a new community landscape. Incentives could be provided for using alternative, resource-efficient landscape plants. At least, requirements for high maintenance turf-grasses should be discouraged. Prior to development, developers could be required to adopt conservation landscape language in their covenants. Model language such as that provided by the UF Conservation Law Clinic (2009) could help new HOAs reinforce sustainable landscapes.

New development permitting regulations in the Florida require that post-development pollutant loads match predevelopment pollutant loads. Therefore, new housing developments are assumed to have no net impact on impaired waters and they are invisible to the TMDL process (England & Listopad 2012). In order for municipalities to meet pollution load reductions as required by the TMDL process, they must install structural devices, conduct maintenance, and implement public education programs. Using the current load calculation model, which assumes new developments have no impact, municipalities focus on older communities to achieve the greatest reduction benefit. In the case of reducing fertilizer impacts, the findings of this dissertation research suggest that this rationale may be flawed. Newer communities, and particularly those governed by a homeowners association, were likely to have higher landscape inputs than older communities. Although the stormwater volume may be collected and temporarily stored, the water quality from these new subdivisions is likely to have more fertilizer-derived nitrogen than older communities.

Institutional controls are needed to make these changes happen. Florida spends $Millions studying aquatic systems, but water degradation continues. Some suggest that although the environmental damage is well documented, not enough is being done to protect aquatic systems due to a regulatory structure that attempts to strike a balance between economic growth and prosperity. In accomplishing this balance, policy inevitably tips the scale in favor of growth and development (Williams 2012).

Research findings suggest that middle and upper-class suburban residents apply more chemicals to their lawn and thus have greater potential to impact ecosystem functions than those living in lower income neighborhoods. Poor water quality resulting from lawn chemical inputs is more likely to impact lower income populations who depend on fish from local surface waters to augment groceries and whose drinking water comes from private wells. This demonstrates a disproportionate impact across social classes and illuminates the broader question of environmental justice that is bound up with the lawn, lawn chemicals, and the lifestyle that surrounds it. Research that further demonstrates the environmental justice and public health issues associated with lawn care is needed to advise institutional decision-making.

Further research should investigate the differences in professional landscape managers and the homeowners who employ them. We know that in Wekiva, PLMs fertilizer frequency varied greatly (1-12 times/yr) and that they applied fertilizer an average of 4.8 times/yr. In Wekiva, 28% of homeowners who hired professionals said fertilizer was applied four times a year, 26% said it was applied six times a year, and 15% applied it twice a year. If the professional service is using the same fertilizer blend to service everyone, it is likely that the homes receiving the more frequent treatments are getting more nutrients annually than those who are treated less frequently. It would be interesting to know how professional services track the nutrients applied to each yard. It would also be interesting to see how the yards receiving one professional treatment differed visually and biologically from the ones receiving four, six, and twelve treatments. A follow-up experiment could ask homeowners receiving different professional fertilizer treatments to participate in a long-term soil and leachate study in their yard to measure their fertilizer needs and losses.

In Wekiva, we used interpolated pervious areas from aerial photography to estimate turfgrass coverage. It would be better to ground truth our estimates to check if our assumptions regarding impervious percentages and turfgrass covers were correct. A way to accurately measure turfgrass using aerial photography is needed and it would be helpful to double check the accuracy of our proposed method.

The STIRPAT model is an augmented IPAT model that measures ecosystem resilience and assumes impact can be reduced relative to population when stochastic measures such as consumption patterns and impact per unit consumption (York *et al* 2003) are considered. Once a measure of environmental impact from suburban fertilizer use is quantified, the next step would be to collect evidence to inform and run the STIIRPAT model which can provide an estimated time needed to accomplish nitrogen load reductions and whether there is adequate time remaining.

Next step – Measuring the Environmental Impact

In the Landscape Exchange project, the mean soil nitrogen concentration in the turfgrass areas of the residential yards was significantly higher than that in soils in the ornamental bed areas and natural areas. This could be due to mineralization of N in turf clippings or from the inputs of N from turf fertilization. Isotope studies of soils in turf, ornamental beds, and natural areas comparing the ratios of $^{15}N/^{14}N$ and $^{18}O/^{16}O$ in Nitrate (NO_3^-) would clarify if the source is from mineralization or fertilizer.

Previous research has shown and attempted to reduce nitrogen losses from fertilizer use. The literature review in this paper demonstrated regional nitrogen loads from fertilizer ranged from 20% to 25% (Howarth *et al* 2002, MACTEC 2009) to 79% (Leggette, Brashears and Graham, Inc. 2004). In control turfgrass plot studies that measured the nitrogen budget, the nitrogen losses ranged from 25% to 37% (Frank *et al* 2006, Engelsjord 2004, Quinones *et al* 2007).

Turfgrass studies by Trenholm (2012) found that that nitrate losses in leachate from controlled turfgrass experiments varied over time. Initial losses were as high as 73% which dropped considerably after the turfgrass because established, with losses as low as 1% in the following year. This supports the nutrient input and losses hypothesis of Vitousek and Reiners (1975) who proposed that biogeochemical cycling of nutrient inputs and outputs changed over the course of succession. They suggested that nutrient outputs would initially equal inputs, then drop as nutrients are accumulated by biomass, only to rise again to equal the nutrient inputs as the system reached carrying capacity and net ecosystem production approached zero. The small-scale design conducted by Trenholm (2012) should be conducted at the ecosystem level, to examine the trends in biogeochemical cycling over human development timeframes. Furthermore, the study should be expanded to capture organic nitrogen and ammonium, which would more represent total nitrogen losses more than just measuring nitrate. Lastly, the use of labeled fertilizer nitrogen (LFN) should be considered to easily identify fertilizer nitrogen relative to other sources.

Because commercial fertilizer nitrogen isotopic compositions are unique and present a narrow range of ^{15}N values (-4 to +6‰), this source of N can be traced through the landscape and into receiving waters using methods refined over decades of ^{15}N research. A small scale nitrogen budget at the suburb level should be implemented to understand the extent that lawn fertilizers are running off into storm systems or leaching into groundwater. Ideally, the project will recruit suburban homeowners to apply a labeled ^{15}N coated fertilizer so that it can be more easily traced from soils, to biomass, to leachate, and into receiving waters, demonstrating the potential for environmental impact that is measurable and reproducible. The research summarized in this dissertation shows the methods, the measures, and the mechanisms for conducting this much needed research.

APPENDIX A: LAND-WATER CONNECTION WEKIVA RESIDENTIAL LANDSCAPE SURVEY FREQUENCIES

Wekiva Land-water Connection Telephone Survey results (n=740) are provided in tabular form with missing data and marginal frequencies. The University of Central Florida Institute for Social and Behavioral Science conducted this random-digit-dialed telephone survey in April 2008.

Wekiva Land-Water Connection Marginal Frequencies
June 2, 2008

q2 About how long have you lived in the house you are currently living in?

	Frequency	Percent	Valid Percent	Cumulative Percent
1 1 Year or less	24	3.2	3.3	3.3
2	30	4.1	4.1	7.3
3	48	6.5	6.5	13.8
4	27	3.6	3.7	17.5
5	65	8.8	8.8	26.3
6	39	5.3	5.3	31.6
7	30	4.1	4.1	35.6
8	52	7	7	42.7
9	19	2.6	2.6	45.3
10	59	8	8	53.3
11	12	1.6	1.6	54.9
12	32	4.3	4.3	59.2
13	18	2.4	2.4	61.7
14	17	2.3	2.3	64
15	23	3.1	3.1	67.1
16	19	2.6	2.6	69.6
17	9	1.2	1.2	70.9
18	18	2.4	2.4	73.3
19	10	1.4	1.4	74.7
20	44	5.9	6	80.6
21	9	1.2	1.2	81.8
22	11	1.5	1.5	83.3
23	4	0.5	0.5	83.9
24	6	0.8	0.8	84.7
25	19	2.6	2.6	87.3
26	7	0.9	0.9	88.2
27	3	0.4	0.4	88.6
28	3	0.4	0.4	89
29	2	0.3	0.3	89.3
30	27	3.6	3.7	93

q2 About how long have you lived in the house you are currently living in?

	Frequency	Percent	Valid Percent	Cumulative Percent
31	6	0.8	0.8	93.8
32	3	0.4	0.4	94.2
33	1	0.1	0.1	94.3
34	2	0.3	0.3	94.6
35	5	0.7	0.7	95.3
36	1	0.1	0.1	95.4
37	2	0.3	0.3	95.7
38	3	0.4	0.4	96.1
39	2	0.3	0.3	96.3
40	4	0.5	0.5	96.9
41	1	0.1	0.1	97
42	1	0.1	0.1	97.2
43	2	0.3	0.3	97.4
44	1	0.1	0.1	97.6
45	3	0.4	0.4	98
46	2	0.3	0.3	98.2
47	2	0.3	0.3	98.5
50	4	0.5	0.5	99.1
51	5	0.7	0.7	99.7
58	1	0.1	0.1	99.9
60	1	0.1	0.1	100
Total	738	99.7	100	
99 Missing	2	0.3		
	740	100		

q4 Do you have a Homeowner's Association in your community?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	500	67.6	68.3	68.3
	2 No	232	31.4	31.7	100.0
	Total	732	98.9	100.0	
Missing	8 Dont know	8	1.1		
Total		740	100.0		

q5 How frequently do you interact with your Homeowners Association?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Never	109	14.7	22.0	22.0
	2 Seldom	252	34.1	50.8	72.8
	3 Often	61	8.2	12.3	85.1
	4 Regularly	74	10.0	14.9	100.0
	Total	496	67.0	100.0	
Missing	8 Dont know	4	.5		
	System	240	32.4		
	Total	244	33.0		
Total		740	100.0		

q6 Has your HOA changed any landscaping rules recently?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	26	3.5	5.9	5.9
	2 No	418	56.5	94.1	100.0
	Total	444	60.0	100.0	
Missing	8 Dont know	56	7.6		
	System	240	32.4		
	Total	296	40.0		
Total		740	100.0		

q7 Do you have central sewer service at your house or do you have a septic tank?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Sanitary sewer	448	60.5	61.5	61.5
	2 Septic tank	281	38.0	38.5	100.0
	Total	729	98.5	100.0	
Missing	8 Dont know	10	1.4		
	9 All other missing	1	.1		
	Total	11	1.5		
Total		740	100.0		

q8 What is the square footage of your house?

	Frequency	Percent	Valid Percent	Cumulative Percent
200	2	0.3	0.3	0.3
600	1	0.1	0.2	0.5
700	3	0.4	0.5	0.9
800	1	0.1	0.2	1.1
850	2	0.3	0.3	1.4
888	2	0.3	0.3	1.7
900	3	0.4	0.5	2.2
910	1	0.1	0.2	2.4
980	1	0.1	0.2	2.5
1000	5	0.7	0.8	3.3
1070	1	0.1	0.2	3.5
1100	7	0.9	1.1	4.6
1148	1	0.1	0.2	4.7
1186	1	0.1	0.2	4.9
1190	1	0.1	0.2	5
1200	23	3.1	3.6	8.6
1238	1	0.1	0.2	8.8
1250	3	0.4	0.5	9.3
1300	13	1.8	2	11.3
1308	1	0.1	0.2	11.5
1350	2	0.3	0.3	11.8
1400	10	1.4	1.6	13.4
1438	1	0.1	0.2	13.5
1440	1	0.1	0.2	13.7
1500	36	4.9	5.7	19.3
1546	1	0.1	0.2	19.5
1550	1	0.1	0.2	19.7
1560	2	0.3	0.3	20
1600	20	2.7	3.1	23.1
1610	1	0.1	0.2	23.3
1650	2	0.3	0.3	23.6
1660	1	0.1	0.2	23.7
1665	2	0.3	0.3	24.1
1700	21	2.8	3.3	27.4
1722	1	0.1	0.2	27.5
1727	1	0.1	0.2	27.7
1750	4	0.5	0.6	28.3

q8 What is the square footage of your house?

	Frequency	Percent	Valid Percent	Cumulative Percent
1765	1	0.1	0.2	28.5
1780	1	0.1	0.2	28.6
1785	1	0.1	0.2	28.8
1800	47	6.4	7.4	36.2
1836	1	0.1	0.2	36.3
1850	4	0.5	0.6	36.9
1875	1	0.1	0.2	37.1
1900	17	2.3	2.7	39.8
1915	1	0.1	0.2	39.9
1937	1	0.1	0.2	40.1
1950	4	0.5	0.6	40.7
1979	1	0.1	0.2	40.9
1992	1	0.1	0.2	41
1999	1	0.1	0.2	41.2
2000	66	8.9	10.4	51.6
2016	1	0.1	0.2	51.7
2100	26	3.5	4.1	55.8
2150	1	0.1	0.2	56
2200	43	5.8	6.8	62.7
2203	1	0.1	0.2	62.9
2250	1	0.1	0.2	63.1
2268	1	0.1	0.2	63.2
2270	1	0.1	0.2	63.4
2300	30	4.1	4.7	68.1
2305	1	0.1	0.2	68.2
2340	1	0.1	0.2	68.4
2350	1	0.1	0.2	68.6
2398	1	0.1	0.2	68.7
2400	31	4.2	4.9	73.6
2425	1	0.1	0.2	73.7
2500	26	3.5	4.1	77.8
2510	1	0.1	0.2	78
2600	17	2.3	2.7	80.7
2650	1	0.1	0.2	80.8
2700	9	1.2	1.4	82.2
2800	18	2.4	2.8	85.1

q8 What is the square footage of your house?

	Frequency	Percent	Valid Percent	Cumulative Percent
2843	1	0.1	0.2	85.2
2900	3	0.4	0.5	85.7
2930	1	0.1	0.2	85.8
3000	37	5	5.8	91.7
3100	7	0.9	1.1	92.8
3200	3	0.4	0.5	93.2
3300	7	0.9	1.1	94.3
3400	2	0.3	0.3	94.7
3500	11	1.5	1.7	96.4
3542	1	0.1	0.2	96.5
3557	1	0.1	0.2	96.7
3600	1	0.1	0.2	96.9
3700	3	0.4	0.5	97.3
4000	7	0.9	1.1	98.4
4200	2	0.3	0.3	98.7
4237	1	0.1	0.2	98.9
4500	1	0.1	0.2	99.1
4700	1	0.1	0.2	99.2
5200	2	0.3	0.3	99.5
5300	1	0.1	0.2	99.7
5400	1	0.1	0.2	99.8
6000	1	0.1	0.2	100
Total	636	85.9	100	
8888	98	13.2		
9999	5	0.7		
System	1	0.1		
Total	104	14.1		
	740	100		

q10 About what percentage of your home's landscape is lawn?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	4	.5	.6	.6
	1	1	.1	.1	.7
	2	4	.5	.6	1.3
	5	5	.7	.7	2.0
	8	1	.1	.1	2.2
	10	12	1.6	1.8	3.9
	12	2	.3	.3	4.2
	15	12	1.6	1.8	6.0
	20	17	2.3	2.5	8.5
	25	45	6.1	6.6	15.1
	28	1	.1	.1	15.2
	30	35	4.7	5.1	20.3
	33	24	3.2	3.5	23.8
	35	8	1.1	1.2	25.0
	40	24	3.2	3.5	28.5
	45	11	1.5	1.6	30.1
	50	123	16.6	18.0	48.1
	51	2	.3	.3	48.4
	55	3	.4	.4	48.8
	60	54	7.3	7.9	56.7
	65	4	.5	.6	57.3
	66	8	1.1	1.2	58.5
	67	1	.1	.1	58.6
	70	32	4.3	4.7	63.3
	75	60	8.1	8.8	72.1
	78	2	.3	.3	72.4
	80	75	10.1	11.0	83.3
	85	13	1.8	1.9	85.2
	88	2	.3	.3	85.5
	90	51	6.9	7.5	93.0
	91	1	.1	.1	93.1
	95	16	2.2	2.3	95.5
	98	2	.3	.3	95.8
	99	3	.4	.4	96.2
	100	26	3.5	3.8	100.0
	Total	684	92.4	100.0	
Missing	888 Dont know	55	7.4		
	System	1	.1		
	Total	56	7.6		
Total		740	100.0		

q11 Who does the majority of your home's landscaping activities?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Homeowner	522	70.5	70.6	70.6
	2 Homeowner hires a landscape company	167	22.6	22.6	93.2
	3 HOA/Landlord does it themselves	3	.4	.4	93.6
	4 HOA/Landlord hires a landscape company	19	2.6	2.6	96.2
	5 Friend or neighbor	23	3.1	3.1	99.3
	6 Other	5	.7	.7	100.0
	Total	739	99.9	100.0	
Missing	9 All other missing	1	.1		
Total		740	100.0		

q13 To what extent do you direct the practices of the landscape maintenance company?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not at all	41	5.5	22.4	22.4
	2 A little	57	7.7	31.1	53.6
	3 Somewhat	40	5.4	21.9	75.4
	4 A lot	45	6.1	24.6	100.0
	Total	183	24.7	100.0	
Missing	8 Dont know	7	.9		
	9 All other missing	1	.1		
	System	549	74.2		
	Total	557	75.3		
Total		740	100.0		

q14 Who fertilizes the lawn?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Homeowner	362	48.9	49.3	49.3
	2 Homeowner hired landscape company	219	29.6	29.8	79.0
	4 HOA/Landlord hired landscape company	23	3.1	3.1	82.2
	5 Friend or neighbor	7	.9	1.0	83.1
	6 Other	4	.5	.5	83.7
	7 We don't fertlize the lawn	120	16.2	16.3	100.0
	Total	735	99.3	100.0	
Missing	8 Don't know	5	.7		
Total		740	100.0		

q15 Is the fertilizer applied to the lawn on a regular schedule or only as needed?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Regular schedule	293	39.6	51.2	51.2
	2 Only as needed	279	37.7	48.8	100.0
	Total	572	77.3	100.0	
Missing	8 Don't know	21	2.8		
	System	147	19.9		
	Total	168	22.7		
Total		740	100.0		

q16 About how many times has fertilizer been applied to the lawn in 2008? (since January)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 Never	113	15.3	20.7	20.7
	1 Once	242	32.7	44.4	65.1
	2	133	18.0	24.4	89.5
	3	35	4.7	6.4	96.0
	4	16	2.2	2.9	98.9
	5	1	.1	.2	99.1
	6	2	.3	.4	99.4
	8	1	.1	.2	99.6
	14	1	.1	.2	99.8
	20	1	.1	.2	100.0
	Total	545	73.6	100.0	
Missing	88 Don't know	48	6.5		
	System	147	19.9		
	Total	195	26.4		
Total		740	100.0		

q17 When will fertilizer be applied again?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Next week	34	4.6	7.4	7.4
	2 Next month	163	22.0	35.4	42.7
	3 Next spring	6	.8	1.3	44.0
	4 Quarterly	28	3.8	6.1	50.1
	5 Summer	88	11.9	19.1	69.2
	6 Fall	60	8.1	13.0	82.2
	7 Winter	8	1.1	1.7	83.9
	8 whenever it needs it	74	10.0	16.1	100.0
	Total	461	62.3	100.0	
Missing	88 Don't know	131	17.7		
	99 All other missing	1	.1		
	System	147	19.9		
	Total	279	37.7		
Total		740	100.0		

q18 About how many times was your lawn fertilized over the last twelve months?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 Never	19	2.6	3.6	3.6
	1 Once	69	9.3	13.0	16.6
	2	127	17.2	24.0	40.6
	3	87	11.8	16.4	57.1
	4	100	13.5	18.9	76.0
	5	21	2.8	4.0	80.0
	6	68	9.2	12.9	92.8
	7	3	.4	.6	93.4
	8	13	1.8	2.5	95.8
	9	1	.1	.2	96.0
	10	1	.1	.2	96.2
	12	17	2.3	3.2	99.4
	15	1	.1	.2	99.6
	50	1	.1	.2	99.8
	80	1	.1	.2	100.0
	Total	529	71.5	100.0	
Missing	88 Don't know	62	8.4		
	99 All other missing	2	.3		
	System	147	19.9		
	Total	211	28.5		
Total		740	100.0		

q19_1 Q19_1 - Liquid fertilizer is used

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	473	63.9	82.4	82.4
	1	101	13.6	17.6	100.0
	Total	574	77.6	100.0	
Missing	System	166	22.4		
Total		740	100.0		

q19_2 Q19_2 - Dry, granulated fertilizer is used

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	188	25.4	32.8	32.8
	1 Yes	386	52.2	67.2	100.0
	Total	574	77.6	100.0	
Missing	System	166	22.4		
Total		740	100.0		

q19_3 Q19_3 - Weed and Feed is used

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	542	73.2	94.4	94.4
	1 Yes	32	4.3	5.6	100.0
	Total	574	77.6	100.0	
Missing	System	166	22.4		
Total		740	100.0		

q19_4 Q19_4 - Organic fertilizer is used

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	543	73.4	94.6	94.6
	1 Yes	31	4.2	5.4	100.0
	Total	574	77.6	100.0	
Missing	System	166	22.4		
Total		740	100.0		

q19_5 Q19_5 - Slow-release fertilizer is used

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	538	72.7	93.7	93.7
	1 Yes	36	4.9	6.3	100.0
	Total	574	77.6	100.0	
Missing	System	166	22.4		
Total		740	100.0		

q19_6 Q19_6 - Other <record open-ended>

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	572	77.3	99.7	99.7
	1 Yes	2	.3	.3	100.0
	Total	574	77.6	100.0	
Missing	System	166	22.4		
Total		740	100.0		

q19_7 Q19_7 - Buy something different every time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	571	77.2	99.5	99.5
	1 Yes	3	.4	.5	100.0
	Total	574	77.6	100.0	
Missing	System	166	22.4		
Total		740	100.0		

q19_8 Q19_8 - Don't know

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	487	65.8	84.8	84.8
	1 Yes	87	11.8	15.2	100.0
	Total	574	77.6	100.0	
Missing	System	166	22.4		
Total		740	100.0		

q20 What method is used to apply fertilizer to the lawn?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Pour directly from the bag onto lawn without any tools	24	3.2	4.8	4.8
	2 Apply using a hand crank fertilizer spreader	59	8.0	11.8	16.5
	3 Apply with a push action broadcast spreader	266	35.9	53.0	69.5
	4 Apply with a push action drop spreader	42	5.7	8.4	77.9
	5 Apply liquid fertilizer with a hose	43	5.8	8.6	86.5
	6 The landscape company does it	59	8.0	11.8	98.2
	7 Pour directly from the bag into flower beds	4	.5	.8	99.0
	8 Measure fertilizer and pour onto beds from measuring cup	5	.7	1.0	100.0
	Total	502	67.8	100.0	
Missing	88 Don't know	69	9.3		
	99 All other missing	2	.3		
	System	167	22.6		
	Total	238	32.2		
Total		740	100.0		

q21 What do you do if granular fertilizer is spilled on the sidewalk, driveway or street?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Leave it	32	4.3	8.8	8.8
	2 Sweep it into the street	14	1.9	3.8	12.6
	3 Sweep it into the lawn or plant beds	247	33.4	67.7	80.3
	4 I never spill fertilizer	45	6.1	12.3	92.6
	5 I don't use granular fertilizer	2	.3	.5	93.2
	6 I use granular fertilizer, but that hasn't happened to me	3	.4	.8	94.0
	7 I avoid the sidewalks, driveways, and street as much as possible	22	3.0	6.0	100.0
	Total	365	49.3	100.0	
Missing	8 Don't know/not applicable	90	12.2		
	9 All other missing	17	2.3		
	System	268	36.2		
	Total	375	50.7		
Total		740	100.0		

q22 How do you decide how much fertilizer to apply to the lawn at one application?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Lawn service	167	22.6	33.5	33.5
	2 Same as previous year	13	1.8	2.6	36.1
	3 Store recommendations	5	.7	1.0	37.1
	4 Fertilizer bag directions	227	30.7	45.5	82.6
	5 However much fits in the spreader	7	.9	1.4	84.0
	6 I guess/estimate	34	4.6	6.8	90.8
	7 IFAS/other expert advice	9	1.2	1.8	92.6
	8 I calculate the correct application according to my lawn size and turf grass needs	28	3.8	5.6	98.2
	9 Other	9	1.2	1.8	100.0
	Total	499	67.4	100.0	
Missing	88 Don't know	73	9.9		
	99 All other missing	1	.1		
	System	167	22.6		
	Total	241	32.6		
Total		740	100.0		

q23 How many bags of fertilizer are applied to the lawn at each application?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 Less than 1/4 bag	13	1.8	4.6	4.6
	1 About 1/2 bag	56	7.6	19.6	24.2
	2 Between 1/2 and 1 bag	30	4.1	10.5	34.7
	3 1 bag	110	14.9	38.6	73.3
	4 2 bags	57	7.7	20.0	93.3
	5 3 bags	12	1.6	4.2	97.5
	6 4 bags	3	.4	1.1	98.6
	7 More than 5 bags	4	.5	1.4	100.0
	Total	285	38.5	100.0	
Missing	8	1	.1		
	88 Don't know	277	37.4		
	99 All other missing	11	1.5		
	System	166	22.4		
	Total	455	61.5		
Total		740	100.0		

q24 How large are the bags of fertilizer that you purchase for the lawn?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 5 lbs	27	3.6	10.5	10.5
	2 10 lbs	59	8.0	23.0	33.6
	3 20 lbs	77	10.4	30.1	63.7
	4 30 lbs	25	3.4	9.8	73.4
	5 40 lbs	41	5.5	16.0	89.5
	6 50 lbs	21	2.8	8.2	97.7
	7 Other	6	.8	2.3	100.0
	Total	256	34.6	100.0	
Missing	8 Don't know	303	40.9		
	9 Missing	15	2.0		
	System	166	22.4		
	Total	484	65.4		
Total		740	100.0		

q25 List the 3 numbers (example 25-3-12) that indicate the nutrient content of the fertilizer used most frequently on the la

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	22003	1	0.1	1.4	1.4
	60006	1	0.1	1.4	2.8
	60200	1	0.1	1.4	4.2
	60606	19	2.6	26.4	30.6
	80808	1	0.1	1.4	31.9
	81208	1	0.1	1.4	33.3
	90024	1	0.1	1.4	34.7
	100011	1	0.1	1.4	36.1
	100408	1	0.1	1.4	37.5
	101010	3	0.4	4.2	41.7
	102030	1	0.1	1.4	43.1
	128888	1	0.1	1.4	44.4
	130606	2	0.3	2.8	47.2
	150015	1	0.1	1.4	48.6
	150711	1	0.1	1.4	50
	160212	1	0.1	1.4	51.4
	160408	1	0.1	1.4	52.8
	170211	1	0.1	1.4	54.2
	170311	1	0.1	1.4	55.6
	170511	1	0.1	1.4	56.9
	180612	1	0.1	1.4	58.3
	180906	1	0.1	1.4	59.7
	200606	1	0.1	1.4	61.1
	202020	1	0.1	1.4	62.5
	230403	1	0.1	1.4	63.9
	230510	1	0.1	1.4	65.3
	231010	1	0.1	1.4	66.7
	240824	1	0.1	1.4	68.1
	250008	1	0.1	1.4	69.4
	260209	1	0.1	1.4	70.8
	260213	2	0.3	2.8	73.6
	260311	1	0.1	1.4	75
	261102	1	0.1	1.4	76.4
	270305	1	0.1	1.4	77.8
	270308	1	0.1	1.4	79.2

q25 List the 3 numbers (example 25-3-12) that indicate the nutrient content of the fertilizer used most frequently on the la

		Frequency	Percent	Valid Percent	Cumulative Percent
	270312	1	0.1	1.4	80.6
	270603	1	0.1	1.4	81.9
	290216	1	0.1	1.4	83.3
	290304	7	0.9	9.7	93.1
	290305	1	0.1	1.4	94.4
	290306	1	0.1	1.4	95.8
	290308	1	0.1	1.4	97.2
	290609	1	0.1	1.4	98.6
	666666	1	0.1	1.4	100
	Total	72	9.7	100	
Missing	888888 Don't know	498	67.3		
	999999 All other missing	4	0.5		
	System	166	22.4		
	Total	668	90.3		
	Total	740	100		

q27 Who is responsible for watering your lawn?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Homeowner	668	90.3	90.4	90.4
	2 Homeowner hires a landscape company	4	.5	.5	90.9
	3 HOA/landlord does it themselves	2	.3	.3	91.2
	4 HOA/landlord hires a landscape company	1	.1	.1	91.3
	5 Friend or neighbor	1	.1	.1	91.5
	6 Other	5	.7	.7	92.2
	7 We never water the lawn	58	7.8	7.8	100.0
	Total	739	99.9	100.0	
Missing	8 Don't know	1	.1		
Total		740	100.0		

q28 What is the primary method used to water your lawn?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 In-ground, automatic irrigation system	521	70.4	77.8	77.8
	2 Hand water using a hose	65	8.8	9.7	87.5
	3 Set an above ground sprinkler out by hand	68	9.2	10.1	97.6
	4 Drip irrigation from hoses at surface	4	.5	.6	98.2
	5 Other	12	1.6	1.8	100.0
	Total	670	90.5	100.0	
Missing	8 Don't know	3	.4		
	System	67	9.1		
	Total	70	9.5		
Total		740	100.0		

q29 Which of the following best describes how you use your sprinkler system? Would you say you:

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Always leave it on automatic	266	35.9	51.3	51.3
	2 Turn it on manually as needed	167	22.6	32.2	83.4
	3 Turn it off if it rains	68	9.2	13.1	96.5
	4 Always leave it off	4	.5	.8	97.3
	5 Other	14	1.9	2.7	100.0
	Total	519	70.1	100.0	
Missing	8 Don't know	2	.3		
	System	219	29.6		
	Total	221	29.9		
Total		740	100.0		

q30 Does your irrigation system have a rain sensor on it?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	243	32.8	49.3	49.3
	2 No	250	33.8	50.7	100.0
	Total	493	66.6	100.0	
Missing	8 Don't know	28	3.8		
	System	219	29.6		
	Total	247	33.4		
Total		740	100.0		

q31 Does the rain sensor seem to work correctly?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	190	25.7	84.4	84.4
	2 No	35	4.7	15.6	100.0
	Total	225	30.4	100.0	
Missing	8 Don't know	41	5.5		
	9 ll other missing	5	.7		
	System	469	63.4		
	Total	515	69.6		
Total		740	100.0		

q32 Is your irrigation system maintained by a professional service?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	141	19.1	27.4	27.4
	2 No	374	50.5	72.6	100.0
	Total	515	69.6	100.0	
Missing	8 Don't know	6	.8		
	System	219	29.6		
	Total	225	30.4		
Total		740	100.0		

q33 How frequently do you or your professional service change the irrigation system timer?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Never	171	23.1	36.9	36.9
	2 Rarely	199	26.9	43.0	79.9
	3 Often	73	9.9	15.8	95.7
	4 Always	20	2.7	4.3	100.0
	Total	463	62.6	100.0	
Missing	8 Don't know	43	5.8		
	9 All other missing	15	2.0		
	System	219	29.6		
	Total	277	37.4		
Total		740	100.0		

q34 Does the watering schedule for your lawn vary throughout the year or stay pretty much the same?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	340	45.9	51.8	51.8
	2 No-water the same amount throughout the year	317	42.8	48.2	100.0
	Total	657	88.8	100.0	
Missing	8 Don't know	7	.9		
	9 Missing	6	.8		
	System	70	9.5		
	Total	83	11.2		
Total		740	100.0		

q35 On average, about how many days a week is your lawn watered?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	109	14.7	17.6	17.6
	2	454	61.4	73.1	90.7
	3	46	6.2	7.4	98.1
	4	2	.3	.3	98.4
	5	2	.3	.3	98.7
	7	8	1.1	1.3	100.0
	Total	621	83.9	100.0	
Missing	8 Don't know	28	3.8		
	9 All other missing	21	2.8		
	System	70	9.5		
	Total	119	16.1		
Total		740	100.0		

q36 During what season do you typically irrigate the lawn the most?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Spring	100	13.5	15.7	15.7
	2 Summer	353	47.7	55.5	71.2
	3 Fall	10	1.4	1.6	72.8
	4 Winter	37	5.0	5.8	78.6
	5 All seasons are irrigated the same	126	17.0	19.8	98.4
	6 I never irrigate my lawn	10	1.4	1.6	100.0
	Total	636	85.9	100.0	
Missing	8 Don't know	27	3.6		
	9 All other missing	7	.9		
	System	70	9.5		
	Total	104	14.1		
Total		740	100.0		

q37 During what season do you typically irrigate the lawn the least?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Spring	12	1.6	1.9	1.9
	2 Summer	88	11.9	13.9	15.8
	3 Fall	16	2.2	2.5	18.3
	4 Winter	386	52.2	60.9	79.2
	5 All seasons are irrigated the same	122	16.5	19.2	98.4
	6 I never irrigate my lawn	10	1.4	1.6	100.0
	Total	634	85.7	100.0	
Missing	8 Don't know	32	4.3		
	9 All other missing	4	.5		
	System	70	9.5		
	Total	106	14.3		
Total		740	100.0		

q38 Is your landscape irrigated with well water, city water, surface water, reclaimed water, or some other source?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Community well (from neighborhood)	12	1.6	1.9	1.9
	2 Private well (on homeowner's property)	103	13.9	16.1	17.9
	3 City water	453	61.2	70.7	88.6
	4 Reclaimed water	66	8.9	10.3	98.9
	5 Surface water source, such as a lake, canal, retention pond etc	6	.8	.9	99.8
	6 Rainwater collected in cistern or rain barrel	1	.1	.2	100.0
	Total	641	86.6	100.0	
Missing	8 Don't know	25	3.4		
	9 All other missing	4	.5		
	System	70	9.5		
	Total	99	13.4		
Total		740	100.0		

q39 A home's landscape is important to the community.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Disagree strongly	8	1.1	1.1	1.1
	2 Disagree	26	3.5	3.5	4.6
	3 Agree	352	47.6	48.0	52.7
	4 Agree strongly	347	46.9	47.3	100.0
	Total	733	99.1	100.0	
Missing	8 Don't know/haven't thought about it/don't care	7	.9		
Total		740	100.0		

q40 A lawn should consist of a single type of grass.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Disagree strongly	55	7.4	8.3	8.3
	2 Disagree	200	27.0	30.1	38.4
	3 Agree	288	38.9	43.4	81.8
	4 Agree strongly	121	16.4	18.2	100.0
	Total	664	89.7	100.0	
Missing	8 Don't know/haven't thought about it/don't care	74	10.0		
	9 All other missing	2	.3		
	Total	76	10.3		
Total		740	100.0		

q41 Homeowner landscape practices can have a negative affect on water quality.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Disagree strongly	16	2.2	2.4	2.4
	2 Disagree	71	9.6	10.8	13.2
	3 Agree	336	45.4	50.9	64.1
	4 Agree strongly	237	32.0	35.9	100.0
	Total	660	89.2	100.0	
Missing	8 Don't know/haven't thought about it/don't care	79	10.7		
	9 All other missing	1	.1		
	Total	80	10.8		
Total		740	100.0		

q42 It doesn't bother me if my grass turns a bit brown during the winter months.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Disagree strongly	69	9.3	9.4	9.4
	2 Disagree	138	18.6	18.8	28.2
	3 Agree	372	50.3	50.6	78.8
	4 Agree strongly	156	21.1	21.2	100.0
	Total	735	99.3	100.0	
Missing	8 Don't know/haven't thought about it/don't care	4	.5		
	9 All other missing	1	.1		
	Total	5	.7		
Total		740	100.0		

q43 It is important for me to have the nicest lawn on the block.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Disagree strongly	187	25.3	25.7	25.7
	2 Disagree	360	48.6	49.5	75.2
	3 Agree	134	18.1	18.4	93.7
	4 Agree strongly	46	6.2	6.3	100.0
	Total	727	98.2	100.0	
Missing	8 Don't know/haven't thought about it/don't care	13	1.8		
Total		740	100.0		

q44 It is important to me what the neighbors think about my yard.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Disagree strongly	115	15.5	15.9	15.9
	2 Disagree	230	31.1	31.9	47.8
	3 Agree	306	41.4	42.4	90.2
	4 Agree strongly	71	9.6	9.8	100.0
	Total	722	97.6	100.0	
Missing	8 Don't know/haven't thought about it/don't care	16	2.2		
	9 All other missing	2	.3		
	Total	18	2.4		
Total		740	100.0		

q45 In the last month or so, how many days have you spent working in your garden or lawn?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 Less than 1 day	123	16.6	17.2	17.2
	1 About 1 day	60	8.1	8.4	25.6
	2	84	11.4	11.7	37.3
	3	69	9.3	9.7	47.0
	4	100	13.5	14.0	61.0
	5	51	6.9	7.1	68.1
	6	36	4.9	5.0	73.1
	7	17	2.3	2.4	75.5
	8	29	3.9	4.1	79.6
	9	2	.3	.3	79.9
	10	22	3.0	3.1	82.9
	12	13	1.8	1.8	84.8
	13	5	.7	.7	85.5
	14	5	.7	.7	86.2
	15	30	4.1	4.2	90.3
	16	3	.4	.4	90.8
	18	1	.1	.1	90.9
	20	18	2.4	2.5	93.4
	21	2	.3	.3	93.7
	24	5	.7	.7	94.4
	25	10	1.4	1.4	95.8
	28	1	.1	.1	95.9
	29	3	.4	.4	96.4
	30	16	2.2	2.2	98.6
	31	10	1.4	1.4	100.0
	Total	715	96.6	100.0	
Missing	88 Don't know	23	3.1		
	99 All other missing	1	.1		
	System	1	.1		
	Total	25	3.4		
Total		740	100.0		

q46_1 Q46_1 - Planting new plants

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	445	60.1	72.1	72.1
	1 Yes	172	23.2	27.9	100.0
	Total	617	83.4	100.0	
Missing	System	123	16.6		
Total		740	100.0		

q46_2 Q46_2 - Mowing the grass

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	367	49.6	59.5	59.5
	1 Yes	250	33.8	40.5	100.0
	Total	617	83.4	100.0	
Missing	System	123	16.6		
Total		740	100.0		

q46_3 Q46_3 - Pruning and trimming

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	221	29.9	35.8	35.8
	1 Yes	396	53.5	64.2	100.0
	Total	617	83.4	100.0	
Missing	System	123	16.6		
Total		740	100.0		

q46_4 Q46_4 - Irrigating and watering

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	543	73.4	88.0	88.0
	1 Yes	74	10.0	12.0	100.0
	Total	617	83.4	100.0	
Missing	System	123	16.6		
Total		740	100.0		

Q46_5 - Applying fertilizers

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	579	78.2	93.8	93.8
	1 Yes	38	5.1	6.2	100.0
	Total	617	83.4	100.0	
Missing	System	123	16.6		
Total		740	100.0		

Q46_6 - Installing new lawn

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	605	81.8	98.1	98.1
	1 Yes	12	1.6	1.9	100.0
	Total	617	83.4	100.0	
Missing	System	123	16.6		
Total		740	100.0		

Q46_7 - Installing new trees or flower beds

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	593	80.1	96.1	96.1
	1 Yes	24	3.2	3.9	100.0
	Total	617	83.4	100.0	
Missing	System	123	16.6		
Total		740	100.0		

Q46_8 - Installing new irrigation system

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	611	82.6	99.0	99.0
	1 Yes	6	.8	1.0	100.0
	Total	617	83.4	100.0	
Missing	System	123	16.6		
Total		740	100.0		

Q46_9 - <Record other open ended>

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	493	66.6	79.9	79.9
	1 Yes	124	16.8	20.1	100.0
	Total	617	83.4	100.0	
Missing	System	123	16.6		
Total		740	100.0		

Q46_10 - Don't know/not applicable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	596	80.5	96.6	96.6
	1 Yes	21	2.8	3.4	100.0
	Total	617	83.4	100.0	
Missing	System	123	16.6		
Total		740	100.0		

q47 If you were planning to be out of town or leaving for the summer, would that influence your irrigation schedule?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	216	29.2	30.9	30.9
	2 No	484	65.4	69.1	100.0
	Total	700	94.6	100.0	
Missing	8 Don't know	18	2.4		
	9 All other missing	22	3.0		
	Total	40	5.4		
Total		740	100.0		

q48 If your lawn changes color, do you consider it a sign that you need to change something about you're landscape maintenance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	497	67.2	70.8	70.8
	2 No	205	27.7	29.2	100.0
	Total	702	94.9	100.0	
Missing	8 Don't know	22	3.0		
	9 All other missing	16	2.2		
	Total	38	5.1		
Total		740	100.0		

q49 If yes, what would you do?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Add water	142	19.2	30.0	30.0
	2 Add fertilizer	37	5.0	7.8	37.8
	3 Leave it alone, it is resting	5	.7	1.1	38.9
	4 Rip it out and consider a replacement grass	10	1.4	2.1	41.0
	5 Contact the landscape company	80	10.8	16.9	57.9
	6 Contact the HOA	2	.3	.4	58.4
	7 Other	197	26.6	41.6	100.0
	Total	473	63.9	100.0	
Missing	8 Don't know	46	6.2		
	9 All other missing	16	2.2		
	System	205	27.7		
	Total	267	36.1		
Total		740	100.0		

q50 Has the current drought situation caused you to change what you do in your yard?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	267	36.1	37.3	37.3
	2 No	449	60.7	62.7	100.0
	Total	716	96.8	100.0	
Missing	8 Don't know	12	1.6		
	9 All other missing	12	1.6		
	Total	24	3.2		
Total		740	100.0		

q51 If yes, what did you change?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Add water	80	10.8	30.9	30.9
	2 Add fertilizer	2	.3	.8	31.7
	3 Leave it alone, it is adapting	16	2.2	6.2	37.8
	4 Rip it out and consider a replacement grass	25	3.4	9.7	47.5
	5 Contact the landscape company	2	.3	.8	48.3
	6 Contact the HOA	1	.1	.4	48.6
	7 Other	133	18.0	51.4	100.0
	Total	259	35.0	100.0	
Missing	8 Don't know	17	2.3		
	9 All other missing	15	2.0		
	System	449	60.7		
	Total	481	65.0		
Total		740	100.0		

q52 Does the look of your neighbor's yard influence what you do in your yard?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	199	26.9	27.2	27.2
	2 No	533	72.0	72.8	100.0
	Total	732	98.9	100.0	
Missing	8 Don't know	6	.8		
	9 All other missing	2	.3		
	Total	8	1.1		
Total		740	100.0		

Q53_1 - Neighbor/Family member

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	574	77.6	77.6	77.6
	1 Yes	166	22.4	22.4	100.0
	Total	740	100.0	100.0	

Q53_2 - Home improvement centers/hardware stores

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	623	84.2	84.2	84.2
	1 Yes	117	15.8	15.8	100.0
	Total	740	100.0	100.0	

Q53_3 - Landscaping company

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	618	83.5	83.5	83.5
	1 Yes	122	16.5	16.5	100.0
	Total	740	100.0	100.0	

Q53_4 - Magazines or newspaper

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	614	83.0	83.0	83.0
	1 Yes	126	17.0	17.0	100.0
	Total	740	100.0	100.0	

Q53_5 - Television

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	694	93.8	93.8	93.8
	1 Yes	46	6.2	6.2	100.0
	Total	740	100.0	100.0	

Q53_6 - Website

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	601	81.2	81.2	81.2
	1 Yes	139	18.8	18.8	100.0
	Total	740	100.0	100.0	

Q53_7 - University of Florida/Agriculture Extension Service/Dept. of Agriculture

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	721	97.4	97.4	97.4
	1 Yes	19	2.6	2.6	100.0
	Total	740	100.0	100.0	

Q53_8 - City or county government - Where do you get information on landscape maintenance?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	726	98.1	98.1	98.1
	1 Yes	14	1.9	1.9	100.0
	Total	740	100.0	100.0	

Q53_9 - State government/FDEP - Where do you get information on landscape maintenance?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	739	99.9	99.9	99.9
	1 Yes	1	.1	.1	100.0
	Total	740	100.0	100.0	

Q53_10 - Water Management District - Where do you get information on landscape maintenance?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	738	99.7	99.7	99.7
	1 Yes	2	.3	.3	100.0
	Total	740	100.0	100.0	

Q53_11 - Local garden club - Where do you get information on landscape maintenance?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	728	98.4	98.4	98.4
	1 Yes	12	1.6	1.6	100.0
	Total	740	100.0	100.0	

Q53_12 - Other <Record open ended> - Where do you get information on landscape maintenance?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	589	79.6	79.6	79.6
	1 Yes	151	20.4	20.4	100.0
	Total	740	100.0	100.0	

Q53_13 - Don't know - Where do you get information on landscape maintenance?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0 No	694	93.8	93.8	93.8
	1 Yes	46	6.2	6.2	100.0
	Total	740	100.0	100.0	

q54 How much formal schooling have you had?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Less than high school	15	2.0	2.1	2.1
	2 High school or equivalent	118	15.9	16.3	18.3
	3 Some college	234	31.6	32.2	50.6
	4 College graduate	242	32.7	33.3	83.9
	5 Graduate or professional degree	117	15.8	16.1	100.0
	Total	726	98.1	100.0	
Missing	9 Don't know	14	1.9		
Total		740	100.0		

q55 How long have you lived in Florida?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	0.4	0.4	0.4
	2	4	0.5	0.6	1
	3	4	0.5	0.6	1.5
	4	10	1.4	1.4	2.9
	5	12	1.6	1.7	4.6
	6	6	0.8	0.8	5.4
	7	7	0.9	1	6.3
	8	15	2	2.1	8.4
	9	6	0.8	0.8	9.2
	10	30	4.1	4.1	13.4
	11	10	1.4	1.4	14.8
	12	16	2.2	2.2	17
	13	17	2.3	2.3	19.3
	14	14	1.9	1.9	21.2
	15	21	2.8	2.9	24.1
	16	7	0.9	1	25.1
	17	12	1.6	1.7	26.8
	18	18	2.4	2.5	29.2
	19	13	1.8	1.8	31
	20	39	5.3	5.4	36.4
	21	12	1.6	1.7	38.1
	22	14	1.9	1.9	40
	23	13	1.8	1.8	41.8
	24	9	1.2	1.2	43
	25	33	4.5	4.6	47.6
	26	14	1.9	1.9	49.5
	27	9	1.2	1.2	50.8
	28	16	2.2	2.2	53
	29	4	0.5	0.6	53.5
	30	43	5.8	5.9	59.4
	31	13	1.8	1.8	61.2
	32	14	1.9	1.9	63.2
	33	6	0.8	0.8	64
	34	7	0.9	1	65
	35	30	4.1	4.1	69.1
	36	7	0.9	1	70.1
	37	7	0.9	1	71
	38	12	1.6	1.7	72.7

q55 How long have you lived in Florida?

	Frequency	Percent	Valid Percent	Cumulative Percent
39	5	0.7	0.7	73.4
40	33	4.5	4.6	77.9
41	4	0.5	0.6	78.5
42	11	1.5	1.5	80
43	9	1.2	1.2	81.2
44	1	0.1	0.1	81.4
45	14	1.9	1.9	83.3
46	3	0.4	0.4	83.7
47	6	0.8	0.8	84.6
48	5	0.7	0.7	85.2
49	6	0.8	0.8	86.1
50	22	3	3	89.1
51	11	1.5	1.5	90.6
52	11	1.5	1.5	92.1
53	5	0.7	0.7	92.8
54	3	0.4	0.4	93.2
55	6	0.8	0.8	94.1
56	3	0.4	0.4	94.5
57	3	0.4	0.4	94.9
58	2	0.3	0.3	95.2
59	1	0.1	0.1	95.3
60	4	0.5	0.6	95.9
61	5	0.7	0.7	96.6
62	1	0.1	0.1	96.7
63	2	0.3	0.3	97
64	1	0.1	0.1	97.1
65	4	0.5	0.6	97.7
66	1	0.1	0.1	97.8
69	1	0.1	0.1	97.9
70	1	0.1	0.1	98.1
71	1	0.1	0.1	98.2
72	2	0.3	0.3	98.5
73	1	0.1	0.1	98.6
76	1	0.1	0.1	98.8
78	5	0.7	0.7	99.4
79	1	0.1	0.1	99.6
80	2	0.3	0.3	99.9

q55 How long have you lived in Florida?

		Frequency	Percent	Valid Percent	Cumulative Percent
	84	1	0.1	0.1	100
	Total	725	98	100	
Missing	99 All other missing	1	0.1		
	999	14	1.9		
	Total	15	2		
Total		740	100		

q56 Do you live in Florida year-round or just part of the year?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Year round resident	718	97.0	97.8	97.8
	2 Part-time resident	16	2.2	2.2	100.0
	Total	734	99.2	100.0	
Missing	8 Don't know	2	.3		
	9 All others missing	4	.5		
	Total	6	.8		
Total		740	100.0		

q57 What is your current employment status?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Employed full time	314	42.4	43.3	43.3
	2 Employed part time	53	7.2	7.3	50.6
	3 Self-employed	59	8.0	8.1	58.7
	4 Retired	185	25.0	25.5	84.2
	5 Not employed	51	6.9	7.0	91.2
	6 Disabled (volunteered response)	15	2.0	2.1	93.3
	7 Full time student (volunteered response)	14	1.9	1.9	95.2
	8 Housewife or house husband (volunteered response)	35	4.7	4.8	100.0
	Total	726	98.1	100.0	
Missing	88 DK/NA/Refused	10	1.4		
	99 All other responses	4	.5		
	Total	14	1.9		
Total		740	100.0		

q58 Which of the following do you consider as your racial or ethnic group?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 White	596	80.5	82.9	82.9
	2 Black/African-American	44	5.9	6.1	89.0
	3 Hispanic	32	4.3	4.5	93.5
	4 Asian/Pacific Islander	6	.8	.8	94.3
	5 Native American	8	1.1	1.1	95.4
	6 Multi-racial or multi-ethnic	20	2.7	2.8	98.2
	7 Other	13	1.8	1.8	100.0
	Total	719	97.2	100.0	
Missing	8 Don't know	10	1.4		
	9 All other missing	11	1.5		
	Total	21	2.8		
Total		740	100.0		

q59 What year were you born?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1914	1	0.1	0.1	0.1
	1917	1	0.1	0.1	0.3
	1921	1	0.1	0.1	0.4
	1922	4	0.5	0.6	1
	1923	3	0.4	0.4	1.4
	1924	3	0.4	0.4	1.9
	1925	2	0.3	0.3	2.1
	1926	7	0.9	1	3.1
	1927	9	1.2	1.3	4.4
	1928	6	0.8	0.9	5.3
	1929	8	1.1	1.1	6.4
	1930	12	1.6	1.7	8.1

q59 What year were you born?

	Frequency	Percent	Valid Percent	Cumulative Percent
1931	6	0.8	0.9	9
1932	8	1.1	1.1	10.1
1934	5	0.7	0.7	10.8
1935	6	0.8	0.9	11.7
1936	11	1.5	1.6	13.2
1937	11	1.5	1.6	14.8
1938	8	1.1	1.1	16
1939	12	1.6	1.7	17.7
1940	12	1.6	1.7	19.4
1941	8	1.1	1.1	20.5
1942	14	1.9	2	22.5
1943	13	1.8	1.9	24.4
1944	7	0.9	1	25.4
1945	15	2	2.1	27.5
1946	17	2.3	2.4	29.9
1947	19	2.6	2.7	32.6
1948	13	1.8	1.9	34.5
1949	11	1.5	1.6	36
1950	18	2.4	2.6	38.6
1951	14	1.9	2	40.6
1952	23	3.1	3.3	43.9
1953	19	2.6	2.7	46.6
1954	14	1.9	2	48.6
1955	22	3	3.1	51.7
1956	17	2.3	2.4	54.1
1957	24	3.2	3.4	57.5
1958	10	1.4	1.4	59
1959	20	2.7	2.8	61.8
1960	15	2	2.1	64
1961	16	2.2	2.3	66.2
1962	14	1.9	2	68.2
1963	17	2.3	2.4	70.7
1964	21	2.8	3	73.6
1965	21	2.8	3	76.6
1966	17	2.3	2.4	79.1
1967	12	1.6	1.7	80.8
1968	16	2.2	2.3	83

		Frequency	Percent	Valid Percent	Cumulative Percent
	1969	11	1.5	1.6	84.6
	1970	10	1.4	1.4	86
	1971	5	0.7	0.7	86.8
	1972	8	1.1	1.1	87.9
	1973	4	0.5	0.6	88.5
	1974	7	0.9	1	89.5
	1975	8	1.1	1.1	90.6
	1976	10	1.4	1.4	92
	1977	5	0.7	0.7	92.7
	1978	5	0.7	0.7	93.4
	1979	8	1.1	1.1	94.6
	1980	4	0.5	0.6	95.2
	1981	5	0.7	0.7	95.9
	1982	3	0.4	0.4	96.3
	1983	2	0.3	0.3	96.6
	1984	1	0.1	0.1	96.7
	1985	2	0.3	0.3	97
	1986	5	0.7	0.7	97.7
	1987	4	0.5	0.6	98.3
	1988	2	0.3	0.3	98.6
	1989	7	0.9	1	99.6
	1990	3	0.4	0.4	100
	Total	702	94.9	100	
Missing	8888	7	0.9		
	8999	1	0.1		
	9999 missing	30	4.1		
	Total	38	5.1		
Total		740	100		

q60 What is your five-digit zip-code?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	32010	1	.1	.1	.1
	32465	1	.1	.1	.3
	32702	1	.1	.1	.4
	32703	202	27.3	28.2	28.6
	32707	1	.1	.1	28.8
	32712	205	27.7	28.6	57.4
	32714	22	3.0	3.1	60.5
	32736	1	.1	.1	60.6
	32768	1	.1	.1	60.8
	32779	153	20.7	21.4	82.1
	32781	2	.3	.3	82.4
	32792	1	.1	.1	82.5
	32801	1	.1	.1	82.7
	32807	1	.1	.1	82.8
	32810	97	13.1	13.5	96.4
	32818	8	1.1	1.1	97.5
	32827	1	.1	.1	97.6
	33703	1	.1	.1	97.8
	34761	13	1.8	1.8	99.6
	35280	1	.1	.1	99.7
	37302	1	.1	.1	99.9
	39772	1	.1	.1	100.0
	Total	716	96.8	100.0	
Missing	88888	8	1.1		
	99999 Missing	16	2.2		
	Total	24	3.2		
Total		740	100.0		

q61 Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Female	443	59.9	59.9	59.9
	2 Male	297	40.1	40.1	100.0
	Total	740	100.0	100.0	

q62 Would you be willing to participate in the next phase of the project?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes continue	239	32.3	32.4	32.4
	2 No thanks	498	67.3	67.6	100.0
	Total	737	99.6	100.0	
Missing	System	3	.4		
Total		740	100.0		

q63 Have you lived in your current home for at least 5 years?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	190	25.7	80.2	80.2
	2 No	47	6.4	19.8	100.0
	Total	237	32.0	100.0	
Missing	9 Missing	2	.3		
	System	501	67.7		
	Total	503	68.0		
Total		740	100.0		

q64 How healthy would you say that your home's landscape has been over the past 5 years?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Not healthy at all	14	1.9	6.0	6.0
	2 Somewhat healthy	60	8.1	25.9	31.9
	3 Healthy	110	14.9	47.4	79.3
	4 Very Healthy	48	6.5	20.7	100.0
	Total	232	31.4	100.0	
Missing	8 Don't know	3	.4		
	9 All other missing	4	.5		
	System	501	67.7		
	Total	508	68.6		
Total		740	100.0		

q65 Have you had to re-seed or re-sod your lawn or make other major changes to your landscape in the past five years?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1 Yes	100	13.5	43.9	43.9
	2 No	128	17.3	56.1	100.0
	Total	228	30.8	100.0	
Missing	8 Don't know	6	.8		
	9 All other missing	4	.5		
	System	502	67.8		
	Total	512	69.2		
Total		740	100.0		

Frequencies

Notes

Output Created		19-MAY-2008 10:27:14
Comments		
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	Active Dataset	DataSet1
	File Label	wekiva08
	Filter	filter_$ q61 > 0 (FILTER)
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	Split File	<none>
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Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data.
Syntax		fre age.
Resources	Elapsed Time	0:00:00.02
	Processor Time	0:00:00.03

Compute age from year born

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18.00	3	.4	.4	.4
	19.00	7	.9	1.0	1.4
	20.00	2	.3	.3	1.7
	21.00	4	.5	.6	2.3
	22.00	5	.7	.7	3.0
	23.00	2	.3	.3	3.3
	24.00	1	.1	.1	3.4
	25.00	2	.3	.3	3.7
	26.00	3	.4	.4	4.1
	27.00	5	.7	.7	4.8
	28.00	4	.5	.6	5.4
	29.00	8	1.1	1.1	6.6
	30.00	5	.7	.7	7.3
	31.00	5	.7	.7	8.0
	32.00	10	1.4	1.4	9.4
	33.00	8	1.1	1.1	10.5
	34.00	7	.9	1.0	11.5
	35.00	4	.5	.6	12.1
	36.00	8	1.1	1.1	13.2
	37.00	5	.7	.7	14.0
	38.00	10	1.4	1.4	15.4
	39.00	11	1.5	1.6	17.0
	40.00	16	2.2	2.3	19.2
	41.00	12	1.6	1.7	20.9
	42.00	17	2.3	2.4	23.4
	43.00	21	2.8	3.0	26.4
	44.00	21	2.8	3.0	29.3
	45.00	17	2.3	2.4	31.8
	46.00	14	1.9	2.0	33.8
	47.00	16	2.2	2.3	36.0
	48.00	15	2.0	2.1	38.2
	49.00	20	2.7	2.8	41.0
	50.00	10	1.4	1.4	42.5
	51.00	24	3.2	3.4	45.9
	52.00	17	2.3	2.4	48.3
	53.00	22	3.0	3.1	51.4
	54.00	14	1.9	2.0	53.4
	55.00	19	2.6	2.7	56.1
	56.00	23	3.1	3.3	59.4
	57.00	14	1.9	2.0	61.4
	58.00	18	2.4	2.6	64.0
	59.00	11	1.5	1.6	65.5

		Frequency	Percent	Valid Percent	Cumulative Percent
	60.00	13	1.8	1.9	67.4
	61.00	19	2.6	2.7	70.1
	62.00	17	2.3	2.4	72.5
	63.00	15	2.0	2.1	74.6
	64.00	7	.9	1.0	75.6
	65.00	13	1.8	1.9	77.5
	66.00	14	1.9	2.0	79.5
	67.00	8	1.1	1.1	80.6
	68.00	12	1.6	1.7	82.3
	69.00	12	1.6	1.7	84.0
	70.00	8	1.1	1.1	85.2
	71.00	11	1.5	1.6	86.8
	72.00	11	1.5	1.6	88.3
	73.00	6	.8	.9	89.2
	74.00	5	.7	.7	89.9
	76.00	8	1.1	1.1	91.0
	77.00	6	.8	.9	91.9
	78.00	12	1.6	1.7	93.6
	79.00	8	1.1	1.1	94.7
	80.00	6	.8	.9	95.6
	81.00	9	1.2	1.3	96.9
	82.00	7	.9	1.0	97.9
	83.00	2	.3	.3	98.1
	84.00	3	.4	.4	98.6
	85.00	3	.4	.4	99.0
	86.00	4	.5	.6	99.6
	87.00	1	.1	.1	99.7
	91.00	1	.1	.1	99.9
	94.00	1	.1	.1	100.0
	Total	702	94.9	100.0	
Missing	System	38	5.1		
Total		740	100.0		

ager

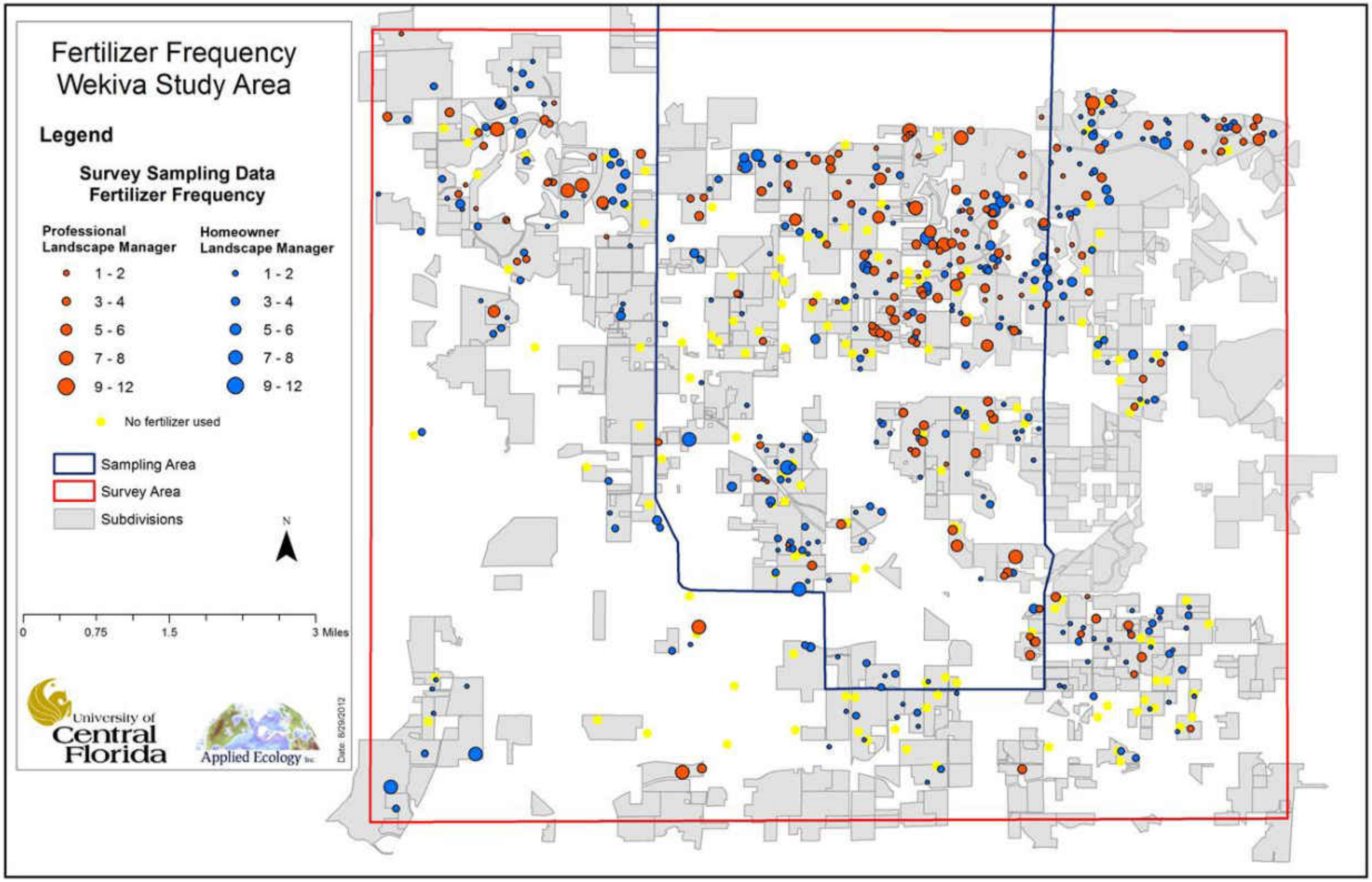
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00 18-44	206	27.8	29.3	29.3
	2.00 45-64	325	43.9	46.3	75.6
	3.00 65 and older	171	23.1	24.4	100.0
	Total	702	94.9	100.0	
Missing	System	38	5.1		
Total		740	100.0		

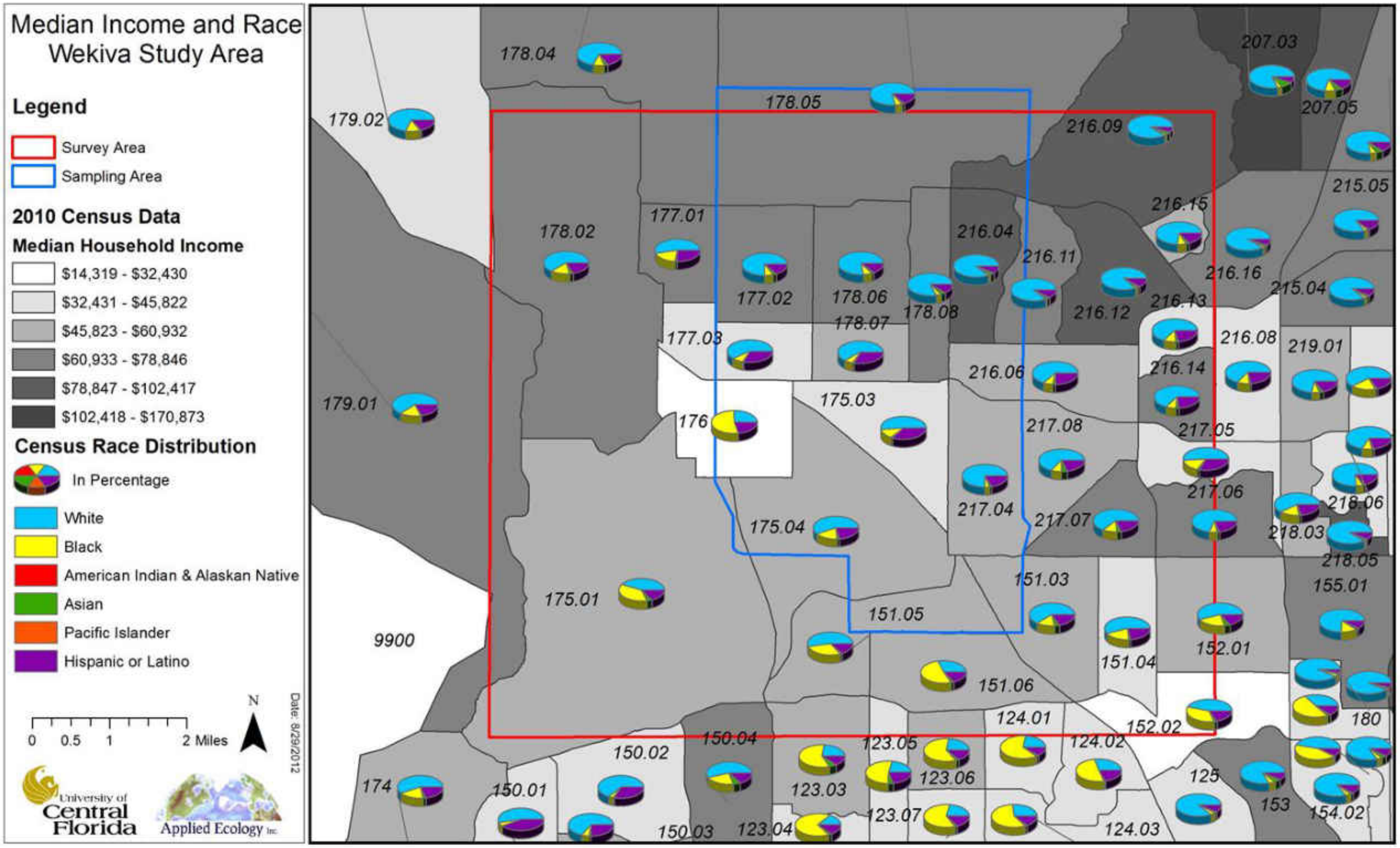
APPENDIX B: ADDITIONAL LAND -WATER CONNECTION MAPS

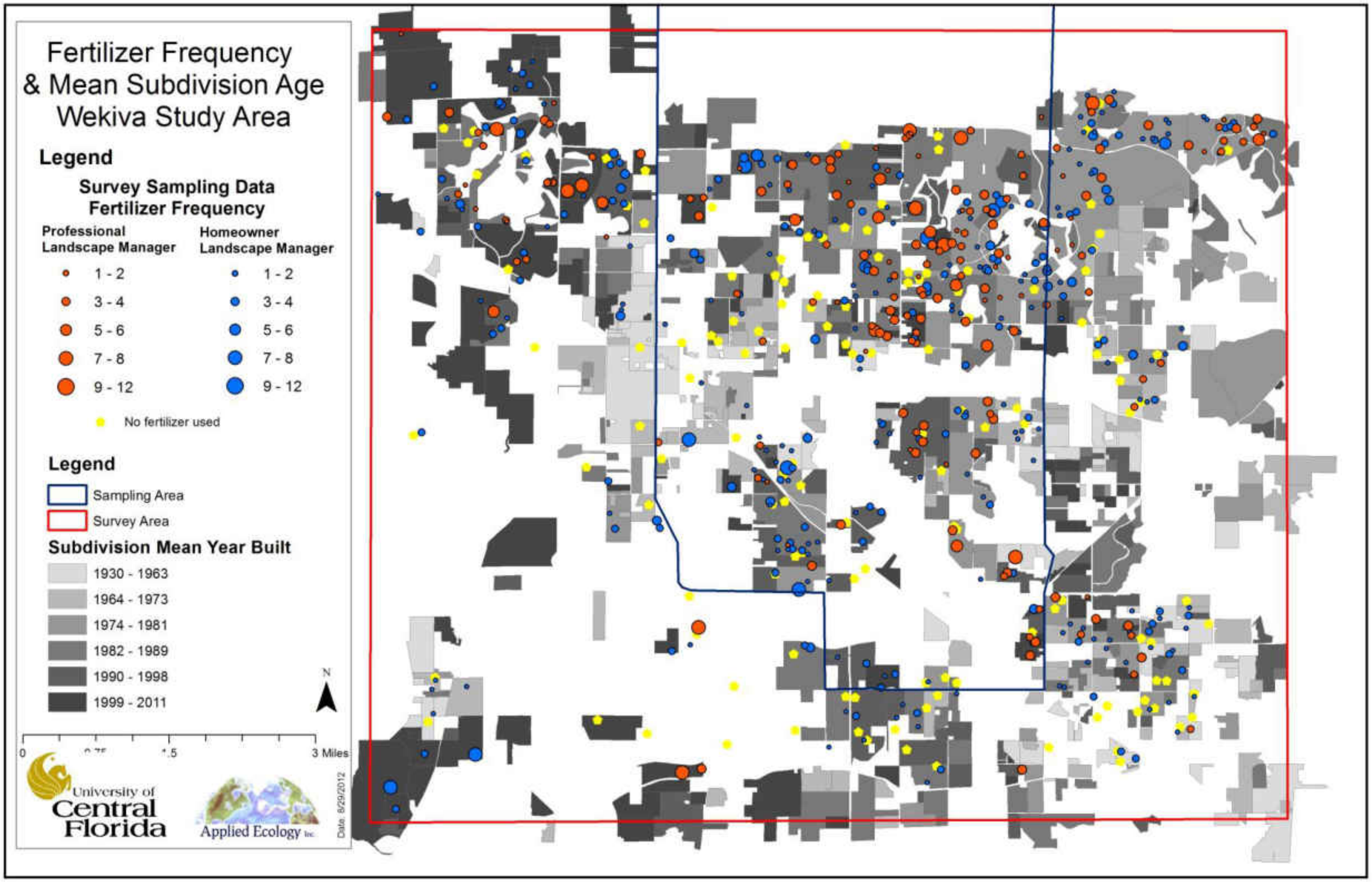
Fertilizer Frequency and Wekiva Study Area map shows the fertilizer frequency data points for homeowner and professional landscaped yards in the Wekiva Research Area. This map shows the communities with clusters of high professional use and higher fertilizer frequency.

The Median Income and Race in Wekiva Study Area map should the median household income and racial composition by Census tracts. The link between income and racial distribution is evident from this map. There is less racial diversity in the higher income tracts.

The Mean Fertilizer frequency and Subdivision Age map includes the homeowner and professional fertilizer frequency data points on top of the mean year built of subdivisions. The yellow points on the map are those who don’t fertilize. It is evident from this map the extent that people who don’t fertilize live in older communities.


Fertilizer Frequency
Wekiva Study Area
Legend
Survey Sampling Data
Fertilizer Frequency
Professional Landscape Manager
Homeowner Landscape Manager
1 - 2
3 - 4
5 - 6
7 - 8
9 - 12
No fertilizer used
Sampling Area
Survey Area
Subdivisions
N
0
0.75
1.5
3 Miles
University of Central Florida
Applied Ecology Inc
Date: 8/29/2012


Median Income and Race
Wekiva Study Area
Legend
Survey Area
Sampling Area
2010 Census Data
Median Household Income
$14,319 - $32,430
$32,431 - $45,822
$45,823 - $60,932
$60,933 - $78,846
$78,847 - $102,417
$102,418 - $170,873
Census Race Distribution
In Percentage
White
Black
American Indian & Alaskan Native
Asian
Pacific Islander
Hispanic or Latino
0 0.5 1 2 Miles
N
Date: 8/29/2012
University of Central Florida
Applied Ecology Inc.
178.04
178.05
179.02
216.09
207.03
207.05
215.05
178.02
177.01
216.04
216.11
216.15
216.16
215.04
177.02
178.06
178.07
178.08
216.12
216.13
216.08
219.01
177.03
216.06
216.14
179.01
176
175.03
217.08
217.05
217.04
217.07
217.06
218.06
218.03
218.05
175.04
151.03
155.01
175.01
151.05
152.01
9900
151.04
151.06
124.01
152.02
180
150.04
123.05
124.02
150.02
123.06
125
174
150.01
123.03
153
154.02
123.07
150.03
123.04
124.03


Fertilizer Frequency
& Mean Subdivision Age
Wekiva Study Area
Legend
Survey Sampling Data
Fertilizer Frequency
Professional
Landscape Manager
Homeowner
Landscape Manager
1 - 2
3 - 4
5 - 6
7 - 8
9 - 12
1 - 2
3 - 4
5 - 6
7 - 8
9 - 12
No fertilizer used
Legend
Sampling Area
Survey Area
Subdivision Mean Year Built
1930 - 1963
1964 - 1973
1974 - 1981
1982 - 1989
1990 - 1998
1999 - 2011
N
0
3 Miles
University of
Central
Florida
Applied Ecology
Date: 8/29/2012

APPENDIX C: PREDICTING INTENSITY STATEWIDE SURVEY FREQUENCIES

The results of the web-based survey of Florida homeowners conducted for the Predicting Landscape Maintenance Intensity project are provided in tabular form with missing data. Knowledge Networks conducted this random selection panel survey in June 2011 and 939 homeowners responded.

Predicting Intensity Statewide Survey

July 5, 2011

Survey in English or Spanish

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	English version	894	95.2	95.2	95.2
	Spanish version	45	4.8	4.8	100.0
	Total	939	100.0	100.0	

Language primarily spoken

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	English Dominant	31	3.3	3.3	3.3
	Bilingual	47	5.0	5.0	8.3
	Spanish Dominant	38	4.0	4.0	12.4
	Non-Hispanic	823	87.6	87.6	100.0
	Total	939	100.0	100.0	

party7

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strong Republican	171	18.2	18.2	18.2
	Not Strong Republican	136	14.5	14.5	32.7
	Leans Republican	190	20.2	20.2	52.9
	Undecided/Independent/Other	26	2.8	2.8	55.7
	Leans Democrat	168	17.9	17.9	73.6
	Not Strong Democrat	105	11.2	11.2	84.8
	Strong Democrat	143	15.2	15.2	100.0
	Total	939	100.0	100.0	

ideology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	7	.7	.7	.7
	Extremely liberal	17	1.8	1.8	2.6
	Liberal	123	13.1	13.1	15.7
	Slightly liberal	82	8.7	8.7	24.4
	Moderate, middle of the road	304	32.4	32.4	56.8
	Slightly conservative	135	14.4	14.4	71.1
	Conservative	228	24.3	24.3	95.4
	Extremely conservative	43	4.6	4.6	100.0
	Total	939	100.0	100.0	

Are you the person responsible for making most of the decisions about yard maintenance in your home?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	597	63.6	63.6	63.6
	No	34	3.6	3.6	67.2
	Shared decision-making	308	32.8	32.8	100.0
	Total	939	100.0	100.0	

Is the person responsible for making the decisions about yard maintenance in your home available to complete this survey?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	34	3.6	100.0	100.0
Missing	System	905	96.4		
Total		939	100.0		

Are you primarily responsible for making the decisions about yard maintenance in your home?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	34	3.6	100.0	100.0
Missing	System	905	96.4		
Total		939	100.0		

[Mow the lawn]Please indicate who does the following?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	1	.1	.1	.1
	Someone in the household	518	55.2	55.2	55.3
	Professional or other outside the home	396	42.2	42.2	97.4
	Don't do at all	16	1.7	1.7	99.1
	Don't know/Not applicable	8	.9	.9	100.0
	Total	939	100.0	100.0	

[Apply fertilizer to the lawn]Please indicate who does the following?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	4	.4	.4	.4
	Someone in the household	408	43.5	43.5	43.9
	Professional or other outside the home	304	32.4	32.4	76.3
	Don't do at all	204	21.7	21.7	98.0
	Don't know/Not applicable	19	2.0	2.0	100.0
	Total	939	100.0	100.0	

[Apply Weed and Feed, weed killer or herbicide to the lawn]Please indicate who does the following?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	10	1.1	1.1	1.1
	Someone in the household	414	44.1	44.1	45.2
	Professional or other outside the home	302	32.2	32.2	77.3
	Don't do at all	193	20.6	20.6	97.9
	Don't know/Not applicable	20	2.1	2.1	100.0
	Total	939	100.0	100.0	

[Apply pesticides or insect killer to the lawn]Please indicate who does the following?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	10	1.1	1.1	1.1
	Someone in the household	395	42.1	42.1	43.1
	Professional or other outside the home	311	33.1	33.1	76.3
	Don't do at all	200	21.3	21.3	97.6
	Don't know/Not applicable	23	2.4	2.4	100.0
	Total	939	100.0	100.0	

[Tend to garden and flower beds]Please indicate who does the following?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	7	.7	.7	.7
	Someone in the household	745	79.3	79.3	80.1
	Professional or other outside the home	98	10.4	10.4	90.5
	Don't do at all	70	7.5	7.5	98.0
	Don't know/Not applicable	19	2.0	2.0	100.0
	Total	939	100.0	100.0	

[Water the lawn in addition to rainfall events]Please indicate who does the following?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	5	.5	.5	.5
	Someone in the household	701	74.7	74.7	75.2
	Professional or other outside the home	77	8.2	8.2	83.4
	Don't do at all	133	14.2	14.2	97.6
	Don't know/Not applicable	23	2.4	2.4	100.0
	Total	939	100.0	100.0	

How do you decide how much fertilizer to apply to the lawn at one application?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Lawn service	5	.5	1.2	1.2
	Same as previous year (habit)	24	2.6	5.9	7.1
	Store recommendations	23	2.4	5.6	12.7
	Fertilizer bag directions	262	27.9	64.2	77.0
	However much fits in the spreader	3	.3	.7	77.7
	I guess/estimate	33	3.5	8.1	85.8
	IFAS/Other expert advice	5	.5	1.2	87.0
	I calculate the correct application according to my lawn siz	38	4.0	9.3	96.3
	Other	8	.9	2.0	98.3
	Don't know	7	.7	1.7	100.0
	Total	408	43.5	100.0	
Missing	System	531	56.5		
Total		939	100.0		

Q4 other text

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid		931	99.1	99.1	99.1
	don't fertilizer	1	.1	.1	99.3
	fertilize only garden beds according to can directions	1	.1	.1	99.4
	former worker w/company	1	.1	.1	99.5
	I attend meetings of the Agri Exten Service and try to follow his advice	1	.1	.1	99.6
	I fertilze less than bag directions indicate	1	.1	.1	99.7
	I use liquid & instructions on bottle.	1	.1	.1	99.8
	son works in lawn care figures	1	.1	.1	99.9
	use Miracle Grow liquid applicator	1	.1	.1	100.0
	Total	939	100.0	100.0	

[How many bags of fertilizer are applied to the lawn at each application?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	3	.3	.7	.7
	Less than 1/4 bag	28	3.0	6.9	7.6
	About 1/2 bag	72	7.7	17.6	25.2
	Between ½ and 1 bag	64	6.8	15.7	40.9
	1 bag	107	11.4	26.2	67.2
	2 bags	59	6.3	14.5	81.6
	3 bags	9	1.0	2.2	83.8
	4 bags	10	1.1	2.5	86.3
	More than 5 bags	11	1.2	2.7	89.0
	Don't know	45	4.8	11.0	100.0
	Total	408	43.5	100.0	
Missing	System	531	56.5		
Total		939	100.0		

How large are the bags of fertilizer that you purchase for the lawn?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	2	.2	.5	.5
	5 Lbs	34	3.6	8.3	8.8
	10 Lbs	88	9.4	21.6	30.4
	20 Lbs	124	13.2	30.4	60.8
	30 Lbs	33	3.5	8.1	68.9
	40 Lbs	45	4.8	11.0	79.9
	50 Lbs	25	2.7	6.1	86.0
	I don't purchase them.	17	1.8	4.2	90.2
	Don't know	40	4.3	9.8	100.0
	Total	408	43.5	100.0	
Missing	System	531	56.5		
Total		939	100.0		

What are the 3 numbers for the fertilizer used most frequently on your lawn?

	Frequency	Percent	Valid Percent	Cumulative Percent
Missing	812	86.5	86.5	86.5
00-00-06	1	0.1	0.1	86.6
00-00-17	1	0.1	0.1	86.7
03-10-10	1	0.1	0.1	86.8
05-02-00	1	0.1	0.1	86.9
05-10-05	2	0.2	0.2	87.1
06-06-06	20	2.1	2.1	89.2
06-20-20	1	0.1	0.1	89.4
08-00-08	1	0.1	0.1	89.5
08-08-08	3	0.3	0.3	89.8
09-00-24	1	0.1	0.1	89.9
10-10-10	15	1.6	1.6	91.5
10-10-15	1	0.1	0.1	91.6
10-12-15	1	0.1	0.1	91.7
10-20-05	1	0.1	0.1	91.8
12-00-12	1	0.1	0.1	91.9
12-02-14	1	0.1	0.1	92
12-03-18	1	0.1	0.1	92.1
13-13-13	3	0.3	0.3	92.4
14-05-14	1	0.1	0.1	92.5
15-00-04	1	0.1	0.1	92.7
15-00-05	1	0.1	0.1	92.8
15-00-15	4	0.4	0.4	93.2
15-00-30	1	0.1	0.1	93.3
15-06-10	1	0.1	0.1	93.4
15-15-15	1	0.1	0.1	93.5

What are the 3 numbers for the fertilizer used most frequently on your lawn?

	Frequency	Percent	Valid Percent	Cumulative Percent
16-00-04	1	0.1	0.1	93.6
16-04-08	6	0.6	0.6	94.2
16-06-06	1	0.1	0.1	94.4
18-03-16	1	0.1	0.1	94.5
18-10-06	1	0.1	0.1	94.6
20-00-08	1	0.1	0.1	94.7
20-05-20	1	0.1	0.1	94.8
20-06-08	1	0.1	0.1	94.9
20-06-10	1	0.1	0.1	95
20-10-10	2	0.2	0.2	95.2
20-20-20	1	0.1	0.1	95.3
20-40-20	1	0.1	0.1	95.4
21-03-03	1	0.1	0.1	95.5
21-07-14	1	0.1	0.1	95.6
22-00-06	1	0.1	0.1	95.7
24-00-11	1	0.1	0.1	95.8
24-03-10	1	0.1	0.1	96
24-03-12	1	0.1	0.1	96.1
24-08-16	1	0.1	0.1	96.2
25-00-10	1	0.1	0.1	96.3
25-02-15	1	0.1	0.1	96.4
25-03-03	1	0.1	0.1	96.5
25-03-12	4	0.4	0.4	96.9
25-05-15	1	0.1	0.1	97
26-00-08	1	0.1	0.1	97.1
26-02-09	1	0.1	0.1	97.2
26-02-11	1	0.1	0.1	97.3
26-02-13	1	0.1	0.1	97.4

What are the 3 numbers for the fertilizer used most frequently on your lawn?

	Frequency	Percent	Valid Percent	Cumulative Percent
27-03-08	1	0.1	0.1	97.6
27-05-10	1	0.1	0.1	97.7
28-02-10	1	0.1	0.1	97.8
28-12-08	1	0.1	0.1	97.9
29-00-10	1	0.1	0.1	98
29-01-10	9	1	1	98.9
29-03-04	2	0.2	0.2	99.1
30-03-09	1	0.1	0.1	99.3
30-06-25	1	0.1	0.1	99.4
30-10-10	1	0.1	0.1	99.5
30-15-30	1	0.1	0.1	99.6
32-00-04	1	0.1	0.1	99.7
32-00-10	1	0.1	0.1	99.8
36-06-06	1	0.1	0.1	99.9
50-50-25	1	0.1	0.1	100
Total	939	100	100	

[Don't know]What are the3 numbers for the fertilizer used most frequently on your lawn?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	131	14.0	32.1	32.1
	Don't know	277	29.5	67.9	100.0
	Total	408	43.5	100.0	
Missing	System	531	56.5		
Total		939	100.0		

[Schedule]Apply fertilizer to the lawn

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	100	10.6	14.0	14.0
	Regular Schedule	327	34.8	45.9	60.0
	As-needed	285	30.4	40.0	100.0
	Total	712	75.8	100.0	
Missing	System	227	24.2		
Total		939	100.0		

[Schedule]Apply Weed and Feed, weed killer or herbicide to the lawn

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	107	11.4	14.9	14.9
	Regular Schedule	238	25.3	33.2	48.2
	As-needed	371	39.5	51.8	100.0
	Total	716	76.3	100.0	
Missing	System	223	23.7		
Total		939	100.0		

[Schedule]Apply pesticides or insect killer to the lawn

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	119	12.7	16.9	16.9
	Regular Schedule	225	24.0	31.9	48.7
	As-needed	362	38.6	51.3	100.0
	Total	706	75.2	100.0	
Missing	System	233	24.8		
Total		939	100.0		

[Schedule]Tend to garden and flower beds

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	72	7.7	8.5	8.5
	Regular Schedule	180	19.2	21.4	29.9
	As-needed	591	62.9	70.1	100.0
	Total	843	89.8	100.0	
Missing	System	96	10.2		
Total		939	100.0		

[Schedule]Water the lawn in addition to rainfall events

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	74	7.9	9.5	9.5
	Regular Schedule	305	32.5	39.2	48.7
	As-needed	399	42.5	51.3	100.0
	Total	778	82.9	100.0	
Missing	System	161	17.1		
Total		939	100.0		

[Number of times per year]Apply fertilizer to the lawn

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	206	21.9	28.9	28.9
	1	116	12.4	16.3	45.2
	2	170	18.1	23.9	69.1
	3	60	6.4	8.4	77.5
	4	93	9.9	13.1	90.6
	5	8	.9	1.1	91.7
	6	28	3.0	3.9	95.6
	7	1	.1	.1	95.8
	8	9	1.0	1.3	97.1
	9	2	.2	.3	97.3
	10	2	.2	.3	97.6
	11	1	.1	.1	97.8
	12	12	1.3	1.7	99.4
	16	1	.1	.1	99.6
	104	3	.3	.4	100.0
	Total	712	75.8	100.0	
Missing	System	227	24.2		
Total		939	100.0		

[Number of times per year]Apply Weed and Feed, weed killer or herbicide to the lawn

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	266	28.3	37.2	37.2
	1	107	11.4	14.9	52.1
	2	146	15.5	20.4	72.5
	3	48	5.1	6.7	79.2
	4	80	8.5	11.2	90.4
	5	5	.5	.7	91.1
	6	37	3.9	5.2	96.2
	7	1	.1	.1	96.4
	8	5	.5	.7	97.1
	9	2	.2	.3	97.3
	10	3	.3	.4	97.8
	12	15	1.6	2.1	99.9
	350	1	.1	.1	100.0
	Total	716	76.3	100.0	
Missing	System	223	23.7		
Total		939	100.0		

[Number of times per year]Apply pesticides or insect killer to the lawn

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	282	30.0	39.9	39.9
	1	93	9.9	13.2	53.1
	2	124	13.2	17.6	70.7
	3	37	3.9	5.2	75.9
	4	82	8.7	11.6	87.5
	5	10	1.1	1.4	89.0
	6	45	4.8	6.4	95.3
	7	1	.1	.1	95.5
	8	4	.4	.6	96.0
	9	1	.1	.1	96.2
	10	5	.5	.7	96.9
	12	19	2.0	2.7	99.6
	20	1	.1	.1	99.7
	52	1	.1	.1	99.9
	350	1	.1	.1	100.0
	Total	706	75.2	100.0	
Missing	System	233	24.8		
Total		939	100.0		

[Number of times per year]Tend to garden and flower beds

	Frequency	Percent	Valid Percent	Cumulative Percent
Refused	325	34.6	38.6	38.6
1	17	1.8	2	40.6
2	26	2.8	3.1	43.7
3	22	2.3	2.6	46.3
4	56	6	6.6	52.9
5	13	1.4	1.5	54.4
6	50	5.3	5.9	60.4
7	2	0.2	0.2	60.6
8	13	1.4	1.5	62.2
9	1	0.1	0.1	62.3
10	23	2.4	2.7	65
11	1	0.1	0.1	65.1
12	68	7.2	8.1	73.2
13	4	0.4	0.5	73.7
14	1	0.1	0.1	73.8
15	6	0.6	0.7	74.5
20	20	2.1	2.4	76.9
21	1	0.1	0.1	77
22	1	0.1	0.1	77.1
24	18	1.9	2.1	79.2
25	6	0.6	0.7	80
26	11	1.2	1.3	81.3
30	18	1.9	2.1	83.4
32	1	0.1	0.1	83.5
35	2	0.2	0.2	83.7
36	2	0.2	0.2	84

[Number of times per year]Tend to garden and flower beds

	Frequency	Percent	Valid Percent	Cumulative Percent
40	10	1.1	1.2	85.2
45	2	0.2	0.2	85.4
48	3	0.3	0.4	85.8
50	13	1.4	1.5	87.3
52	45	4.8	5.3	92.6
53	1	0.1	0.1	92.8
60	1	0.1	0.1	92.9
65	1	0.1	0.1	93
66	1	0.1	0.1	93.1
75	2	0.2	0.2	93.4
80	2	0.2	0.2	93.6
90	2	0.2	0.2	93.8
100	6	0.6	0.7	94.5
102	1	0.1	0.1	94.7
104	14	1.5	1.7	96.3
125	1	0.1	0.1	96.4
150	3	0.3	0.4	96.8
156	2	0.2	0.2	97
180	1	0.1	0.1	97.2
200	4	0.4	0.5	97.6
208	1	0.1	0.1	97.7
250	3	0.3	0.4	98.1
275	1	0.1	0.1	98.2
300	9	1	1.1	99.3
320	1	0.1	0.1	99.4
352	1	0.1	0.1	99.5
365	4	0.4	0.5	100
Total	843	89.8	100	
System	96	10.2		
	939	100		

[Don’t do] Apply fertilizer to the lawn

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	657	70.0	92.3	92.3
	Don't do	55	5.9	7.7	100.0
	Total	712	75.8	100.0	
Missing	System	227	24.2		
Total		939	100.0		

[Don’t do] Apply Weed and Feed, weed killer or herbicide to the lawn

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	651	69.3	90.9	90.9
	Don't do	65	6.9	9.1	100.0
	Total	716	76.3	100.0	
Missing	System	223	23.7		
Total		939	100.0		

[Don’t do] Apply pesticides or insect killer to the lawn

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	633	67.4	89.7	89.7
	Don't do	73	7.8	10.3	100.0
	Total	706	75.2	100.0	
Missing	System	233	24.8		
Total		939	100.0		

[Don’t do] Tend to garden and flower beds

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	813	86.6	96.4	96.4
	Don't do	30	3.2	3.6	100.0
	Total	843	89.8	100.0	
Missing	System	96	10.2		
Total		939	100.0		

[Don’t do] Water the lawn in addition to rainfall events

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	741	78.9	95.2	95.2
	Don't do	37	3.9	4.8	100.0
	Total	778	82.9	100.0	
Missing	System	161	17.1		
Total		939	100.0		

[Very rewarding] The way my lawn is currently maintained is...

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	7	.7	.7	.7
	Strongly Disagree	28	3.0	3.0	3.7
	Disagree	62	6.6	6.6	10.3
	Somewhat Disagree	100	10.6	10.6	21.0
	Somewhat Agree	247	26.3	26.3	47.3
	Agree	287	30.6	30.6	77.8
	Strongly Agree	167	17.8	17.8	95.6
	Not applicable	35	3.7	3.7	99.4
	Don't Know	6	.6	.6	100.0
	Total	939	100.0	100.0	

[Safe for the environment] The way my lawn is currently maintained is...

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	6	.6	.6	.6
	Strongly Disagree	10	1.1	1.1	1.7
	Disagree	11	1.2	1.2	2.9
	Somewhat Disagree	55	5.9	5.9	8.7
	Somewhat Agree	193	20.6	20.6	29.3
	Agree	397	42.3	42.3	71.6
	Strongly Agree	209	22.3	22.3	93.8
	Not applicable	19	2.0	2.0	95.8
	Don't Know	39	4.2	4.2	100.0
	Total	939	100.0	100.0	

[Safe for animal and human health] The way my lawn is currently maintained is...

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	8	.9	.9	.9
	Strongly Disagree	6	.6	.6	1.5
	Disagree	7	.7	.7	2.2
	Somewhat Disagree	35	3.7	3.7	6.0
	Somewhat Agree	148	15.8	15.8	21.7
	Agree	419	44.6	44.6	66.3
	Strongly Agree	269	28.6	28.6	95.0
	Not applicable	18	1.9	1.9	96.9
	Don't Know	29	3.1	3.1	100.0
	Total	939	100.0	100.0	

[Very inconvenient] The way my lawn is currently maintained is...

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	8	.9	.9	.9
	Strongly Disagree	143	15.2	15.2	16.1
	Disagree	284	30.2	30.2	46.3
	Somewhat Disagree	189	20.1	20.1	66.5
	Somewhat Agree	134	14.3	14.3	80.7
	Agree	91	9.7	9.7	90.4
	Strongly Agree	40	4.3	4.3	94.7
	Not applicable	41	4.4	4.4	99.0
	Don't Know	9	1.0	1.0	100.0
	Total	939	100.0	100.0	

[Important for property values] The way my lawn is currently maintained is...

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	5	.5	.5	.5
	Strongly Disagree	11	1.2	1.2	1.7
	Disagree	12	1.3	1.3	3.0
	Somewhat Disagree	29	3.1	3.1	6.1
	Somewhat Agree	146	15.5	15.5	21.6
	Agree	324	34.5	34.5	56.1
	Strongly Agree	375	39.9	39.9	96.1
	Not applicable	18	1.9	1.9	98.0
	Don't Know	19	2.0	2.0	100.0
	Total	939	100.0	100.0	

[Important to my community] The way my lawn is currently maintained is...

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	8	.9	.9	.9
	Strongly Disagree	14	1.5	1.5	2.3
	Disagree	29	3.1	3.1	5.4
	Somewhat Disagree	57	6.1	6.1	11.5
	Somewhat Agree	190	20.2	20.2	31.7
	Agree	354	37.7	37.7	69.4
	Strongly Agree	238	25.3	25.3	94.8
	Not applicable	30	3.2	3.2	98.0
	Don't Know	19	2.0	2.0	100.0
	Total	939	100.0	100.0	

[Not harmful to water quality] The way my lawn is currently maintained is...

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	5	.5	.5	.5
	Strongly Disagree	7	.7	.7	1.3
	Disagree	18	1.9	1.9	3.2
	Somewhat Disagree	72	7.7	7.7	10.9
	Somewhat Agree	159	16.9	16.9	27.8
	Agree	376	40.0	40.0	67.8
	Strongly Agree	237	25.2	25.2	93.1
	Not applicable	20	2.1	2.1	95.2
	Don't Know	45	4.8	4.8	100.0
	Total	939	100.0	100.0	

[Very inexpensive] The way my lawn is currently maintained is...

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	6	.6	.6	.6
	Strongly Disagree	45	4.8	4.8	5.4
	Disagree	135	14.4	14.4	19.8
	Somewhat Disagree	212	22.6	22.6	42.4
	Somewhat Agree	231	24.6	24.6	67.0
	Agree	213	22.7	22.7	89.7
	Strongly Agree	75	8.0	8.0	97.7
	Not applicable	12	1.3	1.3	98.9
	Don't Know	10	1.1	1.1	100.0
	Total	939	100.0	100.0	

[Difficult to change] The way my lawn is currently maintained is...

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	10	1.1	1.1	1.1
	Strongly Disagree	56	6.0	6.0	7.0
	Disagree	152	16.2	16.2	23.2
	Somewhat Disagree	212	22.6	22.6	45.8
	Somewhat Agree	215	22.9	22.9	68.7
	Agree	147	15.7	15.7	84.3
	Strongly Agree	49	5.2	5.2	89.6
	Not applicable	54	5.8	5.8	95.3
	Don't Know	44	4.7	4.7	100.0
	Total	939	100.0	100.0	

[Very easy] The way my lawn is currently maintained is...

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	12	1.3	1.3	1.3
	Strongly Disagree	29	3.1	3.1	4.4
	Disagree	77	8.2	8.2	12.6
	Somewhat Disagree	167	17.8	17.8	30.4
	Somewhat Agree	286	30.5	30.5	60.8
	Agree	234	24.9	24.9	85.7
	Strongly Agree	99	10.5	10.5	96.3
	Not applicable	22	2.3	2.3	98.6
	Don't Know	13	1.4	1.4	100.0
	Total	939	100.0	100.0	

[Pesticides applied to the lawn can be harmful to pets and animals] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	6	.6	.6	.6
	Strongly Disagree	13	1.4	1.4	2.0
	Disagree	45	4.8	4.8	6.8
	Somewhat Disagree	60	6.4	6.4	13.2
	Somewhat Agree	266	28.3	28.3	41.5
	Agree	285	30.4	30.4	71.9
	Strongly Agree	226	24.1	24.1	96.0
	Not applicable	13	1.4	1.4	97.3
	Don't Know	25	2.7	2.7	100.0
	Total	939	100.0	100.0	

[A homes front yard should be almost entirely grass] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	14	1.5	1.5	1.5
	Strongly Disagree	86	9.2	9.2	10.6
	Disagree	196	20.9	20.9	31.5
	Somewhat Disagree	227	24.2	24.2	55.7
	Somewhat Agree	180	19.2	19.2	74.9
	Agree	144	15.3	15.3	90.2
	Strongly Agree	53	5.6	5.6	95.8
	Not applicable	15	1.6	1.6	97.4
	Don't Know	24	2.6	2.6	100.0
	Total	939	100.0	100.0	

[I enjoy mowing the grass] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	10	1.1	1.1	1.1
	Strongly Disagree	177	18.8	18.8	19.9
	Disagree	143	15.2	15.2	35.1
	Somewhat Disagree	109	11.6	11.6	46.8
	Somewhat Agree	164	17.5	17.5	64.2
	Agree	124	13.2	13.2	77.4
	Strongly Agree	68	7.2	7.2	84.7
	Not applicable	136	14.5	14.5	99.1
	Don't Know	8	.9	.9	100.0
	Total	939	100.0	100.0	

[It doesn't bother me if my grass turns a bit brown in the winter] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	7	.7	.7	.7
	Strongly Disagree	62	6.6	6.6	7.3
	Disagree	99	10.5	10.5	17.9
	Somewhat Disagree	135	14.4	14.4	32.3
	Somewhat Agree	222	23.6	23.6	55.9
	Agree	278	29.6	29.6	85.5
	Strongly Agree	108	11.5	11.5	97.0
	Not applicable	24	2.6	2.6	99.6
	Don't Know	4	.4	.4	100.0
	Total	939	100.0	100.0	

[Most chemicals applied to the lawn are harmful to human health] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	8	.9	.9	.9
	Strongly Disagree	20	2.1	2.1	3.0
	Disagree	85	9.1	9.1	12.0
	Somewhat Disagree	168	17.9	17.9	29.9
	Somewhat Agree	302	32.2	32.2	62.1
	Agree	175	18.6	18.6	80.7
	Strongly Agree	94	10.0	10.0	90.7
	Not applicable	13	1.4	1.4	92.1
	Don't Know	74	7.9	7.9	100.0
	Total	939	100.0	100.0	

[Trying new plants in the yard is pleasurable to me.] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	7	.7	.7	.7
	Strongly Disagree	38	4.0	4.0	4.8
	Disagree	68	7.2	7.2	12.0
	Somewhat Disagree	95	10.1	10.1	22.2
	Somewhat Agree	220	23.4	23.4	45.6
	Agree	285	30.4	30.4	75.9
	Strongly Agree	171	18.2	18.2	94.1
	Not applicable	51	5.4	5.4	99.6
	Don't Know	4	.4	.4	100.0

[Trying new plants in the yard is pleasurable to me.] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	7	.7	.7	.7
	Strongly Disagree	38	4.0	4.0	4.8
	Disagree	68	7.2	7.2	12.0
	Somewhat Disagree	95	10.1	10.1	22.2
	Somewhat Agree	220	23.4	23.4	45.6
	Agree	285	30.4	30.4	75.9
	Strongly Agree	171	18.2	18.2	94.1
	Not applicable	51	5.4	5.4	99.6
	Don't Know	4	.4	.4	100.0
	Total	939	100.0	100.0	

[Having plants other than grass in the yard attracts unwanted wildlife.] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	5	.5	.5	.5
	Strongly Disagree	156	16.6	16.6	17.1
	Disagree	285	30.4	30.4	47.5
	Somewhat Disagree	269	28.6	28.6	76.1
	Somewhat Agree	91	9.7	9.7	85.8
	Agree	41	4.4	4.4	90.2
	Strongly Agree	11	1.2	1.2	91.4
	Not applicable	17	1.8	1.8	93.2
	Don't Know	64	6.8	6.8	100.0
	Total	939	100.0	100.0	

[People can help improve water quality by not applying fertilizer to the lawn] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	9	1.0	1.0	1.0
	Strongly Disagree	23	2.4	2.4	3.4
	Disagree	68	7.2	7.2	10.6
	Somewhat Disagree	161	17.1	17.1	27.8
	Somewhat Agree	261	27.8	27.8	55.6
	Agree	175	18.6	18.6	74.2
	Strongly Agree	109	11.6	11.6	85.8
	Not applicable	15	1.6	1.6	87.4
	Don't Know	118	12.6	12.6	100.0
	Total	939	100.0	100.0	

[I consider any plant other than grass in the lawn to be a weed] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	12	1.3	1.3	1.3
	Strongly Disagree	209	22.3	22.3	23.5
	Disagree	245	26.1	26.1	49.6
	Somewhat Disagree	161	17.1	17.1	66.8
	Somewhat Agree	137	14.6	14.6	81.4
	Agree	120	12.8	12.8	94.1
	Strongly Agree	32	3.4	3.4	97.6
	Not applicable	10	1.1	1.1	98.6
	Don't Know	13	1.4	1.4	100.0
	Total	939	100.0	100.0	

[I enjoy watching the plants in my yard change and cycle throughout the year.] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	11	1.2	1.2	1.2
	Strongly Disagree	9	1.0	1.0	2.1
	Disagree	39	4.2	4.2	6.3
	Somewhat Disagree	60	6.4	6.4	12.7
	Somewhat Agree	227	24.2	24.2	36.8
	Agree	339	36.1	36.1	72.9
	Strongly Agree	212	22.6	22.6	95.5
	Not applicable	34	3.6	3.6	99.1
	Don't Know	8	.9	.9	100.0
	Total	939	100.0	100.0	

[I like working in the garden more than maintaining the lawn] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	8	.9	.9	.9
	Strongly Disagree	48	5.1	5.1	6.0
	Disagree	100	10.6	10.6	16.6
	Somewhat Disagree	152	16.2	16.2	32.8
	Somewhat Agree	192	20.4	20.4	53.2
	Agree	202	21.5	21.5	74.8
	Strongly Agree	136	14.5	14.5	89.2
	Not applicable	91	9.7	9.7	98.9
	Don't Know	10	1.1	1.1	100.0
	Total	939	100.0	100.0	

[I enjoy watching butterflies and birds in my yard.] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	14	1.5	1.5	1.5
	Strongly Disagree	8	.9	.9	2.3
	Disagree	11	1.2	1.2	3.5
	Somewhat Disagree	19	2.0	2.0	5.5
	Somewhat Agree	117	12.5	12.5	18.0
	Agree	307	32.7	32.7	50.7
	Strongly Agree	432	46.0	46.0	96.7
	Not applicable	20	2.1	2.1	98.8
	Don't Know	11	1.2	1.2	100.0
	Total	939	100.0	100.0	

[Trees are not safe to have in my front yard] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	10	1.1	1.1	1.1
	Strongly Disagree	281	29.9	29.9	31.0
	Disagree	351	37.4	37.4	68.4
	Somewhat Disagree	168	17.9	17.9	86.3
	Somewhat Agree	60	6.4	6.4	92.7
	Agree	29	3.1	3.1	95.7
	Strongly Agree	12	1.3	1.3	97.0
	Not applicable	16	1.7	1.7	98.7
	Don't Know	12	1.3	1.3	100.0
	Total	939	100.0	100.0	

[I seek environmentally friendly products to use in my yard] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	11	1.2	1.2	1.2
	Strongly Disagree	12	1.3	1.3	2.4
	Disagree	51	5.4	5.4	7.9
	Somewhat Disagree	88	9.4	9.4	17.3
	Somewhat Agree	314	33.4	33.4	50.7
	Agree	252	26.8	26.8	77.5
	Strongly Agree	124	13.2	13.2	90.7
	Not applicable	58	6.2	6.2	96.9
	Don't Know	29	3.1	3.1	100.0
	Total	939	100.0	100.0	

[Having 50% lawn and 50% plant beds is a good idea for the front yard] Please answer the following questions according to your own personal beliefs.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	9	1.0	1.0	1.0
	Strongly Disagree	21	2.2	2.2	3.2
	Disagree	64	6.8	6.8	10.0
	Somewhat Disagree	170	18.1	18.1	28.1
	Somewhat Agree	309	32.9	32.9	61.0
	Agree	188	20.0	20.0	81.0
	Strongly Agree	63	6.7	6.7	87.8
	Not applicable	35	3.7	3.7	91.5
	Don't Know	80	8.5	8.5	100.0
	Total	939	100.0	100.0	

[Most of my neighbors maintain a green lawn all year round\] The next series of questions is about how your neighbors and community members maintain their yards based on what you see.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	10	1.1	1.1	1.1
	Strongly Disagree	46	4.9	4.9	6.0
	Disagree	144	15.3	15.3	21.3
	Somewhat Disagree	166	17.7	17.7	39.0
	Somewhat Agree	253	26.9	26.9	65.9
	Agree	214	22.8	22.8	88.7
	Strongly Agree	75	8.0	8.0	96.7
	Not applicable	20	2.1	2.1	98.8
	Don't Know	11	1.2	1.2	100.0
	Total	939	100.0	100.0	

[Most of my neighbors hire professionals to maintain their yard] The next series of questions is about how your neighbors and community members maintain their yards based on what you see.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	8	.9	.9	.9
	Strongly Disagree	72	7.7	7.7	8.5
	Disagree	144	15.3	15.3	23.9
	Somewhat Disagree	146	15.5	15.5	39.4
	Somewhat Agree	186	19.8	19.8	59.2
	Agree	226	24.1	24.1	83.3
	Strongly Agree	109	11.6	11.6	94.9
	Not applicable	21	2.2	2.2	97.1
	Don't Know	27	2.9	2.9	100.0
	Total	939	100.0	100.0	

[My neighbors typically maintain a weed-free, green lawn.] The next series of questions is about how your neighbors and community members maintain their yards based on what you see.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	9	1.0	1.0	1.0
	Strongly Disagree	68	7.2	7.2	8.2
	Disagree	152	16.2	16.2	24.4
	Somewhat Disagree	195	20.8	20.8	45.2
	Somewhat Agree	229	24.4	24.4	69.5
	Agree	180	19.2	19.2	88.7
	Strongly Agree	57	6.1	6.1	94.8
	Not applicable	23	2.4	2.4	97.2
	Don't Know	26	2.8	2.8	100.0
	Total	939	100.0	100.0	

[People with the most money have the best lawns.] The next series of questions is about how your neighbors and community members maintain their yards based on what you see.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	7	.7	.7	.7
	Strongly Disagree	50	5.3	5.3	6.1
	Disagree	118	12.6	12.6	18.6
	Somewhat Disagree	168	17.9	17.9	36.5
	Somewhat Agree	224	23.9	23.9	60.4
	Agree	186	19.8	19.8	80.2
	Strongly Agree	134	14.3	14.3	94.5
	Not applicable	18	1.9	1.9	96.4
	Don't Know	34	3.6	3.6	100.0
	Total	939	100.0	100.0	

[Most of my neighbors dont apply chemicals to maintain their yard] The next series of questions is about how your neighbors and community members maintain their yards based on what you see.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	10	1.1	1.1	1.1
	Strongly Disagree	45	4.8	4.8	5.9
	Disagree	181	19.3	19.3	25.1
	Somewhat Disagree	194	20.7	20.7	45.8
	Somewhat Agree	124	13.2	13.2	59.0
	Agree	104	11.1	11.1	70.1
	Strongly Agree	34	3.6	3.6	73.7
	Not applicable	25	2.7	2.7	76.4
	Don't Know	222	23.6	23.6	100.0
	Total	939	100.0	100.0	

[My neighbors would not care if I removed the lawn in the front yard and planted something else] The next series of questions is about how your neighbors and community members maintain their yards based on what you see.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	8	.9	.9	.9
	Strongly Disagree	106	11.3	11.3	12.1
	Disagree	132	14.1	14.1	26.2
	Somewhat Disagree	150	16.0	16.0	42.2
	Somewhat Agree	141	15.0	15.0	57.2
	Agree	182	19.4	19.4	76.6
	Strongly Agree	65	6.9	6.9	83.5
	Not applicable	28	3.0	3.0	86.5
	Don't Know	127	13.5	13.5	100.0
	Total	939	100.0	100.0	

[I would prefer not to use fertilizer on the lawn] These questions are about your own personal beliefs and values and how they affect your landscape maintenance practices.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	8	.9	.9	.9
	Strongly Disagree	33	3.5	3.5	4.4
	Disagree	133	14.2	14.2	18.5
	Somewhat Disagree	185	19.7	19.7	38.2
	Somewhat Agree	257	27.4	27.4	65.6
	Agree	173	18.4	18.4	84.0
	Strongly Agree	99	10.5	10.5	94.6
	Not applicable	25	2.7	2.7	97.2
	Don't Know	26	2.8	2.8	100.0
	Total	939	100.0	100.0	

[I feel obligated to conserve water] These questions are about your own personal beliefs and values and how they affect your landscape maintenance practices.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	11	1.2	1.2	1.2
	Strongly Disagree	10	1.1	1.1	2.2
	Disagree	30	3.2	3.2	5.4
	Somewhat Disagree	58	6.2	6.2	11.6
	Somewhat Agree	265	28.2	28.2	39.8
	Agree	335	35.7	35.7	75.5
	Strongly Agree	219	23.3	23.3	98.8
	Not applicable	9	1.0	1.0	99.8
	Don't Know	2	.2	.2	100.0
	Total	939	100.0	100.0	

[I feel obligated to maintain a green weed-free lawn] These questions are about your own personal beliefs and values and how they affect your landscape maintenance practices.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	10	1.1	1.1	1.1
	Strongly Disagree	58	6.2	6.2	7.2
	Disagree	138	14.7	14.7	21.9
	Somewhat Disagree	173	18.4	18.4	40.4
	Somewhat Agree	265	28.2	28.2	68.6
	Agree	194	20.7	20.7	89.2
	Strongly Agree	72	7.7	7.7	96.9
	Not applicable	24	2.6	2.6	99.5
	Don't Know	5	.5	.5	100.0
	Total	939	100.0	100.0	

[I would rather not apply chemical pesticides to the lawn] These questions are about your own personal beliefs and values and how they affect your landscape maintenance practices.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	11	1.2	1.2	1.2
	Strongly Disagree	16	1.7	1.7	2.9
	Disagree	42	4.5	4.5	7.3
	Somewhat Disagree	125	13.3	13.3	20.7
	Somewhat Agree	267	28.4	28.4	49.1
	Agree	257	27.4	27.4	76.5
	Strongly Agree	182	19.4	19.4	95.8
	Not applicable	20	2.1	2.1	98.0
	Don't Know	19	2.0	2.0	100.0
	Total	939	100.0	100.0	

[I wish I could remove more of the lawn in my front yard and plant something else] These questions are about your own personal beliefs and values and how they affect your landscape maintenance practices.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	11	1.2	1.2	1.2
	Strongly Disagree	111	11.8	11.8	13.0
	Disagree	227	24.2	24.2	37.2
	Somewhat Disagree	205	21.8	21.8	59.0
	Somewhat Agree	138	14.7	14.7	73.7
	Agree	94	10.0	10.0	83.7
	Strongly Agree	65	6.9	6.9	90.6
	Not applicable	52	5.5	5.5	96.2
	Don't Know	36	3.8	3.8	100.0
	Total	939	100.0	100.0	

[I would like to reduce the amount of water used on the lawn] These questions are about your own personal beliefs and values and how they affect your landscape maintenance practices.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	14	1.5	1.5	1.5
	Strongly Disagree	18	1.9	1.9	3.4
	Disagree	65	6.9	6.9	10.3
	Somewhat Disagree	97	10.3	10.3	20.7
	Somewhat Agree	272	29.0	29.0	49.6
	Agree	264	28.1	28.1	77.7
	Strongly Agree	124	13.2	13.2	90.9
	Not applicable	79	8.4	8.4	99.4
	Don't Know	6	.6	.6	100.0
	Total	939	100.0	100.0	

[I wish I didn’t have to spend so much time maintaining the yard] These questions are about your own personal beliefs and values and how they affect your landscape maintenance practices.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	12	1.3	1.3	1.3
	Strongly Disagree	28	3.0	3.0	4.3
	Disagree	111	11.8	11.8	16.1
	Somewhat Disagree	178	19.0	19.0	35.0
	Somewhat Agree	261	27.8	27.8	62.8
	Agree	164	17.5	17.5	80.3
	Strongly Agree	84	8.9	8.9	89.2
	Not applicable	94	10.0	10.0	99.3
	Don't Know	7	.7	.7	100.0
	Total	939	100.0	100.0	

[I would have a hard time changing the way I currently maintain my front yard] These questions are about your own personal beliefs and values and how they affect your landscape maintenance practices.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	16	1.7	1.7	1.7
	Strongly Disagree	37	3.9	3.9	5.6
	Disagree	125	13.3	13.3	19.0
	Somewhat Disagree	176	18.7	18.7	37.7
	Somewhat Agree	225	24.0	24.0	61.7
	Agree	219	23.3	23.3	85.0
	Strongly Agree	75	8.0	8.0	93.0
	Not applicable	52	5.5	5.5	98.5
	Don't Know	14	1.5	1.5	100.0
	Total	939	100.0	100.0	

[Sometimes I wonder whether applying chemicals to the lawn is harmful] These questions are about your own personal beliefs and values and how they affect your landscape maintenance practices.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	11	1.2	1.2	1.2
	Strongly Disagree	33	3.5	3.5	4.7
	Disagree	94	10.0	10.0	14.7
	Somewhat Disagree	139	14.8	14.8	29.5
	Somewhat Agree	251	26.7	26.7	56.2
	Agree	215	22.9	22.9	79.1
	Strongly Agree	97	10.3	10.3	89.5
	Not applicable	70	7.5	7.5	96.9
	Don't Know	29	3.1	3.1	100.0
	Total	939	100.0	100.0	

[If I knew it were harmful to the environment, I would stop applying fertilizer to the lawn] These questions are about your own personal beliefs and values and how they affect your landscape maintenance practices.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	11	1.2	1.2	1.2
	Strongly Disagree	10	1.1	1.1	2.2
	Disagree	35	3.7	3.7	6.0
	Somewhat Disagree	125	13.3	13.3	19.3
	Somewhat Agree	258	27.5	27.5	46.8
	Agree	230	24.5	24.5	71.2
	Strongly Agree	139	14.8	14.8	86.0
	Not applicable	100	10.6	10.6	96.7
	Don't Know	31	3.3	3.3	100.0
	Total	939	100.0	100.0	

Please check one of the followings statements that best represents your homes environmentally-friendly landscaping practices

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	14	1.5	1.5	1.5
	I currently practice environmentally-friendly landscaping to	287	30.6	30.6	32.1
	I don't intend to ever change anything about the way I maint	290	30.9	30.9	62.9
	I intend to do more environmentally-friendly landscaping pra	348	37.1	37.1	100.0
	Total	939	100.0	100.0	

[Apply lawn fertilizer less frequently] How likely are you to do the following practices in the next year?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	1	.1	.3	.3
	Very Unlikely	4	.4	1.1	1.4
	Unlikely	26	2.8	7.5	8.9
	Somewhat Unlikely	60	6.4	17.2	26.1
	Somewhat Likely	110	11.7	31.6	57.8
	Likely	70	7.5	20.1	77.9
	Very Likely	35	3.7	10.1	87.9
	Not applicable	42	4.5	12.1	100.0
	Total	348	37.1	100.0	
Missing	System	591	62.9		
Total		939	100.0		

[Apply weed killer less frequently to the lawn] How likely are you to do the following practices in the next year?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	5	.5	1.4	1.4
	Very Unlikely	3	.3	.9	2.3
	Unlikely	31	3.3	8.9	11.2
	Somewhat Unlikely	55	5.9	15.8	27.0
	Somewhat Likely	102	10.9	29.3	56.3
	Likely	67	7.1	19.3	75.6
	Very Likely	43	4.6	12.4	87.9
	Not applicable	42	4.5	12.1	100.0
	Total	348	37.1	100.0	
Missing	System	591	62.9		
Total		939	100.0		

[Apply pesticides less frequently to the lawn] How likely are you to do the following practices in the next year?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	4	.4	1.1	1.1
	Very Unlikely	3	.3	.9	2.0
	Unlikely	32	3.4	9.2	11.2
	Somewhat Unlikely	64	6.8	18.4	29.6
	Somewhat Likely	87	9.3	25.0	54.6
	Likely	65	6.9	18.7	73.3
	Very Likely	45	4.8	12.9	86.2
	Not applicable	48	5.1	13.8	100.0
	Total	348	37.1	100.0	
Missing	System	591	62.9		
Total		939	100.0		

[Apply water less frequently to the lawn] How likely are you to do the following practices in the next year?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	5	.5	1.4	1.4
	Very Unlikely	9	1.0	2.6	4.0
	Unlikely	35	3.7	10.1	14.1
	Somewhat Unlikely	89	9.5	25.6	39.7
	Somewhat Likely	93	9.9	26.7	66.4
	Likely	68	7.2	19.5	85.9
	Very Likely	27	2.9	7.8	93.7
	Not applicable	22	2.3	6.3	100.0
	Total	348	37.1	100.0	
Missing	System	591	62.9		
Total		939	100.0		

[Remove more turf grass areas in the yard and install larger plant beds or trees] How likely are you to do the following practices in the next year?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	1	.1	.3	.3
	Very Unlikely	24	2.6	6.9	7.2
	Unlikely	59	6.3	17.0	24.1
	Somewhat Unlikely	83	8.8	23.9	48.0
	Somewhat Likely	92	9.8	26.4	74.4
	Likely	47	5.0	13.5	87.9
	Very Likely	27	2.9	7.8	95.7
	Not applicable	15	1.6	4.3	100.0
	Total	348	37.1	100.0	
Missing	System	591	62.9		
Total		939	100.0		

[Plant more native plants or butterfly plants in existing plant beds] How likely are you to do the following practices in the next year?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	2	.2	.6	.6
	Very Unlikely	2	.2	.6	1.1
	Unlikely	25	2.7	7.2	8.3
	Somewhat Unlikely	33	3.5	9.5	17.8
	Somewhat Likely	129	13.7	37.1	54.9
	Likely	88	9.4	25.3	80.2
	Very Likely	57	6.1	16.4	96.6
	Not applicable	12	1.3	3.4	100.0
	Total	348	37.1	100.0	
Missing	System	591	62.9		
Total		939	100.0		

[Be easy to design it] If I or someone else wanted to have a more environmentally –friendly landscape yard, I believe it would…

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	9	1.0	1.0	1.0
	Strongly Disagree	16	1.7	1.7	2.7
	Disagree	91	9.7	9.7	12.4
	Somewhat Disagree	191	20.3	20.3	32.7
	Somewhat Agree	222	23.6	23.6	56.3
	Agree	234	24.9	24.9	81.3
	Strongly Agree	66	7.0	7.0	88.3
	Not applicable	20	2.1	2.1	90.4
	Don't Know	90	9.6	9.6	100.0
	Total	939	100.0	100.0	

[Be easy to decide what plants to use] If I or someone else wanted to have a more environmentally –friendly landscape yard, I believe it would…

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	9	1.0	1.0	1.0
	Strongly Disagree	20	2.1	2.1	3.1
	Disagree	83	8.8	8.8	11.9
	Somewhat Disagree	222	23.6	23.6	35.6
	Somewhat Agree	232	24.7	24.7	60.3
	Agree	223	23.7	23.7	84.0
	Strongly Agree	56	6.0	6.0	90.0
	Not applicable	17	1.8	1.8	91.8
	Don't Know	77	8.2	8.2	100.0
	Total	939	100.0	100.0	

[Cost a lot of money to install] If I or someone else wanted to have a more environmentally –friendly landscape yard, I believe it would…

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	8	.9	.9	.9
	Strongly Disagree	15	1.6	1.6	2.4
	Disagree	47	5.0	5.0	7.5
	Somewhat Disagree	135	14.4	14.4	21.8
	Somewhat Agree	243	25.9	25.9	47.7
	Agree	249	26.5	26.5	74.2
	Strongly Agree	155	16.5	16.5	90.7
	Not applicable	19	2.0	2.0	92.8
	Don't Know	68	7.2	7.2	100.0
	Total	939	100.0	100.0	

[Be easy maintain] If I or someone else wanted to have a more environmentally – friendly landscape yard, I believe it would…

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	10	1.1	1.1	1.1
	Strongly Disagree	15	1.6	1.6	2.7
	Disagree	44	4.7	4.7	7.3
	Somewhat Disagree	106	11.3	11.3	18.6
	Somewhat Agree	261	27.8	27.8	46.4
	Agree	297	31.6	31.6	78.1
	Strongly Agree	107	11.4	11.4	89.5
	Not applicable	19	2.0	2.0	91.5
	Don't Know	80	8.5	8.5	100.0
	Total	939	100.0	100.0	

[Be easy to resell the property] If I or someone else wanted to have a more environmentally –friendly landscape yard, I believe it would…

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	8	.9	.9	.9
	Strongly Disagree	15	1.6	1.6	2.4
	Disagree	34	3.6	3.6	6.1
	Somewhat Disagree	106	11.3	11.3	17.4
	Somewhat Agree	268	28.5	28.5	45.9
	Agree	279	29.7	29.7	75.6
	Strongly Agree	82	8.7	8.7	84.3
	Not applicable	25	2.7	2.7	87.0
	Don't Know	122	13.0	13.0	100.0
	Total	939	100.0	100.0	

[Be very rewarding] If I or someone else wanted to have a more environmentally –friendly landscape yard, I believe it would…

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	9	1.0	1.0	1.0
	Strongly Disagree	8	.9	.9	1.8
	Disagree	20	2.1	2.1	3.9
	Somewhat Disagree	59	6.3	6.3	10.2
	Somewhat Agree	248	26.4	26.4	36.6
	Agree	340	36.2	36.2	72.8
	Strongly Agree	163	17.4	17.4	90.2
	Not applicable	22	2.3	2.3	92.5
	Don't Know	70	7.5	7.5	100.0
	Total	939	100.0	100.0	

[Be difficult to find native plants] If I or someone else wanted to have a more environmentally –friendly landscape yard, I believe it would…

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	10	1.1	1.1	1.1
	Strongly Disagree	71	7.6	7.6	8.6
	Disagree	209	22.3	22.3	30.9
	Somewhat Disagree	297	31.6	31.6	62.5
	Somewhat Agree	137	14.6	14.6	77.1
	Agree	71	7.6	7.6	84.7
	Strongly Agree	28	3.0	3.0	87.6
	Not applicable	20	2.1	2.1	89.8
	Don't Know	96	10.2	10.2	100.0
	Total	939	100.0	100.0	

[Be easy to find someone to help] If I or someone else wanted to have a more environmentally –friendly landscape yard, I believe it would…

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	11	1.2	1.2	1.2
	Strongly Disagree	48	5.1	5.1	6.3
	Disagree	101	10.8	10.8	17.0
	Somewhat Disagree	176	18.7	18.7	35.8
	Somewhat Agree	209	22.3	22.3	58.0
	Agree	197	21.0	21.0	79.0
	Strongly Agree	81	8.6	8.6	87.6
	Not applicable	26	2.8	2.8	90.4
	Don't Know	90	9.6	9.6	100.0
	Total	939	100.0	100.0	

[Be a fun project] If I or someone else wanted to have a more environmentally –friendly landscape yard, I believe it would…

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	19	2.0	2.0	2.0
	Strongly Disagree	37	3.9	3.9	6.0
	Disagree	70	7.5	7.5	13.4
	Somewhat Disagree	120	12.8	12.8	26.2
	Somewhat Agree	228	24.3	24.3	50.5
	Agree	258	27.5	27.5	78.0
	Strongly Agree	122	13.0	13.0	90.9
	Not applicable	26	2.8	2.8	93.7
	Don't Know	59	6.3	6.3	100.0
	Total	939	100.0	100.0	

How long have you lived in Florida?

	Frequency	Percent	Valid Percent	Cumulative Percent
Refused	2	0.2	0.2	0.2
1	8	0.9	0.9	1.1
2	5	0.5	0.5	1.6
3	9	1	1	2.6
4	10	1.1	1.1	3.6
5	13	1.4	1.4	5
6	24	2.6	2.6	7.6
7	32	3.4	3.4	11
8	37	3.9	3.9	14.9
9	16	1.7	1.7	16.6
10	39	4.2	4.2	20.8
11	30	3.2	3.2	24
12	21	2.2	2.2	26.2
13	10	1.1	1.1	27.3
14	16	1.7	1.7	29
15	21	2.2	2.2	31.2
16	21	2.2	2.2	33.4
17	11	1.2	1.2	34.6
18	12	1.3	1.3	35.9
19	14	1.5	1.5	37.4
20	36	3.8	3.8	41.2
21	16	1.7	1.7	42.9
22	24	2.6	2.6	45.5
23	21	2.2	2.2	47.7
24	20	2.1	2.1	49.8
25	28	3	3	52.8

How long have you lived in Florida?

	Frequency	Percent	Valid Percent	Cumulative Percent
26	19	2	2	54.8
27	16	1.7	1.7	56.5
28	10	1.1	1.1	57.6
29	8	0.9	0.9	58.5
30	22	2.3	2.3	60.8
31	12	1.3	1.3	62.1
32	11	1.2	1.2	63.3
33	13	1.4	1.4	64.6
34	13	1.4	1.4	66
35	23	2.4	2.4	68.5
36	11	1.2	1.2	69.6
37	8	0.9	0.9	70.5
38	12	1.3	1.3	71.8
39	9	1	1	72.7
40	25	2.7	2.7	75.4
41	11	1.2	1.2	76.6
42	14	1.5	1.5	78.1
43	8	0.9	0.9	78.9
44	8	0.9	0.9	79.8
45	19	2	2	81.8
46	4	0.4	0.4	82.2
47	7	0.7	0.7	83
48	10	1.1	1.1	84
49	10	1.1	1.1	85.1
50	21	2.2	2.2	87.3

How long have you lived in Florida?

	Frequency	Percent	Valid Percent	Cumulative Percent
51	6	0.6	0.6	88
52	6	0.6	0.6	88.6
53	4	0.4	0.4	89
54	5	0.5	0.5	89.6
55	8	0.9	0.9	90.4
56	5	0.5	0.5	90.9
57	9	1	1	91.9
58	8	0.9	0.9	92.8
59	8	0.9	0.9	93.6
60	12	1.3	1.3	94.9
61	5	0.5	0.5	95.4
62	6	0.6	0.6	96.1
63	2	0.2	0.2	96.3
64	3	0.3	0.3	96.6
65	7	0.7	0.7	97.3
66	3	0.3	0.3	97.7
67	1	0.1	0.1	97.8
68	1	0.1	0.1	97.9
69	1	0.1	0.1	98
70	5	0.5	0.5	98.5
71	1	0.1	0.1	98.6
72	1	0.1	0.1	98.7
74	2	0.2	0.2	98.9
76	3	0.3	0.3	99.3
77	2	0.2	0.2	99.5
78	1	0.1	0.1	99.6
79	1	0.1	0.1	99.7
80	1	0.1	0.1	99.8
81	1	0.1	0.1	99.9
82	1	0.1	0.1	100
Total	939	100	100	

How many months a year do you live in Florida?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	7	.7	.7	.7
	1	3	.3	.3	1.1
	4	2	.2	.2	1.3
	5	1	.1	.1	1.4
	6	7	.7	.7	2.1
	7	9	1.0	1.0	3.1
	8	3	.3	.3	3.4
	9	7	.7	.7	4.2
	10	13	1.4	1.4	5.5
	11	14	1.5	1.5	7.0
	12	873	93.0	93.0	100.0
	Total	939	100.0	100.0	

What year was your house built?

	Frequency	Percent	Valid Percent	Cumulative Percent
Refused	17	1.8	1.8	1.8
1875	1	0.1	0.1	1.9
1918	1	0.1	0.1	2
1920	3	0.3	0.3	2.3
1921	1	0.1	0.1	2.4
1922	1	0.1	0.1	2.6
1923	2	0.2	0.2	2.8
1924	1	0.1	0.1	2.9
1925	1	0.1	0.1	3
1926	3	0.3	0.3	3.3
1928	2	0.2	0.2	3.5
1930	2	0.2	0.2	3.7
1932	1	0.1	0.1	3.8
1934	1	0.1	0.1	3.9
1936	2	0.2	0.2	4.2
1938	1	0.1	0.1	4.3
1940	4	0.4	0.4	4.7
1941	2	0.2	0.2	4.9
1942	1	0.1	0.1	5
1947	2	0.2	0.2	5.2
1948	1	0.1	0.1	5.3
1949	2	0.2	0.2	5.5
1950	8	0.9	0.9	6.4
1951	5	0.5	0.5	6.9
1952	10	1.1	1.1	8
1953	2	0.2	0.2	8.2

What year was your house built?

	Frequency	Percent	Valid Percent	Cumulative Percent
1954	9	1	1	9.2
1955	11	1.2	1.2	10.3
1956	11	1.2	1.2	11.5
1957	6	0.6	0.6	12.1
1958	8	0.9	0.9	13
1959	9	1	1	14
1960	13	1.4	1.4	15.3
1961	10	1.1	1.1	16.4
1962	4	0.4	0.4	16.8
1963	8	0.9	0.9	17.7
1964	14	1.5	1.5	19.2
1965	9	1	1	20.1
1967	7	0.7	0.7	20.9
1968	12	1.3	1.3	22.2
1969	6	0.6	0.6	22.8
1970	11	1.2	1.2	24
1971	10	1.1	1.1	25
1972	14	1.5	1.5	26.5
1973	12	1.3	1.3	27.8
1974	14	1.5	1.5	29.3
1975	14	1.5	1.5	30.8
1976	11	1.2	1.2	31.9
1977	9	1	1	32.9
1978	28	3	3	35.9
1979	13	1.4	1.4	37.3
1980	25	2.7	2.7	39.9
1981	8	0.9	0.9	40.8
1982	22	2.3	2.3	43.1

What year was your house built?

	Frequency	Percent	Valid Percent	Cumulative Percent
1983	11	1.2	1.2	44.3
1984	27	2.9	2.9	47.2
1985	25	2.7	2.7	49.8
1986	23	2.4	2.4	52.3
1987	13	1.4	1.4	53.7
1988	19	2	2	55.7
1989	24	2.6	2.6	58.3
1990	22	2.3	2.3	60.6
1991	15	1.6	1.6	62.2
1992	11	1.2	1.2	63.4
1993	24	2.6	2.6	65.9
1994	16	1.7	1.7	67.6
1995	16	1.7	1.7	69.3
1996	24	2.6	2.6	71.9
1997	14	1.5	1.5	73.4
1998	22	2.3	2.3	75.7
1999	20	2.1	2.1	77.8
2000	34	3.6	3.6	81.5
2001	26	2.8	2.8	84.2
2002	26	2.8	2.8	87
2003	20	2.1	2.1	89.1
2004	27	2.9	2.9	92
2005	31	3.3	3.3	95.3
2006	23	2.4	2.4	97.8
2007	7	0.7	0.7	98.5
2008	6	0.6	0.6	99.1
2009	5	0.5	0.5	99.7
2010	3	0.3	0.3	100
Total	939	100	100	

How long have you lived in the house?

	Frequency	Percent	Valid Percent	Cumulative Percent
Refused	2	0.2	0.2	0.2
1	30	3.2	3.2	3.4
2	21	2.2	2.2	5.6
3	31	3.3	3.3	8.9
4	29	3.1	3.1	12
5	56	6	6	18
6	46	4.9	4.9	22.9
7	63	6.7	6.7	29.6
8	55	5.9	5.9	35.5
9	41	4.4	4.4	39.8
10	58	6.2	6.2	46
11	54	5.8	5.8	51.8
12	31	3.3	3.3	55.1
13	32	3.4	3.4	58.5
14	23	2.4	2.4	60.9
15	34	3.6	3.6	64.5
16	28	3	3	67.5
17	23	2.4	2.4	70
18	23	2.4	2.4	72.4
19	11	1.2	1.2	73.6
20	35	3.7	3.7	77.3
21	15	1.6	1.6	78.9
22	24	2.6	2.6	81.5
23	14	1.5	1.5	83
24	10	1.1	1.1	84
25	27	2.9	2.9	86.9
26	14	1.5	1.5	88.4
27	9	1	1	89.4
28	4	0.4	0.4	89.8
29	6	0.6	0.6	90.4
30	8	0.9	0.9	91.3
31	9	1	1	92.2
32	8	0.9	0.9	93.1

How long have you lived in the house?

	Frequency	Percent	Valid Percent	Cumulative Percent
33	2	0.2	0.2	93.3
34	4	0.4	0.4	93.7
35	7	0.7	0.7	94.5
36	6	0.6	0.6	95.1
37	5	0.5	0.5	95.6
38	4	0.4	0.4	96.1
39	1	0.1	0.1	96.2
40	11	1.2	1.2	97.3
41	2	0.2	0.2	97.6
42	1	0.1	0.1	97.7
43	2	0.2	0.2	97.9
44	2	0.2	0.2	98.1
45	2	0.2	0.2	98.3
46	3	0.3	0.3	98.6
50	3	0.3	0.3	98.9
51	1	0.1	0.1	99
52	1	0.1	0.1	99.1
53	1	0.1	0.1	99.3
54	1	0.1	0.1	99.4
55	2	0.2	0.2	99.6
56	1	0.1	0.1	99.7
57	1	0.1	0.1	99.8
58	1	0.1	0.1	99.9
60	1	0.1	0.1	100
Total	939	100	100	

How big is your homes property (how many acres or part of an acre)?				
	Frequency	Percent	Valid Percent	Cumulative Percent
Refused	485	51.7	51.7	51.7
0.0167	1	0.1	0.1	51.8
0.05	5	0.5	0.5	52.3
0.1	7	0.7	0.7	53
0.12	4	0.4	0.4	53.5
0.125	3	0.3	0.3	53.8
0.14	1	0.1	0.1	53.9
0.15	1	0.1	0.1	54
0.16	1	0.1	0.1	54.1
0.17	2	0.2	0.2	54.3
0.18	1	0.1	0.1	54.4
0.2	10	1.1	1.1	55.5
0.23	1	0.1	0.1	55.6
0.25	106	11.3	11.3	66.9
0.258	1	0.1	0.1	67
0.26	1	0.1	0.1	67.1
0.277	1	0.1	0.1	67.2
0.3	17	1.8	1.8	69
0.33	13	1.4	1.4	70.4
0.3333	1	0.1	0.1	70.5
0.35	5	0.5	0.5	71
0.38	1	0.1	0.1	71.1
0.4	7	0.7	0.7	71.9
0.41	1	0.1	0.1	72
0.45	1	0.1	0.1	72.1
0.5	61	6.5	6.5	78.6

How big is your homes property (how many acres or part of an acre)?				
	Frequency	Percent	Valid Percent	Cumulative Percent
0.55	1	0.1	0.1	78.7
0.56	1	0.1	0.1	78.8
0.6	2	0.2	0.2	79
0.63	1	0.1	0.1	79.1
0.65	2	0.2	0.2	79.3
0.67	1	0.1	0.1	79.4
0.75	10	1.1	1.1	80.5
0.85	2	0.2	0.2	80.7
1	97	10.3	10.3	91.1
1.06	1	0.1	0.1	91.2
1.1	1	0.1	0.1	91.3
1.2	3	0.3	0.3	91.6
1.25	2	0.2	0.2	91.8
1.3	1	0.1	0.1	91.9
1.5	10	1.1	1.1	93
1.6	1	0.1	0.1	93.1
1.75	3	0.3	0.3	93.4
2	12	1.3	1.3	94.7
2.42	1	0.1	0.1	94.8
2.5	4	0.4	0.4	95.2
3	5	0.5	0.5	95.7
3.5	1	0.1	0.1	95.8
3.6	1	0.1	0.1	96
4	8	0.9	0.9	96.8
5	13	1.4	1.4	98.2
5.2	1	0.1	0.1	98.3
6	3	0.3	0.3	98.6
7	1	0.1	0.1	98.7
8.25	1	0.1	0.1	98.8
9	1	0.1	0.1	98.9
10	10	1.1	1.1	100
Total	939	100	100	

[Not sure]How big is your homes property (how many acres or part of an acre)?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	457	48.7	48.7	48.7
	I am not sure	482	51.3	51.3	100.0
	Total	939	100.0	100.0	

Do you live in a neighborhood governed by a homeowners association?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	1	.1	.1	.1
	Yes	441	47.0	47.0	47.1
	No	485	51.7	51.7	98.7
	Don't Know	12	1.3	1.3	100.0
	Total	939	100.0	100.0	

How actively does your HOA enforce landscaping rules?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	3	.3	.7	.7
	Very active	178	19.0	40.4	41.0
	Somewhat active	148	15.8	33.6	74.6
	Somewhat inactive	39	4.2	8.8	83.4
	Very inactive	54	5.8	12.2	95.7
	Don't know, never really thought about it	19	2.0	4.3	100.0
	Total	441	47.0	100.0	
Missing	System	498	53.0		
Total		939	100.0		

To what extent were environmental or ecological topics covered in your educational experience?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Refused	5	.5	.5	.5
	Not at all	337	35.9	35.9	36.4
	A little	283	30.1	30.1	66.6
	Somewhat	207	22.0	22.0	88.6
	Quite a lot	77	8.2	8.2	96.8
	Very much	30	3.2	3.2	100.0
	Total	939	100.0	100.0	

Age

	Frequency	Percent	Valid Percent	Cumulative Percent
19	1	0.1	0.1	0.1
20	1	0.1	0.1	0.2
21	4	0.4	0.4	0.6
22	2	0.2	0.2	0.9
23	3	0.3	0.3	1.2
24	3	0.3	0.3	1.5
25	4	0.4	0.4	1.9
26	2	0.2	0.2	2.1
27	2	0.2	0.2	2.3
28	3	0.3	0.3	2.7
29	3	0.3	0.3	3
30	4	0.4	0.4	3.4
31	6	0.6	0.6	4
32	5	0.5	0.5	4.6
33	5	0.5	0.5	5.1
34	7	0.7	0.7	5.9
35	3	0.3	0.3	6.2
36	7	0.7	0.7	6.9
37	8	0.9	0.9	7.8
38	6	0.6	0.6	8.4
39	12	1.3	1.3	9.7
40	9	1	1	10.6
41	14	1.5	1.5	12.1
42	10	1.1	1.1	13.2
43	9	1	1	14.2
44	14	1.5	1.5	15.7
45	11	1.2	1.2	16.8
46	16	1.7	1.7	18.5
47	14	1.5	1.5	20
48	19	2	2	22
49	27	2.9	2.9	24.9
50	21	2.2	2.2	27.2
51	21	2.2	2.2	29.4
52	24	2.6	2.6	31.9

Age

	Frequency	Percent	Valid Percent	Cumulative Percent
53	23	2.4	2.4	34.4
54	18	1.9	1.9	36.3
55	20	2.1	2.1	38.4
56	31	3.3	3.3	41.7
57	30	3.2	3.2	44.9
58	22	2.3	2.3	47.3
59	27	2.9	2.9	50.2
60	32	3.4	3.4	53.6
61	26	2.8	2.8	56.3
62	24	2.6	2.6	58.9
63	29	3.1	3.1	62
64	32	3.4	3.4	65.4
65	33	3.5	3.5	68.9
66	19	2	2	70.9
67	28	3	3	73.9
68	25	2.7	2.7	76.6
69	29	3.1	3.1	79.7
70	27	2.9	2.9	82.5
71	14	1.5	1.5	84
72	17	1.8	1.8	85.8
73	12	1.3	1.3	87.1
74	14	1.5	1.5	88.6
75	20	2.1	2.1	90.7
76	20	2.1	2.1	92.9
77	16	1.7	1.7	94.6
78	4	0.4	0.4	95
79	9	1	1	96
80	9	1	1	96.9
81	6	0.6	0.6	97.6
82	7	0.7	0.7	98.3
83	1	0.1	0.1	98.4
84	7	0.7	0.7	99.1
85	3	0.3	0.3	99.5
86	2	0.2	0.2	99.7
87	1	0.1	0.1	99.8
91	1	0.1	0.1	99.9
93	1	0.1	0.1	100
Total	939	100	100	

Age - 7 Categories

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-24	14	1.5	1.5	1.5
	25-34	41	4.4	4.4	5.9
	35-44	92	9.8	9.8	15.7
	45-54	194	20.7	20.7	36.3
	55-64	273	29.1	29.1	65.4
	65-74	218	23.2	23.2	88.6
	75+	107	11.4	11.4	100.0
	Total	939	100.0	100.0	

Age - 4 Categories

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-29	28	3.0	3.0	3.0
	30-44	119	12.7	12.7	15.7
	45-59	324	34.5	34.5	50.2
	60+	468	49.8	49.8	100.0
	Total	939	100.0	100.0	

Education (Highest Degree Received)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1st, 2nd, 3rd, or 4th grade	1	.1	.1	.1
	5th or 6th grade	1	.1	.1	.2
	7th or 8th grade	4	.4	.4	.6
	9th grade	2	.2	.2	.9
	10th grade	5	.5	.5	1.4
	11th grade	2	.2	.2	1.6
	12th grade NO DIPLOMA	10	1.1	1.1	2.7
	HIGH SCHOOL GRADUATE - high school DIPLOMA or the equivalent	150	16.0	16.0	18.6
	Some college, no degree	247	26.3	26.3	44.9
	Associate degree	122	13.0	13.0	57.9
	Bachelors degree	230	24.5	24.5	82.4
	Masters degree	117	12.5	12.5	94.9
	Professional or Doctorate degree	48	5.1	5.1	100.0
	Total	939	100.0	100.0	

Education (Categorical)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than high school	25	2.7	2.7	2.7
	High school	150	16.0	16.0	18.6
	Some college	369	39.3	39.3	57.9
	Bachelor's degree or higher	395	42.1	42.1	100.0
	Total	939	100.0	100.0	

Race / Ethnicity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	White, Non-Hispanic	763	81.3	81.3	81.3
	Black, Non-Hispanic	27	2.9	2.9	84.1
	Other, Non-Hispanic	12	1.3	1.3	85.4
	Hispanic	116	12.4	12.4	97.8
	2+ Races, Non-Hispanic	21	2.2	2.2	100.0
	Total	939	100.0	100.0	

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	398	42.4	42.4	42.4
	Female	541	57.6	57.6	100.0
	Total	939	100.0	100.0	

Household Head

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	68	7.2	7.2	7.2
	Yes	871	92.8	92.8	100.0
	Total	939	100.0	100.0	

Household Size

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	163	17.4	17.4	17.4
	2	487	51.9	51.9	69.2
	3	134	14.3	14.3	83.5
	4	90	9.6	9.6	93.1
	5	36	3.8	3.8	96.9
	6	22	2.3	2.3	99.3
	7	4	.4	.4	99.7
	8	2	.2	.2	99.9
	9	1	.1	.1	100.0
	Total	939	100.0	100.0	

Housing Type

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	A one-family house detached from any other house	794	84.6	84.6	84.6
	A one-family house attached to one or more houses	63	6.7	6.7	91.3
	A mobile home	82	8.7	8.7	100.0
	Total	939	100.0	100.0	

Household Income

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than $5,000	8	.9	.9	.9
	$5,000 to $7,499	6	.6	.6	1.5
	$7,500 to $9,999	11	1.2	1.2	2.7
	$10,000 to $12,499	20	2.1	2.1	4.8
	$12,500 to $14,999	22	2.3	2.3	7.1
	$15,000 to $19,999	27	2.9	2.9	10.0
	$20,000 to $24,999	48	5.1	5.1	15.1
	$25,000 to $29,999	45	4.8	4.8	19.9
	$30,000 to $34,999	54	5.8	5.8	25.7
	$35,000 to $39,999	65	6.9	6.9	32.6
	$40,000 to $49,999	101	10.8	10.8	43.3
	$50,000 to $59,999	99	10.5	10.5	53.9
	$60,000 to $74,999	128	13.6	13.6	67.5
	$75,000 to $84,999	55	5.9	5.9	73.4
	$85,000 to $99,999	86	9.2	9.2	82.5
	$100,000 to $124,999	76	8.1	8.1	90.6
	$125,000 to $149,999	29	3.1	3.1	93.7
	$150,000 to $174,999	28	3.0	3.0	96.7
	$175,000 or more	31	3.3	3.3	100.0
	Total	939	100.0	100.0	

Marital Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Married	603	64.2	64.2	64.2
	Widowed	71	7.6	7.6	71.8
	Divorced	125	13.3	13.3	85.1
	Separated	6	.6	.6	85.7
	Never married	78	8.3	8.3	94.0
	Living with partner	56	6.0	6.0	100.0
	Total	939	100.0	100.0	

MSA Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Non-Metro	57	6.1	6.1	6.1
	Metro	882	93.9	93.9	100.0
	Total	939	100.0	100.0	

Region 4 - Based on State of Residence

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	South	939	100.0	100.0	100.0

Region 9 - Based on State of Residence

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	South Atlantic	939	100.0	100.0	100.0

Ownership Status of Living Quarters

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Owned or being bought by you or someone in your household	939	100.0	100.0	100.0

State

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	FL	939	100.0	100.0	100.0

Presence of Household Members - Children 0-2

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	919	97.9	97.9	97.9
	1	19	2.0	2.0	99.9
	2	1	.1	.1	100.0
	Total	939	100.0	100.0	

Presence of Household Members - Children 2-5

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	894	95.2	95.2	95.2
	1	37	3.9	3.9	99.1
	2	7	.7	.7	99.9
	3	1	.1	.1	100.0
	Total	939	100.0	100.0	

Presence of Household Members - Children 6-12

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	849	90.4	90.4	90.4
	1	61	6.5	6.5	96.9
	2	24	2.6	2.6	99.5
	3	4	.4	.4	99.9
	4	1	.1	.1	100.0
	Total	939	100.0	100.0	

Presence of Household Members - Children 13-17

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0	836	89.0	89.0	89.0
	1	83	8.8	8.8	97.9
	2	20	2.1	2.1	100.0
	Total	939	100.0	100.0	

Presence of Household Members - Adults 18+

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	180	19.2	19.2	19.2
	2	589	62.7	62.7	81.9
	3	118	12.6	12.6	94.5
	4	34	3.6	3.6	98.1
	5	15	1.6	1.6	99.7
	6	3	.3	.3	100.0
	Total	939	100.0	100.0	

Current Employment Status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Working - as a paid employee	359	38.2	38.2	38.2
	Working - self-employed	85	9.1	9.1	47.3
	Not working - on temporary layoff from a job	5	.5	.5	47.8
	Not working - looking for work	69	7.3	7.3	55.2
	Not working - retired	319	34.0	34.0	89.1
	Not working - disabled	50	5.3	5.3	94.5
	Not working - other	52	5.5	5.5	100.0
	Total	939	100.0	100.0	

HH Internet Access

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	45	4.8	4.8	4.8
	Yes	894	95.2	95.2	100.0
	Total	939	100.0	100.0	

2nd respondent - Age

	Frequency	Percent	Valid Percent	Cumulative Percent
21	1	0.1	3.1	3.1
25	1	0.1	3.1	6.2
33	1	0.1	3.1	9.4
34	1	0.1	3.1	12.5
37	1	0.1	3.1	15.6
42	1	0.1	3.1	18.8
43	1	0.1	3.1	21.9
46	1	0.1	3.1	25
47	1	0.1	3.1	28.1
48	1	0.1	3.1	31.2
51	3	0.3	9.4	40.6
53	3	0.3	9.4	50
56	1	0.1	3.1	53.1
57	1	0.1	3.1	56.2
59	2	0.2	6.2	62.5
63	2	0.2	6.2	68.8
68	1	0.1	3.1	71.9
69	1	0.1	3.1	75
71	2	0.2	6.2	81.2
72	1	0.1	3.1	84.4
76	1	0.1	3.1	87.5
78	1	0.1	3.1	90.6
81	1	0.1	3.1	93.8
82	1	0.1	3.1	96.9
84	1	0.1	3.1	100
Total	32	3.4	100	
Missing	907	96.6		
	939	100		

2nd respondent - DATA ONLY: Age Group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	18-24	1	.1	3.1	3.1
	25-34	3	.3	9.4	12.5
	35-44	3	.3	9.4	21.9
	45-54	9	1.0	28.1	50.0
	55-64	6	.6	18.8	68.8
	65-74	5	.5	15.6	84.4
	75 and over	5	.5	15.6	100.0
	Total	32	3.4	100.0	
Missing	System	907	96.6		
Total		939	100.0		

2nd respondent - Education (highest degree received)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5th or 6th grade	1	.1	2.9	2.9
	11th grade	1	.1	2.9	5.9
	HIGH SCHOOL GRADUATE - high school DIPLOMA or the equivalent	9	1.0	26.5	32.4
	Some college, no degree	7	.7	20.6	52.9
	Associate degree	1	.1	2.9	55.9
	Bachelor's degree	10	1.1	29.4	85.3
	Master's degree	4	.4	11.8	97.1
	Professional or Doctorate degree	1	.1	2.9	100.0
	Total	34	3.6	100.0	
Missing	System	905	96.4		
Total		939	100.0		

2nd respondent - Education (Categorical)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than high school	2	.2	5.9	5.9
	High school	9	1.0	26.5	32.4
	Some college	8	.9	23.5	55.9
	Bachelors degree or higher	15	1.6	44.1	100.0
	Total	34	3.6	100.0	
Missing	System	905	96.4		
Total		939	100.0		

2nd respondent - Race/Ethnicity, Census categories

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	White, Non-Hispanic	24	2.6	70.6	70.6
	Black, Non-Hispanic	4	.4	11.8	82.4
	Hispanic	6	.6	17.6	100.0
	Total	34	3.6	100.0	
Missing	System	905	96.4		
Total		939	100.0		

2nd respondent - Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	23	2.4	67.6	67.6
	Female	11	1.2	32.4	100.0
	Total	34	3.6	100.0	
Missing	System	905	96.4		
Total		939	100.0		

2nd respondent - Marital status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Married	25	2.7	73.5	73.5
	Widowed	2	.2	5.9	79.4
	Divorced	2	.2	5.9	85.3
	Separated	1	.1	2.9	88.2
	Never married	2	.2	5.9	94.1
	Living with partner	2	.2	5.9	100.0
	Total	34	3.6	100.0	
Missing	System	905	96.4		
Total		939	100.0		

2nd respondent - Current employment status

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Working - as a paid employee	18	1.9	52.9	52.9
	Working - self-employed	1	.1	2.9	55.9
	Not working - on temporary layoff from a job	1	.1	2.9	58.8
	Not working - looking for work	2	.2	5.9	64.7
	Not working - retired	10	1.1	29.4	94.1
	Not working - disabled	1	.1	2.9	97.1
	Not working - other	1	.1	2.9	100.0
	Total	34	3.6	100.0	
Missing	System	905	96.4		
Total		939	100.0		

APPENDIX D: IRB APPROVAL NOTICES

The University of Central Florida Institutional Review Board review approval letters and exempt status notices are included for the Landscape Exchange Ethnographic Study, the Wekiva homeowner interviewers and telephone survey, and the Predicting Maintenance Intensity statewide web-based survey.

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2012 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Notice of Expedited Initial Review and Approval

From : **UCF Institutional Review Board**
FWA00000351, Exp. 10/8/11, IRB00001138

To : **Leesa Souto and Penelope Canan**

Date : **January 26, 2009**

IRB Number: **SBE-09-05997**

Study Title: **Landscaping Perceptions Phase II: Rivendell Homeowner Ethnography**

Dear Researcher:

Your research protocol noted above was approved by **expedited** review by the UCF IRB Vice-chair on 1/25/2009. **The expiration date is 1/24/2010.** Your study was determined to be minimal risk for human subjects and expeditable per federal regulations, 45 CFR 46.110. The category for which this study qualifies as expeditable research is as follows:

6. Collection of data from voice, video, digital, or image recordings made for research purposes.
7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The IRB has approved a **consent procedure which requires participants to sign consent forms.** Use of the approved, stamped consent document(s) is required. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs. Also report any unanticipated problems or serious adverse events (within 5 working days). Do not make changes to the protocol methodology or consent form before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at http://iris.research.ucf.edu .

Failure to provide a continuing review report could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies. The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Janice Turchin on 01/26/2009 04:13:57 PM EST

Janice M Turchin

IRB Coordinator

University of
Central
Florida

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Leesa Ann Souto** and Co-PI: **Penelope Canan**

Date: **January 13, 2010**

Dear Researcher:

On 01/13/2010, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	Landscaping Perceptions Phase II: Rivendell Homeowner Ethnography
Investigator:	Leesa Ann Souto
IRB Number:	SBE-09-05997
Funding Agency:	FL Department of Environmental Protection
Grant Title:	
Research ID:	1047013

At the time of this Continuing Review, it was determined that your study meets Exempt Category #2. Therefore, the study no longer has an expiration date. In addition, you are not required to use an Informed Consent document, but as with all human research, you need to follow your consent process with research participants. This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 01/13/2010 04:31:12 PM EST

IRB Coordinator

Page 1 of 1

Landscaping Perceptions and Behaviors Homeowner Ethnographic Study

Leesa Souto, Principal Investigator
Stormwater Management Academy
Lsouto@mail.ucf.edu
321-722-2123

Dr. Ross Hinkle, Chair
Department of Biology
chinkle@mail.ucf.edu
407-823-2124

INFORMED CONSENT FORM

Researchers at the University of Central Florida (UCF) study many topics. To do this we need the help of people who agree to take part in a research study. You are being invited to take part in a research study which will include about one hundred (100) people. You can ask questions about the research. You can read this form and agree to take part right now, or take the form home with you to study before you decide. You will be told if any new information is learned which may affect your willingness to continue taking part in this study. You have been asked to take part in this research study because you are a homeowner in Rivendell subdivision or have attended one of the tours to showcase the landscape designs. You must be 18 years of age or older to be included in the research study and sign this form. This study is being conducted by a team of researchers that includes the University of Central Florida Stormwater Management Academy and the University of Florida and is funded by the Florida Department of Environmental Protection.

The purpose of the study is to understand homeowners' perceptions about Florida-friendly landscaping designs and the potential for sustainable landscaping behaviors. Your participation in this study will help clarify strategies for protecting water quality and quantity in the Sarasota area.

Participating in the research will involve a face to face interview with trained personnel. You should take part in this study only because you want to. There is no penalty for not taking part, and you will not lose any benefits. You have the right to stop at any time. Just tell the researcher or a member of the research team that you want to stop. You will be told if any new information is learned which may affect your willingness to continue taking part in this study. The face to face interview will not be longer than 60 minutes. During the interview, you may be invited to participate in another aspect of this research to have your yard landscape designed and installed as a more environmentally sustainable landscape design. The landscape design project will require that you work with a landscape architect to alter the design of your front yard and allow UCF and UF access to your front yard for monitoring purposes. Contact Leesa Souto, the principle investigator whose name and contact information appears at the end of this form for additional information.

You may be audio taped during this study. If you do not want to be audio taped, discuss this with the researcher or a research team member. If you are audio taped, the tape will be kept in a locked, safe place until what you say has been written down. Once it is written down, the tape will be erased or destroyed. You and your home's yard may be video taped during this study. If you do not want to be video taped, discuss this with the researcher or a research team member. If you are video taped, we may use portions of the videotape for educational purposes in the future, but only with your permission. You will be given the options of opting out of the audiotape, the video tape or the use of video tape for educational purposes later in the consent form.

As a research participant you may benefit directly from this research by learning more about how research is conducted or by learning more sustainable yard practices. There is no compensation or other payment to you for taking part in this study. The researcher will make every effort to prevent anyone who is not on the research team from knowing that you gave us information, or what that

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Leesa Ann Souto**

Date: **February 21, 2011**

Dear Researcher:

On 2/21/2011, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	Landscaping Perceptions and Behaviors Statewide Telephone Survey
Investigator:	Leesa Ann Souto
IRB Number:	SBE-11-07483
Funding Agency:	FL Department of Environmental Protection
Grant Title:	Florida Stormwater Education and Social Marketing (ID 1047013)
Research ID:	1047013

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 02/21/2011 04:57:13 PM EST

Joanne Muratori

IRB Coordinator

Page 1 of 1

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901, 407-882-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Notice of Expedited Initial Review and Approval

From : **UCF Institutional Review Board**
FWA00000351, Exp. 5/07/10, IRB00001138

To : **Leesa Souto**

Date : **June 05, 2008**

IRB Number: **SBE-08-05659**

Study Title: **Wekiva Springshed Landscaping Behaviors: Interviewing Homeowners**

Dear Researcher:

Your research protocol noted above was approved by **expedited** review by the UCF IRB Vice-chair on 6/5/2008. **The expiration date is 6/4/2009.** Your study was determined to be minimal risk for human subjects and expeditable per federal regulations, 45 CFR 46.110. The category for which this study qualifies as expeditable research is as follows:

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

The IRB has approved a **consent procedure which requires participants to sign consent forms.** Use of the approved, stamped consent document(s) is required. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Subjects or their representatives must receive a copy of the consent form(s).

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs. Also report any unanticipated problems or serious adverse events (within 5 working days). Do not make changes to the protocol methodology or consent form before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at http://iris.research.ucf.edu .

Failure to provide a continuing review report could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies. The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 06/05/2008 09:59:29 AM EDT

Joanne Muratori

IRB Coordinator

University of Central Florida Institutional Review Board
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Notice of Expedited Initial Review and Approval

From : **UCF Institutional Review Board**
FWA00000351, Exp. 5/07/10, IRB00001138

To : **Leesa Souto** and Co-PIs: **Brent K. Marshall, James D. Wright**

Date : **April 01, 2008**

IRB Number: **SBE-08-05592**

Study Title: **Wekiva Watershed Homeowner Landscape Survey**

Dear Researcher:

Your research protocol noted above was approved by **expedited** review by the UCF IRB Chair on 4/1/2008. **The expiration date is 3/31/2009.** Your study was determined to be minimal risk for human subjects and expeditable per federal regulations, 45 CFR 46.110. The category for which this study qualifies as expeditable research is as follows:

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

A waiver of documentation of consent has been approved for all subjects. Participants do not have to sign a consent form, but the IRB requires that you give participants a copy of the IRB-approved consent form, letter, information sheet, or statement of voluntary consent at the top of the survey.

All data, which may include signed consent form documents, must be retained in a locked file cabinet for a minimum of three years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained on a password-protected computer if electronic information is used. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

To continue this research beyond the expiration date, a Continuing Review Form must be submitted 2 – 4 weeks prior to the expiration date. Advise the IRB if you receive a subpoena for the release of this information, or if a breach of confidentiality occurs. Also report any unanticipated problems or serious adverse events (within 5 working days). Do not make changes to the protocol methodology or consent form before obtaining IRB approval. Changes can be submitted for IRB review using the Addendum/Modification Request Form. An Addendum/Modification Request Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at http://iris.research.ucf.edu .

Failure to provide a continuing review report could lead to study suspension, a loss of funding and/or publication possibilities, or reporting of noncompliance to sponsors or funding agencies. The IRB maintains the authority under 45 CFR 46.110(e) to observe or have a third party observe the consent process and the research.

On behalf of Tracy Dietz, Ph.D., UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 04/01/2008 02:05:17 PM EST

Joanne Muratori

IRB Coordinator

University of Central Florida

University of Central Florida Institutional Review Board
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Approval of Exempt Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Leesa Ann Souto**

Date: **February 21, 2011**

Dear Researcher:

On 2/21/2011, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	Landscaping Perceptions and Behaviors Statewide Telephone Survey
Investigator:	Leesa Ann Souto
IRB Number:	SBE-11-07483
Funding Agency:	FL Department of Environmental Protection
Grant Title:	Florida Stormwater Education and Social Marketing (ID 1047013)
Research ID:	1047013

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 02/21/2011 04:57:13 PM EST

Joanne Muratori

IRB Coordinator

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LIST OF REFERENCES

Agyeman, Julian, Bullard, Robert D., and Evans, Bob. (2002). Exploring the nexus: Bringing together sustainability, environmental justice and equity. *Space & Polity, 6*(1), 77-90. doi: 10.1080/13562570220137907

Ajzen, Icek. (1985). From intentions to actions: A theory of planned behavior. In J.Kuhl & J.Beckman (Eds.), *Action-control: From cognition to behavior* (pp. 11– 39). Berlin: Springer-Verlag.

Ajzen, Icek. (1988). *Attitudes, personality, and behavior / Icek Ajzen* (U.S. ed. ed.). Chicago, IL: Dorsey Press.

Ajzen, Icek & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior.* Englewood-Cliffs, N.J: Prentice-Hall.

Amundson, Ronald, Austin, A. T., Schuur, E. A. G., Yoo, K., Matzek, V., Kendall, C., . . Baisden, W. T. (2003). Global patterns of the isotopic composition of soil and plant nitrogen. *Global Biogeochem. Cycles, 17*(1), 1031. doi: 10.1029/2002GB001903

Andreasen, Alan R. (2002). Marketing social marketing in the social change marketplace. *Journal of Public Policy & Marketing, 21*(1), 3-13.

Andreasen, Alan R. (2003). The life trajectory of social marketing - Some implications. *Marketing Theory, 3*(3), 293-303.

Baker, L. A., Hope, D., Xu, Y., Edmonds, J., & Lauver, L. (2001). Nitrogen balance for the Central Arizona-Phoenix (CAP) ecosystem. *Ecosystems, 4*(6), 581-602. doi: 10.1007/s10021-001-0031-2

Bamberg, S., & Moser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology, 27*(1), 14-25. doi: 10.1016/j.jenvp.2006.12.002

Bedard-Haughn, A., van Groenigen, J. W., & van Kessel, C. (2003). Tracing 15N through landscapes: potential uses and precautions. *Journal of Hydrology, 272*(1–4), 175-190. doi: 10.1016/S0022-1694(02)00263-9

Beketov, Mikhail A. (2004). Different sensitivity of mayflies (Insecta, Ephemeroptera) to ammonia, nitrite and nitrate: Linkage between experimental and observational data. *Hydrobiologia, 528*(1-3), 209-216.

Bijoor, Neeta S., Czimczik, Claudia I., Pataki, Diane E., & Billings, Sharon A. (2008). Effects of temperature and fertilization on nitrogen cycling and community composition of an urban lawn. *Global Change Biology, 14*(9), 2119-2131. doi: 10.1111/j.1365-2486.2008.01617.x

Bormann, F. Herbert, Balmori, Diana, Geballe, Gordon T., & Vernegaard, Lisa. (1993). *Redesigning the American lawn : A search for environmental harmony / F. Herbert Bormann, Diana Balmori, Gordon T. Geballe ; Lisa Vernegaard, editor-researcher*. New Haven: Yale University Press.

Bowen, Jennifer L., & Valiela, Ivan. (2008). Using δ15N to assess coupling between watersheds and estuaries in temperate and tropical regions. *Journal of Coastal Research, 24*(3), 804-813.

Boyer, Elizabeth W., Goodale, Christine L., Jaworski, Norbert A., & Howarth, Robert W. (2002). Anthropogenic nitrogen sources and relationships to riverine nitrogen export in the northeastern U.S.A. *Biogeochemistry, 57/58*, 137.

Brown, Terry J., Ham, Sam H., & Hughes, Michael. (2010). Picking up litter: An application of theory-based communication to influence tourist behaviour in protected areas. *Journal of Sustainable Tourism, 18*(7), 879-900. doi: 10.1080/09669581003721281

Camargo, Julio A., Alonso, Alvaro, & Salamanca, Annabella. (2005). Nitrate toxicity to aquatic animals: A review with new data for freshwater invertebrates. *Chemosphere, 58*(9), 1255-1267. doi: 10.1016/j.chemosphere.2004.10.044

Cantor, K. P. (1997). Drinking water and cancer. *Cancer Causes & Control, 8*(3), 292-308.

Carlson, Ann E. (2000). Recycling Norms (pp. n/a). Rochester, Rochester.

Carver, Robert H., & Nash, Jane Gradwohl. (2006). *Doing data analysis with SPSS / Robert H. Carver, Jane Gradwohl Nash* (Vers. 14 ed.). Belmont, CA: Thomson/Brooks/Cole.

Center for Watershed Protection (2000). Nutrient movement from the lawn to the stream. Watershed Protection Techniques, 2, 239-246.

Cialdini, Robert B. (2003). Crafting normative messages to protect the environment. *Current Directions in Psychological Science (Wiley-Blackwell), 12*(4), 105. doi: 10.1111/1467-8721.01242

Compton, J. E., Hooker, T. D., & Perakis, S. S. (2007). Ecosystem N distribution and delta 15N during a century of forest regrowth after agricultural abandonment. *Ecosystems, 10*(7), 1197-1208. doi: 10.1007/s10021-007-9087-y

Cooper, Carol. (2007). Successfully changing individual travel behavior: Applying community-based social marketing to travel choice. *Transportation Research Record, 2021*(2021), 89-99. doi: 10.3141/2021-11

Davis, Larry E., Ajzen, Icek, Saunders, Jeanne, & Williams, Trina. (2002). The decision of African American students to complete high school: An application of the theory of planned behavior. *Journal of Educational Psychology, 94*(4), 810-819. doi: 10.1037/0022-0663.94.4.810

Decamp, David. (2009). Advisers on fertilizer ban get industry cash. *The St. Pete Times,* National, pp. 1A.

Dorsey, J.W. (2009). Lawns as symbols of American values: Is it time for a change? *Interdisciplinary Environmental Review, 9* (1,2), 1-19.

Driscoll, Charles, Whitall, David, Aber, John, Boyer, Elizabeth, Castro, Mark, Cronan, Christopher, . . . Ollinger, Scott. (2003). Nitrogen pollution: Sources and consequences in the U.S. Northeast. *Environment, 45*(7), 8-22.

Edwards, T.M., Guillette, Jr, L.J., McCoy, K. and Barbeau, T. (2004). *Effects of Nitrate/nitrite on Two Sentinel Species Associated with Florida's Springs.* Final report, p. 89 (Appendix). Prepared for the Florida Department of Environmental Protection, Tallahassee, FL.

Engelsjord, M. E., Branham, B. E., & Horgan, B. P. (2004). The Fate of Nitrogen-15 Ammonium Sulfate Applied to Kentucky Bluegrass and Perennial Ryegrass Turfs. *Crop Sci., 44*(4), 1341-1347. doi: 10.2135/cropsci2004.1341

England, G. & Listopad, C. (2012) Use of TMDL Credits for BMP Comparisons. *Stormwater: The Journal for Water Quality Professionals.* April 9, 2012. Downloaded on October 7, 2012 from http://www.stormh2o.com/SW/Editorial/Use_of_TMDL_Credits_for_BMP_Comparisons_16777.aspx

Fan, A. M., & Steinberg, V. E. (1996). Health implications of nitrate and nitrite in drinking water: An update on methemoglobinemia occurrence and reproductive and developmental toxicity. *Regulatory Toxicology and Pharmacology, 23*(1 pt.1), 35-43.

FAO (2010) United Nations Food and Agricultural Organization. FAOSTAT, Downloaded on November 15, 2010 from http://faostat.fao.org/site/575/DesktopDefault.aspx?PageID=575#ancor

Florida Department of Environmental Protection (2008). *Florida Friendly Best Management Practices for Protection of Water Resources by the Green Industries*. 2nd printing 2010. State of Florida.

Feagan, Robert, & Ripmeester, Michael. (1999). Contesting natural (ized) lawns: A geography of private green space in the Niagara region. *Urban Geography, 20*(7), 617-634. doi: 10.2747/0272-3638.20.7.617

Fishbein, Martin & Ajzen, Icek joint author. (1975). *Belief, attitude, intention, and behavior : An introduction to theory and research / Martin Fishbein, Icek Ajzen*. Reading, Mass: Addison-Wesley Pub. Co.

Florida-Friendly Landscaping Covenants, Conditions and Restrictions. (2009, January). Conservation Clinic, University of Florida Levin College of Law for the Florida Yards and Neighborhood Program.

Frank, Kevin W., O'Reilly, Kevin M., Crum, James R., & Calhoun, Ronald N. (2006). The Fate of Nitrogen Applied to a Mature Kentucky Bluegrass Turf. *Crop Sci., 46*(1), 209-215. doi: 10.2135/cropsci2005.04-0039

Friedrichs, Jürgen, & Blasius, Jörg. (2009). Attitudes of owners and renters in a deprived neighbourhood. *European Journal of Housing Policy, 9*(4), 435-455. doi: 10.1080/14616710903357219

Galloway, James N., Townsend, Alan R., Erisman, Jan Willem, Bekunda, Mateete, Zucong, Cai, Freney, John R., . . . Sutton, Mark A. (2008). Transformation of the nitrogen cycle: Recent trends, questions, and potential solutions. *Science, 320*(5878), 889-892. doi: 10.1126/science.1136674

Gold, A. J., DeRagon, W. R., Sullivan, W. M., & Lemunyon, J. L. (1990). Nitrate-Nitrogen losses to groundwater from rural and suburban land uses. *Journal of Soil and Water Conservation JSWCA3, Vol. 45, No. 2, p 305-310, 1990. 1 fig, 3 tab, 30 ref. Soil Conservation Service cooperative agreement 69-1106-5-192.*

Grove, J.M., Troy, A.R., O'Neil-Dunne, J.P.M., and Pickett, S.T.A. (2006). Characterization of households and its implications for the vegetation of urban ecosystems. *Ecosystems, 9*, 578-597. doi: 10.1007/s10021-006-0116-z

Guillette Jr, Louis J., & Edwards, Thea M. (2005). Is nitrate an ecologically relevant endocrine disruptor in vertebrates? *Integrative & Comparative Biology, 45*(1), 19-27.

Hair, Joseph F., Black, William C., Babin, Barry J., Anderson, Rolph E., and Tatham, Ronald L. (2006). *Multivariate data analysis / Joseph F. Hair, Jr. ... [et al.]* (6th ed. ed.). Upper Saddle River, N.J: Pearson Prentice Hall.

Haldeman, Tracey, & Turner, Jeanine Warisse. (2009). Implementing a community-based social marketing program to increase recycling. *Social Marketing Quarterly, 15*(3), 114.

Hawken, Paul, Lovins, Amory B., & Lovins, L. Hunter. (1999). *Natural capitalism: Creating the next industrial revolution / Paul Hawken, Amory Lovins, and L. Hunter Lovins* (1st ed. ed.). Boston: Little, Brown and Co.

Hecnar, S. J. (1995). Acute and chronic toxicity of ammonium nitrate fertilizer to amphibians from southern Ontario. *Environmental Toxicology and Chemistry, 14*(12), 2131-2137.

Helfand, G. E., Park, J. S., Nassauer, J. I., & Kosek, S. (2006). The economics of native plants in residential landscape designs. *Landscape and Urban Planning, 78*(3), 229-240. doi: 10.1016/j.landurbplan.2005.08.001

Helmig, Bernd, & Thaler, Julia. (2010). On the effectiveness of social marketing: What do we really know? *Journal of Nonprofit & Public Sector Marketing, 22*(4), 264-287. doi: 10.1080/10495140903566698

Hogberg, Peter. (1997). Tansley review no. 95: 15N natural abundance in soil-plant systems. *New Phytologist, 137*(2), 179-203. doi: 10.1046/j.1469-8137.1997.00808.x

Hope, D., Gries, C., Weixing, Z., Fagan, W. F., Redman, C. L., Grimm, N. B., & ... Kinzig, A. (2003). Socioeconomics drive urban plant diversity. *Proceedings of The National Academy of Sciences of the United States of America*, *100*(15), 8788.

Howarth, R. W., Billen, G., Swaney, D., Townsend, A., Jaworski, N., Lajtha, K., . . . Zhu, Zhao-Liang. (1996). Regional nitrogen budgets and riverine N & P fluxes for the drainages to the North Atlantic Ocean: Natural and human influences. *Biogeochemistry, 35*(1), 75-139.

Howarth, R. W., Boyer, E. W., Pabich, W. J., & Galloway, J. N. (2002). Nitrogen use in the United States from 1961-2000 and potential future trends. *Ambio, 31*(2), 88-96. doi: 10.1043/0044-7447(2002)031(0088:NUITUS)2.0.CO;2

Hunecke, Marcel, Haustein, Sonja, Böhler, Susanne, & Grischkat, Sylvie. (2010). Attitude-based target groups to reduce the ecological impact of daily mobility behavior. *Environment & Behavior, 42*(1), 3-43.

Junk, Gregor, & Svec, Harry J. (1958). The absolute abundance of the nitrogen isotopes in the atmosphere and compressed gas from various sources. *Geochimica et Cosmochimica Acta, 14*(3), 234-243. doi: 10.1016/0016-7037(58)90082-6

Kaye, Jason P., Groffman, Peter M., Grimm, Nancy B., Baker, Lawrence A., & Pouyat, Richard V. (2006). A distinct urban biogeochemistry? *Trends in Ecology & Evolution, 21*(4), 192-199. doi: 10.1016/j.tree.2005.12.006

Kelly, Caroline, & Breinlinger, Sara. (1995). Attitudes, intentions, and behavior: A study of women's participation in collective action. *Journal of Applied Social Psychology, 25*(16), 1430-1445. doi: 10.1111/j.1559-1816.1995.tb02625.x

Knowledge Networks. (2011, April 8). Institutional Review Board Support. Retrieved from www.knowledgenetworks.com/ganp/irbsupport/

Kotler, Philip. (1971). Social marketing: An approach to planned social change. *Journal of Marketing (pre-1986), 35*(000003), 3-3.

Kotler, Philip. (1982). *Marketing for nonprofit organizations / Philip Kotler* (2nd ed. ed.). Englewood Cliffs, N.J: Prentice-Hall.

Kotler, Philip, Lee, Nancy, & Roberto, Ned. (2002). *Social marketing: Improving the quality of life / Philip Kotler, Ned Roberto, Nancy Lee* (2nd ed. ed.). Thousand Oaks, Calif: Sage Publications.

Larsen, Larissa, & Harlan, Sharon L. (2006). Desert dreamscapes: Residential landscape preference and behavior. *Landscape and Urban Planning, 78*(1-2), 85-100. doi: 10.1016/j.landurbplan.2005.06.002

Law, Neely L., Band, Lawrence E., & Grove, J. Morgan. (2004). Nitrogen input from residential lawn care practices in suburban watersheds in Baltimore County, MD. *Journal of Environmental Planning & Management, 47*(5), 737-755. doi: 10.1080/0964056042000274452

Leggette, Brashears & Graham, Inc. (2004). Lake Tarpon ground-water nutrient study. Pinellas County Department of Environmental Management and the Southwest Florida Water Management District.

Li, Dejun, & Wang, Xinming. (2008). Nitrogen isotopic signature of soil-released nitric oxide (NO) after fertilizer application. *Atmospheric Environment, 42*(19), 4747-4754. doi: 10.1016/j.atmosenv.2008.01.042

Maddock, Tara A. (2004). Fragmenting regimes: how water quality regulation is changing political-economic landscapes. *Geoforum, 35*(2), 217-230. doi: 10.1016/j.geoforum.2003.09.004

MACTEC. (2007, March). *Phase I report: Wekiva River basin nitrate sourcing study.* St. Johns River Water Management District and Florida Department of Environmental Protection.

MACTEC. (2009, October). *Phase II report: Wekiva River basin nitrate sourcing study.* St. Johns River Water Management District and Florida Department of Environmental Protection.

Martin, Chris A., Warren, Paige S., & Kinzig, Ann P. (2004). Neighborhood socioeconomic status is a useful predictor of perennial landscape vegetation in residential neighborhoods and embedded small parks of Phoenix, AZ. *Landscape and Urban Planning, 69*(4), 355-368. doi: 10.1016/j.landurbplan.2003.10.034

Mattson, R.A., Lehmensick, M. & Lowe E.F. (2007). *Nitrate toxicity in Florida springs and spring-run streams: A review of the literature and its implications.* St. Johns River Water Management District. Palatka, FL. Publication # SJ2007-PP1.

McClelland, J. W., Valiela, I., & Michener, R. H. (1997). Nitrogen-stable isotope signatures in estuarine food webs: A record of increasing urbanization in coastal watersheds. *Limnology and Oceanography, 42*(5), 930-937.

Nassauer, Joan. (1995). Messy ecosystems, orderly frames. *Landscape journal, 14*(2), 161-170.

Nassauer, Joan Iverson. (1997). *Placing nature: culture and landscape ecology / edited by Joan Iverson Nassauer*. Washington, D.C: Island Press.

Nassauer, Joan Iverson. (2012). Landscape as medium and method for synthesis in urban ecological design. *Landscape and Urban Planning, 106*(3), 221-229. doi: 10.1016/j.landurbplan.2012.03.014

National Gardening Association. (2000). *National gardening survey*. National Gardening Association, Burlington (VM).

Niemeyer, Shirley. (2010). Consumer voices: Adoption of residential energy-efficient practices. *International Journal of Consumer Studies, 34*(2), 140-145. doi: 10.1111/j.1470-6431.2009.00841.x

Nigbur, Dennis, Lyons, Evanthia, & Uzzell, David. (2010). Attitudes, norms, identity and environmental behaviour: Using an expanded theory of planned behaviour to predict participation in a kerbside recycling programme. *British Journal of Social Psychology, 49*(2), 259-284. doi: 10.1348/014466609x449395

Nilsson, A., von Borgstede, C., & Biel, A. (2004). Willingness to accept climate change strategies: The effect of values and norms. *Journal of Environmental Psychology, 24*(3), 267-277. doi: 10.1016/j.jenvp.2004.06.002

Nunnally, Jum C. (1978). *Psychometric theory / Jum C. Nunnally* (2nd ed.). New York: McGraw-Hill.

O' Rourke, Norm, Hatcher, Larry, & Stepanski, Edward J. (2005). *A step-by-step approach to using the SAS system for univariate and multivariate statistics /2nd Edition* (2nd ed.). Cary, NC: SAS Institute.

Pallant, Julie. (2010). *SPSS survival manual: A step by step guide to data analysis using SPSS / Julie Pallant* (4th ed.). Maidenhead: Open University Press/McGraw-Hill.

Peterson, B J, & Fry, B. (1987). Stable isotopes in ecosystem studies. *Annual Review of Ecology and Systematics, 18*(1), 293-320. doi: doi:10.1146/annurev.es.18.110187.001453

Pickett, Steward T. A., Cadenasso, Mary L., Grove, Morgan, Groffman, Peter M., Band, Lawrence E., Boone, Christopher G., . . . Wilson, Matthew A. (2008). Beyond Urban Legends: An Emerging Framework of Urban Ecology, as Illustrated by the Baltimore Ecosystem Study. *Bioscience, 58*(2), 139-150. doi: 10.1641/b580208

Quinones, A., Martinez-Alcantara, B., & Legaz, F. (2007). Influence of irrigation system and fertilization management on seasonal distribution of N in the soil profile and on N-uptake by citrus trees. *Agriculture, Ecosystems & Environment, 122*(3), 399-409. doi: 10.1016/j.agee.2007.02.004

Raciti, S. M., Groffman, P. M., & Fahey, T. J. (2008). Nitrogen retention in urban lawns and forests. *Ecological Applications, 18*(7), 1615-1626.

Redman, C. L., Grove, J. M., & Kuby, L. H. (2004). Integrating social science into the long-term ecological research (LTER) network: Social dimensions of ecological change and ecological dimensions of social change. *Ecosystems, 7*(5), 161-171. doi: 10.1007/s10021-003-0215-z

Roadcap, G.S., K.C. Hackley, H. Hwang, and T.M Johnson. 2001. Application of nitrogen and oxygen Isotopes to identify sources of nitrate. Illinois Groundwater Consortium Conference.

Robbins, Paul. (2007). *Lawn people: How grasses, weeds, and chemicals make us who we are / by Paul Robbins*. Philadelphia: Temple University Press.

Robbins, Paul, & Birkenholtz, Trevor. (2003). Turfgrass revolution: Measuring the expansion of the American lawn. *Land Use Policy, 20*(2), 181-194. doi: 10.1016/S0264-8377(03)00006-1

Robbins, P., Polderman, A., & Birkenholtz, T. (2001). Lawns and toxins An ecology of the city. *Cities, 18*(6), 369-380. doi: 10.1016/s0264-2751(01)00029-4

Robbins, Paul, & Sharp, Julie T. (2003). Producing and consuming chemicals: The moral economy of the American lawn. *Economic Geography, 79*(4), 425-451.

Sandberg, A. L., & Foster, J. (2005). Challenging lawn and order: Environmental discourse and lawn care reform in Canada. *Environmental Politics, 14*(4), 478-494. doi: 10.1080/09644010500175692

Sartain, J.B., Trenholm, L.T., Gilman, E.F., Obreza, T.A., and Toor, G. (2009). Frequently asked questions about landscape fertilization for Florida-friendly landscaping ordinances. (IFAS Publication # ENH1115). University of Florida Environmental Horticulture Department, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences.

Schultz, P. Wesley P. W., Nolan, Jessica M. J. M., Cialdini, Robert B. R. B., Goldstein, Noah J. N. J., & Griskevicius, Vladas V. (2007). The constructive, destructive, and reconstructive power of social norms. *Psychological science, 18*(5), 429-434.

Schwartz, Shalom G. (1977). Normative Influences on altruism. In L. Berkowitz (Ed.), *Advances in Experimental Social Psychology* (Vol. 10, pp. 222-279). New York: Academic Press.

Shern, Lois Carol. (1994). *Suburban lawns: Dimensions of meaning, activities, and environmental concerns reported by homeowning couples in Georgia and Michigan.* (Ph.D. 9525004), Michigan State University, United States -- Michigan. Retrieved from ProQuest Dissertations & Theses A&I database.

Showers, William J., Genna, Bernard, McDade, Timothy, Bolich, Rick, & Fountain, John C. (2008). Nitrate Contamination in Groundwater on an Urbanized Dairy Farm. *Environmental Science & Technology, 42*(13), 4683-4688. doi: 10.1021/es071551t

Sierra Club. *Sierra Club: Numeric nutrient criteria, urban fertilizer and the University of Florida.* (n.d.). Retrieved March 11, 2011, from http://florida.sierraclub.org/docs/Nutrient_Criteria_SCF.pdf

Smil, Vaclav. *Enriching the earth: Fritz Haber, Carl Bosch, and the transformation of world food production*. Cambridge, Mass: MIT Press, 2001.

Spear, Kevin. (2012, 10/5/2012). Neighborhood association sues homeowner who has water-conserving yard, *Orlando Sentinel*.

Spector, Paul E., Faculty, U. S. F., & University Publications, F. T. S. (1992). *Summated rating scale construction :an introduction / Paul E. Spector*. Newbury Park, Calif: Sage Publications.

St. Johns River Water Management District (2007) Special Publication SJ2007-SP4, *Fifty-year retrospective study of the ecology of Silver Springs.*

Templeton, Scott R., Seung Jick, Yoo, & Zilberman, David. (1999). An economic analysis of yard care and synthetic chemical use: The case of San Francisco. *Environmental and Resource Economics, 14*(3), 385-397.

Thackeray, Rosemary, Fulkerson, Katrina N., & Neiger, Brad L. (2012). Defining the product in social marketing: An analysis of published research. *Journal of Nonprofit & Public Sector Marketing, 24*(2), 83-100. doi: 10.1080/10495142.2012.679156

Trenholm, Laurie E. (2012). Nitrate leachate studies. *Florida Turf Digest, 29.* (2) 12-17.

USFWS (2000, July). *Homeowner's guide to protecting frogs – lawn and garden care.* Division of Environmental Contaminants. Arlington, VA.

U.S. Geological Survey Florida Water Science Center. (2010). Lake Wales Ridge groundwater: Overview of agricultural chemicals: Pesticides and nitrate. Retrieved November 16, 2010 from http://fl.water.usgs.gov/lake-wales/groundwater/overview_of_agrichemicals.html

Viederman, Stephen. (1993). Sustainable development: What is it and how do we get there? (Cover story). *Current History, 92*(573), 180.

Vitòria, Laura L., Otero, Neus N., Soler, Albert A., & Canals, Angels A. (2004). Fertilizer characterization: isotopic data (N, S, O, C, and Sr). *Environmental science & technology, 38*(12), 3254-3262.

Vitousek, Peter M., & Reiners, William A. (1975). Ecosystem succession and nutrient retention: A hypothesis. *BioScience, 25*(6), 376-381.

Wagner, Travis P. (2011). Compact fluorescent lights and the impact of convenience and knowledge on household recycling rates. *Waste Management, 31*(6), 1300-1306. doi: 10.1016/j.wasman.2011.01.017

Wall, R., Devine-Wright, P., & Mill, G. A. (2008). Interactions between perceived behavioral control and personal-normative motives - Qualitative and quantitative evidence from a study of commuting-mode choice. *Journal of Mixed Methods Research, 2*(1), 63-86. doi: 10.1177/1558689807309967

Whitney, Kristoffer. (2010). Living lawns, dying waters. *Technology & Culture, 51*(3), 652-674.

Williams, Robert A. (2012, Spring/Summer). Florida springs in jeopardy: An earth jurisprudence solution. *Center for Earth Jurisprudence Groundswell, 1-3.*

Young, Oran R., Lambin, Eric F., Alcock, Frank, Haberl, Helmut, Karlsson, Sylvia I., McConnell, William J., . . . Verburg, Peter H. (2006). A portfolio approach to analyzing complex human-environment interactions: Institutions and land change. *Ecology & Society, 11*(2), 367-381.

Zhu, W. X., Dillard, N. D., & Grimm, N. B. (2004). Urban nitrogen biogeochemistry: status and processes in green retention basins. *Biogeochemistry., 71*(2), 177-196.