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Cover Page Footnote

Thank you to Dr. Bill Richardson and Dr. Rogers Leonard for your support and valuable feedback on this line of research. Also, a very special thanks to my co-author and doctoral committee chair for seeing me through every step of the way.

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Application of the Theory of Planned Behavior to Determine Urban and Suburban Homeowners' Fertilizer Management Practices

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Abstract. A fundamental strategy for reducing nutrient runoff from lawns and landscapes is the implementation of recommended fertilizer management practices (FMPs). Our study evaluated Louisiana urban and suburban homeowners' current FMPs using the Theory of Planned Behavior (TPB) constructs. We measured homeowners' attitude, perceived norm, perceived control, intention, and past behavior regarding 12 salient FMPs. The results of our study identified which recommended FMPs to adopt and which non-recommended practices to change. To effectively modify homeowners' FMPs, we recommended designing tailored Extension educational programming to target the TPB constructs most strongly related to homeowners' decision to perform these practices.

INTRODUCTION

In the United States, 82% of the population has been living in urban and suburban areas since 2011 (Wu, Stewart, Thompson, Kolka & Franz, 2015). From 1982 to 2015, 43 million acres of land in the United States were converted to developed lands, resulting in a total of 115 million developed acres, which are characterized by large expanses of impervious surfaces that increase storm water runoff (Stone, 2004; National Resource Conservation Service, 2018). The lawn coverage of developed U.S. lands has been estimated between 25 and 40 million acres (Robbins & Birkenholtz, 2003). The scale of lawn and landscape synthetic fertilizer application has been increasing in the United States as residents strive for homogeneous, green lawns (Nielson & Smith, 2005; Robbins, Polderman, & Birkenholtz, 2001). Additionally, individuals use non-recommended fertilizer management practices (FMPs) that increase nutrient runoff to achieve the aesthetic standards set forth by their residential communities (Carey et al., 2012).

Non-recommended home lawn and landscape FMPs can lead to increased nonpoint source pollution from neighborhoods as nitrogen and phosphorous runoff enters storm drains and waterways (National Research Council [NRC], 2009b; U.S. Environmental Protection Agency [U.S. EPA], 2014). Nutrient loading into water sources can result in eutrophication or excess algal bloom growth that can be toxic to aquatic organisms and humans (Carey et al., 2013). The rapid growth of algal blooms in water resources can also cause hypoxia or reduced dissolved oxygen levels (Carey et al., 2013). Additionally, when nitrate in drinking water exceeds safe levels, it can cause reduced availability of oxygen in the human body, a phenomenon that affects infants most severely (U.S. EPA, 2005).

The Mississippi/Atchafalaya River Basin (MARB) provides drainage for 41% of the contiguous United States and routes point and nonpoint sources of pollution through Louisiana's waterways to be deposited into the Gulf of Mexico (GOM) (Louisiana Department of Environmental Quality [LDEQ], 2017; NRC, 2009a). Excessive nutrient loading into the MARB from nonpoint sources has been associated with decreased levels of dissolved oxygen in waterbodies and a hypoxic zone in the northern portion of the GOM during the summer months (NRC, 2008). The large extent of U.S. land that the MARB drains and the amount of nutrient pollution entering Louisiana's waters and the GOM have made this a leading environmental issue for the state and the nation.

The preservation of water quality in Louisiana is high priority, as significant portions of the state's financial revenue and employment are connected to GOM fisheries and the outdoor tourism industry. In 2013, Louisiana commercial fisheries had a total economic outcome of $2.1 billion and out-of-state visitors to Louisiana state parks spent close to $12 million (LDEQ, 2016). Louisiana's state agencies

and academic institutions have been working together to implement a nutrient management strategy to improve water quality (Louisiana Nutrient Management Strategy Interagency Team, 2014). The strategy includes stakeholder engagement in watershed communities to enhance water quality restoration through voluntary, incentive-based approaches and includes best management practices for agriculture, forestry, and urban areas.

In Louisiana, water quality has been affected by nutrient pollutants from urban and suburban runoff making homeowners an important population to engage in water quality enhancement. (LDEQ, 2016; Louisiana Department of Natural Resources, 2008). In our study, we measured Louisiana homeowners' current FMPs to determine which practices to change and which recommended practices to adopt. We selected Ajzen's (1991) Theory of Planned Behavior (TPB) because it is a versatile tool that can be used in any U.S. region and within any discipline of Extension research seeking behavioral change. The constructs of the TPB were recreated from Azjen's interactive diagram (Azjen, 2019), which is available for use in academic research such as this study (Figure 1).

The theory begins with the behavioral beliefs people have, which produce either a favorable or unfavorable attitude toward the behavior (Ajzen, 1991). The normative beliefs people have result in perceived social pressure or subjective norms, and control beliefs influence people's perceived behavioral control (PBC) or whether they believe they have the resources and opportunities to complete a behavior (Ajzen, 1991; Ajzen, 2017). The attitude toward the behavior, the subjective norm, and the PBC may all influence the formation of intention to perform a behavior. The relative importance of these three independent determinants of intention will depend on the behavior. Generally, the more favorable the attitude and subjective norm, and the greater perceived control, the more likely people will have a strong intention to perform the behavior (Ajzen, 1991).

If there is an adequate amount of actual behavioral control over performing the behavior, people are expected to carry out their intentions (Ajzen, 1991). However, many behaviors have inherent difficulties of performance (Ajzen, 2017). Therefore, PBC is considered in addition to intention when trying to determine behavioral performance. Depending on the degree to which PBC is veridical, it may serve as a proxy

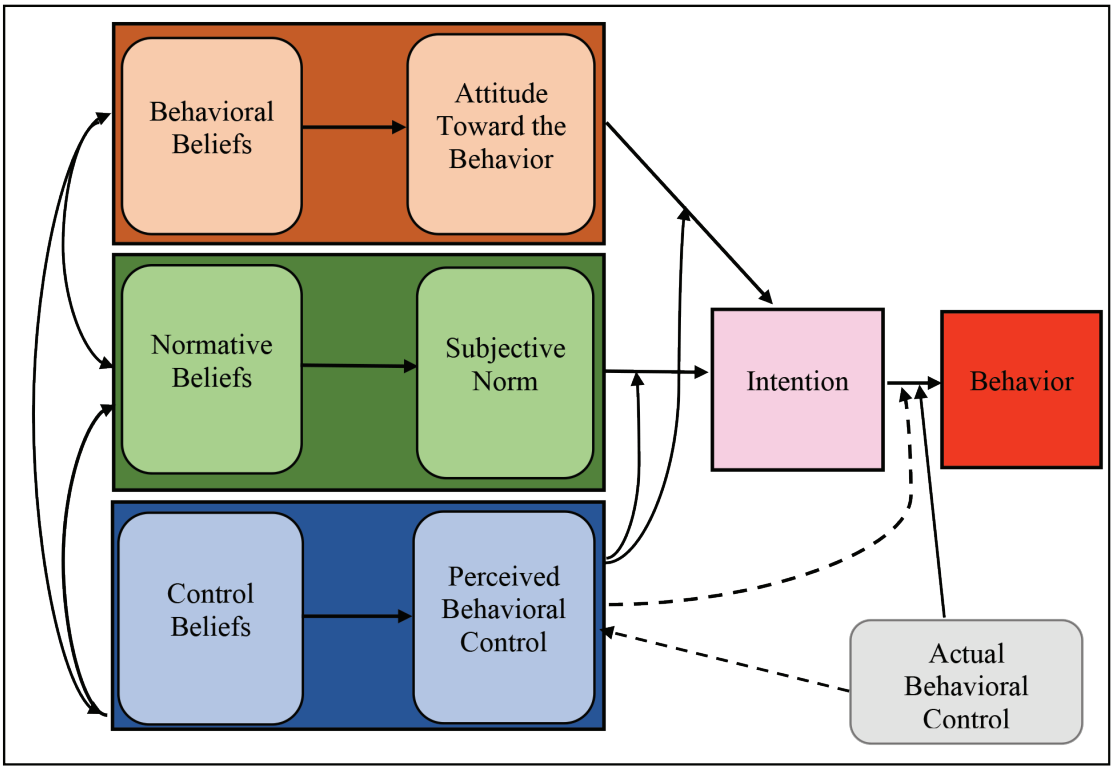

Figure 1. Ajzen's Theory of Planned Behavior.

for actual behavioral control, and PBC and intention can be used to predict the performance of a behavior (Ajzen, 2017). The contribution of these independent determinants of behavior will vary depending on the behavior (Ajzen, 1991).

In a three level meta-analysis article by Steinmetz et al. (2016), the researchers reviewed 123 TPB behavioral interventions and found that TPB-based interventions had a mean effect size of .50 for behavioral change. The results of Steinmetz et al.'s (2016) meta-analysis supports the use of the TPB by a wide audience of Extension researchers. The TPB can be used by Extension professionals to conduct formative research of their own target populations to determine the TPB constructs to target in a tailored behavioral intervention to achieve the desired behavioral change and adoption of recommended practices.

Researchers have used the TPB to examine adoption of recommended practices, such as in the article by Shaw, Radler, Chenoweth, Heiberger, and Dearlove (2011) that sought to predict residents' installation of a rain garden to protect water quality of local lakes. The researchers identified the TPB constructs of attitude and perceived ccontrol to be positively associated with intention to install a rain garden and targeted these in Extension programming to enhance installation (Shaw et al., 2011). In the article by Chaudhary et al. (2017), the researchers examined how effectively TPB constructs could predict Florida irrigation users' intention to perform landscape water conservation practices. They found that the construct subjective norms influenced intention to perform efficient irrigation practices and was the one to target to change water conservation behavior.

In this study, we sought to determine the gaps between the current fertilization practices used by our population and the recommended FMPs that should be performed. The exploratory methodological design, data collection, and analysis discussed were based on Fishbein and Ajzen's (2010) publication on predicting and changing behavior. The objectives of this study were to:

- explore how attitude, perceived norm, and perceived control explained the variance in intention to perform the FMPs identified by our population in a pilot study; and
- determine if intention and perceived control explained a significant portion of the variance in the past behavior of the FMPs being examined.

We studied this population's intention and past behavior regarding home lawn and landscape FMPs to identify which determinants of behavior to target in a nutrient management education program to increase adoption of recommended practices (Fishbein & Ajzen, 2010).

METHODS

Our target population was urban and suburban Louisiana homeowners. We compared the census data on the number of Louisiana housing units from 2000 to 2010 and found urban and suburban housing developments were increasing while rural populations were decreasing (U.S. Census Bureau, 2016b; U.S. Census Bureau, 2016c). We also found that the majority of housing units in Louisiana were owner-occupied (U.S. Census Bureau, 2016a). We determined the homeowner population should be studied, as these residents would have the direct ability to make decisions regarding home lawn and landscape maintenance.

An exploratory design was used in this research, in which a qualitative pilot study was conducted for the development of a quantitative questionnaire (Creswell & Plano-Clark, 2011). The data from the pilot study was used to determine the homeowners' most commonly held behavioral beliefs and to develop the direct measures of homeowners' attitudes, perceived norms, perceived control, intentions, and past behavior concerning the lawn and landscape fertilizer management practices examined in this study (Fishbein & Ajzen, 2010; Ajzen, 2017). The responses from the pilot study were analyzed and used to develop a final questionnaire with a semantic differential response scale to administer to this urban and suburban homeowner population (Fishbein & Ajzen, 2010; Ajzen, 2017).

IDENTIFYING HOMEOWNERS' SALIENT BELIEFS REGARDING FMPS

We conducted a qualitative pilot study using Fishbein and Ajzen's (2010) methodology, to first determine the salient beliefs homeowners had regarding FMPs. The qualitative TPB question format used in the semi structured group interview was derived from Fishbein and Ajzen's (2010) intervention methodology. A TPB interview protocol was developed prior to the group interview to guide data collection of the homeowners' beliefs about five specific fertilizer management practices and provide opportunities for additional relevant topics to be discussed through an open response format (Cohen & Crabtree, 2006; Fishbein & Ajzen, 2010). The fertilizer practices selected for discussion in the interview were determined from the literature review on the types of home lawn and landscape practices that, if not implemented properly, can result in fertilizer runoff (U.S. EPA, 2005; Louisiana State University Agricultural Center [LSU AgCenter], 2007; LSU AgCenter, 2008; Carey et al., 2012a; FFL, 2015).

We consulted with the Director of the Office of Neighborhoods for the City of Baton Rouge to identify the residents' association used for the pilot study. The association selected was well established and contained a representative sample of the general population in Louisiana. Two weeks

prior to the interview, an informational handout was emailed to the past and present association board members. It was also distributed to the participants at the interview. The handout contained information about the meeting's logistics, as well as the specific fertilizer practices that were to be discussed. At the interview, the association members were interviewed as a group. A single interviewer followed a semi structured TPB interview protocol that provided guiding questions regarding fertilizer management practices, which were designed to elicit the interviewees' salient beliefs in an open response format (Cohen & Crabtree, 2006; Fishbein & Ajzen, 2010). The questions were laid out in sections to review the behavioral, normative, and control beliefs the participants held regarding specific fertilizer management practices.

A content analysis was completed from the transcript, to construct a list of the most commonly held beliefs in the research population (Ajzen, 2017; Elo & Kyngas, 2008; Fishbein & Ajzen, 2010). An inductive content analysis method was used to move the collected interview data from what was observed in that sample and combine it into the greater population of urban and suburban homeowners in Louisiana. The analysis process began with open coding of the transcript followed by the construction of categories, and lastly a general description of this populations' beliefs about specific fertilizer management practices (Elo & Kyngas, 2008). The results from the content analysis were used to inform the questions developed for inclusion in the quantitative semantic differential questionnaire, as well as the fertilizer management practices to be examined (Ajzen, 2017; Fishbein & Ajzen, 2010). We identified 12 salient FMPs from the content analysis of the pilot data, and subsequently examined those FMPs in the quantitative questionnaire. We defined the 12 FMPs for use in the quantitative questionnaire and identified them in the literature as being either a recommended fertilization practice, or a practice that had the potential to impact water quality (Table 1).

QUANTITATIVE SEMANTIC DIFFERENTIAL QUESTIONNAIRE

We used data from the qualitative pilot study to develop introductory questions for the questionnaire that examined additional aspects of homeowners' fertilizer management. We further included a section in the questionnaire in which urban and suburban homeowners who had never applied fertilizer to their home lawns and/or landscapes were asked to select the factors that contributed to this decision. We also included a series of demographic questions to provide general characteristics of the population. We designed a quantitative questionnaire to assess the 12 FMPs identified in the pilot study using semantic differential response scales based on the TPB questionnaire construction from Fishbein and Ajzen's (2010) behavioral intervention methodology. In the questionnaire, we measured TPB attitudes, perceived norms, perceived control, intentions, and past behavior constructs for the 12 FMPs. The survey questions used to examine the TPB constructs for each of the FMPs in this study are available as supplemental material. In order to ensure the face and content validity of the instrument, we had a seven-member panel of experts review the questionnaire. The panel of experts included two professors from the Louisiana State University (LSU) School of Plant, Environmental, and Soil Science with expertise in turfgrass and watershed management; two LSU faculty in higher education with expertise in instrument design; and three community and civic association administrators.

TPB CONSTRUCT MEASURES

We measured attitude, perceived norm, perceived control, intention, and past behavior constructs on a 7-point semantic differential scale using polar adjective pairs (Table 2).

We sought to determine the combined effect of attitude, perceived norm and perceived control on homeowners' intention to perform the 12 FMPs examined. We evaluated the measures of attitude, perceived norm, and perceived control to determine homeowners' (a) favorable or unfavorable evaluations of the FMPs, (b) perceived social expectation to perform or not perform the FMPs, and (c) perceived difficulty or ease in performing the FMPs (Ajzen, 1991; Fishbein & Ajzen, 2010) (Figure 2). We ran regression analyses for the 12 FMPS to determine whether attitude, perceived norm, and perceived control explained a significant portion of the variance in intention to perform these practices. Lastly, we evaluated measures of past behavior of the 12 FMPs, as past behavior is highly correlated with future behavior, and we used measures of intention and perceived control to predict the behaviors being studied (Figure 2) (Fishbein & Ajzen, 2010). We further used regression analyses to determine whether intention and perceived control explained a significant portion of the variance in past behavior of the 12 FMPs.

We used Qualtrics, a third-party public opinion survey research company, to accomplish our non-probability opt-in survey sampling. Qualtrics distributed a link inviting 737 individuals to participate and access the questionnaire. The criteria used to determine respondents' eligibility to participate were (a) current Louisiana residency, (b) residence in an urban and/or suburban area, and (c) home ownership. The non-probability opt-in sampling method allowed us to gradually collect samples of respondents that met the three eligibility criteria (Qualtrics, 2014). The non-probability sampling method presented limitations, and the responses we collected were subject to exclusion, selection, and nonparticipation biases (Baker et al., 2013).

Table 1. The Operational Definition and Type of Practice for the 12 FMPs

Management Practice	Operational Definition	Type of Practice
Following fertilizer product label directions	following the label found on the fertilizer product that provides information on how to use that product	recommended
Soil testing	taking a sample of soil from the home lawn and/or landscape that is tested to provide information about which specific fertilizer nutrients (e.g., nitrogen, phosphorous, potassium, etc.) should be applied to promote healthy plant growth	recommended
Calculating the area of lawn	calculating the square footage of your lawn to determine how much fertilizer to apply to that area	recommended
Watering in lawn fertilizer	applying water to the lawn following the application of fertilizer to move the fertilizer down into the soil	recommended
Watering in lawn fertilizer, rain event	coordinating the application of lawn fertilizer with a rain event to use this moisture to move the fertilizer into the soil	not recommended
Precision fertilizer application	using a spreader to uniformly apply fertilizer to the lawn	recommended
Fertilizer application, no schedule	applying fertilizer to the lawn and landscape with no set application schedule or as decided by the individual	not recommended
Fertilizer application, annual schedule	applying fertilizer to the lawn and landscape following an annual application schedule that maximizes plant growth	recommended
Excess fertilizer runoff	when a large amount of fertilizer is applied to the lawn or landscape it cannot be taken up by the plants it was applied to, and there is a potential for this excess fertilizer to runoff and enter streams, lakes, estuaries and groundwater	not recommended
Runoff from fertilizer spills	when fertilizer is applied to areas such as sidewalks, driveways or drainage ditches, it cannot be taken up by the plants it was intended for, and there is a potential for this fertilizer to runoff from these areas and enter streams, lakes, estuaries and groundwater	not recommended
Community fertilizer best management practices	the types of fertilizer management practices used in your community	variable (a)
Fertilizer best management practices	the types of fertilizer management practices that have been developed for your state/region that produce effective and efficient lawn and landscape care results	recommended

Note. 12 FMPs were identified in the literature as either a recommended fertilization practice or a practice that was not recommended due to its potential to impact water quality.
(a) refers to the best fertilization practices as defined by the community. Therefore, practices may or may not adhere to the recommended fertilizer management practices developed for the state/region to protect water quality.

RESULTS

Of the 737 individuals invited to complete the online questionnaire, 670 attempted to respond to it. Of the 670 individuals who attempted to respond, 260 met the three eligibility requirements and provided usable responses for data analysis.

Respondents were able to opt out of the five demographic questions. Therefore, not all questions had 260 responses. The gender ratio of the 260 respondents to this question was 70% female (n = 183) and 30% male (n = 77). The mean age of respondents (n = 257) was 49.6 years (SD = 16.4), with a minimum age of 18 years and a maximum age of 82. The respondents' (n = 240) mean gross household income was $70,074 (SD = $43,738), with a minimum income of $12,000 and a maximum income of $250,000 reported. There were 257 responses to the question about the highest level of education completed. The largest group of respondents (n = 92, 35.8%) indicated a high school diploma and the second largest (n = 80, 31.1%) selected an associate's degree (Table 3).

For the question about race, respondents were allowed to select all the options they identified with; therefore, 265 responses were reported. The majority of respondents (n =

Table 2. Semantic Differential Scale: Polar Adjective Pairs for the TPB Constructs

TPB Construct	Polar Adjective Pairs (Lower Value, Higher Value)	Interpretive Scale (Range from 1.00 to 7.00)
Attitude	harmful, beneficial	1.00 to 1.50 is extremely harmful; 1.51 to 2.50 is quite harmful; 2.51 to 3.50 is slightly harmful; 3.51 to 4.49 is neither harmful nor beneficial; 4.50 to 5.49 is slightly beneficial; 5.50 to 6.49 is quite beneficial; 6.50 to 7.00 is extremely beneficial
Perceived Norm	disagree, agree	1.00 to 1.50 is extremely disagree; 1.51 to 2.50 is quite disagree; 2.51 to 3.50 is slightly disagree; 3.51 to 4.49 is neither disagree nor agree; 4.50 to 5.49 is slightly agree; 5.50 to 6.49 is quite agree; 6.50 to 7.00 is extremely agree
Perceived Control	not at all, completely	1.00 to 1.50 is not at all; 1.51 to 2.50 is to a very small extent; 2.51 to 3.50 is to a small extent; 3.51 to 4.49 is to a moderate extent; 4.50 to 5.49 is to a large extent; 5.50 to 6.49 is to a very large extent; 6.50 to 7.00 is completely
Intention	definitely do not, definitely do	1.00 to 1.50 is definitely do not; 1.51 to 2.50 is probably do not; 2.51 to 3.50 is maybe do not; 3.51 to 4.49 is may or may not; 4.50 to 5.49 is maybe do; 5.50 to 6.49 is probably do; 6.50 to 7.00 is definitely do
Past Behavior	never, almost always	1.00 to 1.50 is never; 1.51 to 2.50 is rarely; 2.51 to 3.50 is seldom; 3.51 to 4.49 is irregularly; 4.50 to 5.49 is occasionally; 5.50 to 6.49 is frequently; 6.50 to 7.00 is almost always.

Note. The polar adjective pairs used for the five TPB constructs were selected from a sample of measures presented in the appendix of Fishbein and Ajzen (2010).

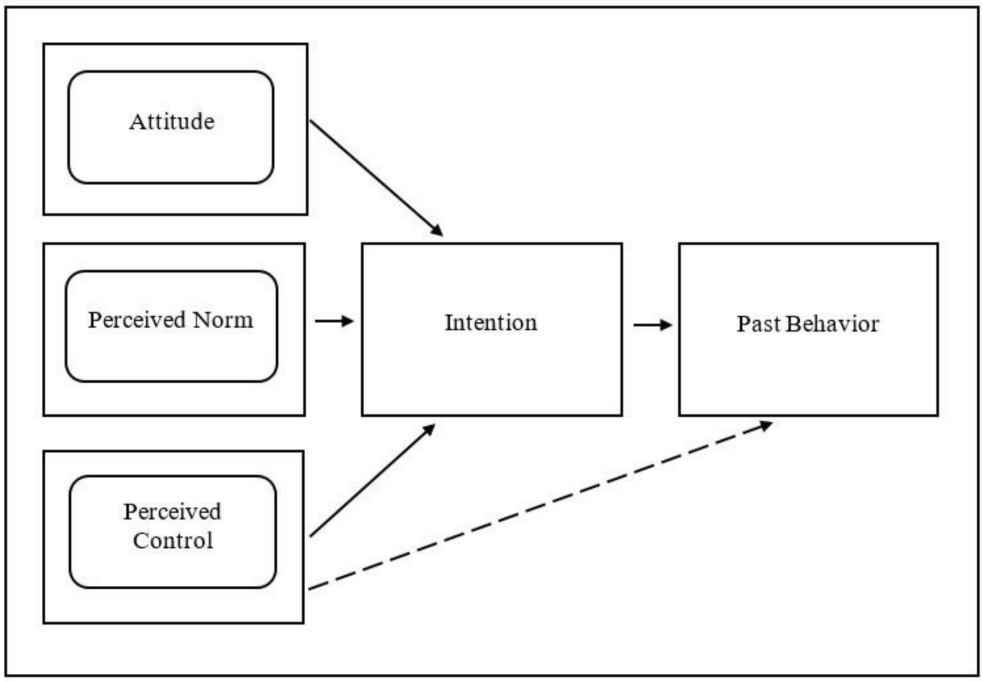

Figure 1. Measures of attitude, perceived norm, and perceived control and the contribution to intention to perform, and intention and perceived control's contribution to past behavior of selected fertilizer management practices.

215, 82.7%) indicated their race as Caucasian. The second most frequently selected race was African American (n = 36, 13.8%) (Table 4).

We asked the 260 respondents if they had ever applied fertilizer to their home lawns and/or the landscapes at their current or former residences. The majority of respondents (n = 192, 73.8%) selected "Yes" and 68 respondents (26.2%) selected "No." We asked the 68 respondents who had not applied fertilizer to select all of the factors that had contributed to their behavior (Figure 3). We developed the list of contributing factors for this question from the responses given in the pilot study regarding FMP control factors (Fishbein & Ajzen, 2010). The greatest number of respondents (n= 25, 36.8%) selected "I do not have the financial means" (Figure 3).

The 192 homeowners who had applied fertilizer were provided a list of five different types of fertilizers and were asked to select all the fertilizer types they had applied to their home lawn and/or landscape (Figure 4). The type of fertilizer selected by the largest number of respondents was "Weed & Feed" (n = 126, 42.6%) (Figure 4). The "All-in-one fertilizer" category had the second largest number of responses (n = 71, 24.0%) (Figure 4).

Table 3. Education Level Completed by Louisiana Urban and Suburban Homeowners

Education Level	n	%
Grade Level (a)	7	2.7
GED	7	2.7
High School Diploma	92	35.8
Associate's Degree	80	31.1
Bachelor's Degree	28	10.9
Master's Degree	10	3.9
Doctoral Degree	33	12.9
Total	**257 (b)**	**100**

Note. (a) The grade levels specified were: first grade (n = 1), ninth grade (n = 2), 10th grade (n = 1), two years of college (n = 2), and some college (n =1). (b) Three study participants did not provide a response to this question.

Table 4. Race of Louisiana Urban and Suburban Homeowners

Race Category	Yes		No		Total	
	n	%	n	%	n	%
White or Caucasian	215	82.7	45	17.3	260	100
Black or African Am.	36	13.8	224	86.2	260	100
Other Race (a)	5	1.9	255	98.1	260	100
American Indian or Alaska Native (b)	3	1.2	257	98.8	260	100
Asian Indian	2	0.8	258	99.2	260	100
Chinese	1	0.4	259	99.6	260	100
Japanese	1	0.4	259	99.6	260	100
Korean	1	0.4	259	99.6	260	100
Vietnamese	1	0.4	259	99.6	260	100

Note. Responses do not total 260, as respondents were asked to select all the race categories that applied. Zero respondents reported race categories of Filipino, other Asian, Native Hawaiian, Guamanian or Chamorro, Samoan, or other Pacific Islander.

(a) The other races specified were American (n = 1), Mixed (n = 2), Cajun (n = 1), and Sicilian (n =1). (b) The reported American Indian or Alaska Native enrolled or principal tribes were Blackfoot (n =1) and Chitamacha (n =1). One respondent did not specify their enrolled or principal tribe.

We further asked the 192 homeowners who had applied fertilizer to indicate the amount of fertilizer they would consider applying to their lawn in a single application. The majority of respondents (n = 149, 77.6%) reported that they would "[a]pply amount listed on the product label" (Figure 5). However, the response selected by the second largest group (n = 35, 18.2%) was "Apply the entire bag" (Figure 5).

We analyzed the reliability of the scales for the TPB constructs ex post facto using Cronbach's (1951) alpha coefficients. Correlations can range from 0.0 (zero correlation) to 1.0 (perfect correlation), with 0.8 having generally good reliability (Cohen, 1988). The standards published by Hair, Black, Babin, and Anderson (2010) indicated that for exploratory studies, alpha coefficients between .60 and .70 are the lower limit of acceptability. Therefore, the reliability analyses we present here have acceptable Cronbach's alpha coefficients for the TPB constructs examined (Table 5). The highest and lowest FMP means that we found for the five TPB constructs are shown in Table 5, with the accompanying semantic differential scale interpretations.

The two results that indicated the greatest potential risk for nutrient runoff were the Soil testing practice and the "Watering in lawn fertilizer, rain event" practice. The 260 homeowners' mean response to the "Soil testing" practice's past behavior item was 2.85 (SD = 2.17), with a scale interpretation of *seldom*. Soil testing is a recommended practice because it allows more accurate determination of the nutrient content of the soil and allows for more precise application of nutrients (LSU AgCenter, 2007). Further, the 260 homeowners' mean response to the "Watering in lawn fertilizer, rain event" practice's perceived control item was 5.36 (SD = 1.73), with a scale interpretation of *having control to a large extent over correctly watering in lawn fertilizer when rain is expected*. Homeowners' mean response for intention was 4.83 (SD = 2.05) with a scale interpretation of *maybe they do intend to coordinate the application of lawn fertilizer when rain is expected*. Rainfall is not a recommended watering in method, as the amount of water being applied cannot be precisely controlled and can cause fertilizer runoff (Louisiana State Agricultural Center, 2007).

We completed 12 regression analyses to determine whether the independent variables, attitude, perceived norms, and perceived control, explained a significant portion of the variance in the dependent variable, intention. All 12 tests were significant, and the coefficient of determination (R^2) ranged from .103 to .521. Perceived norm was the only independent variable that significantly contributed to all of the models. Of the 12 tests analyzed, only the "Soil testing" practice (Table 6) had a model in which the single independent variable, perceived norm, made a significant contribution.

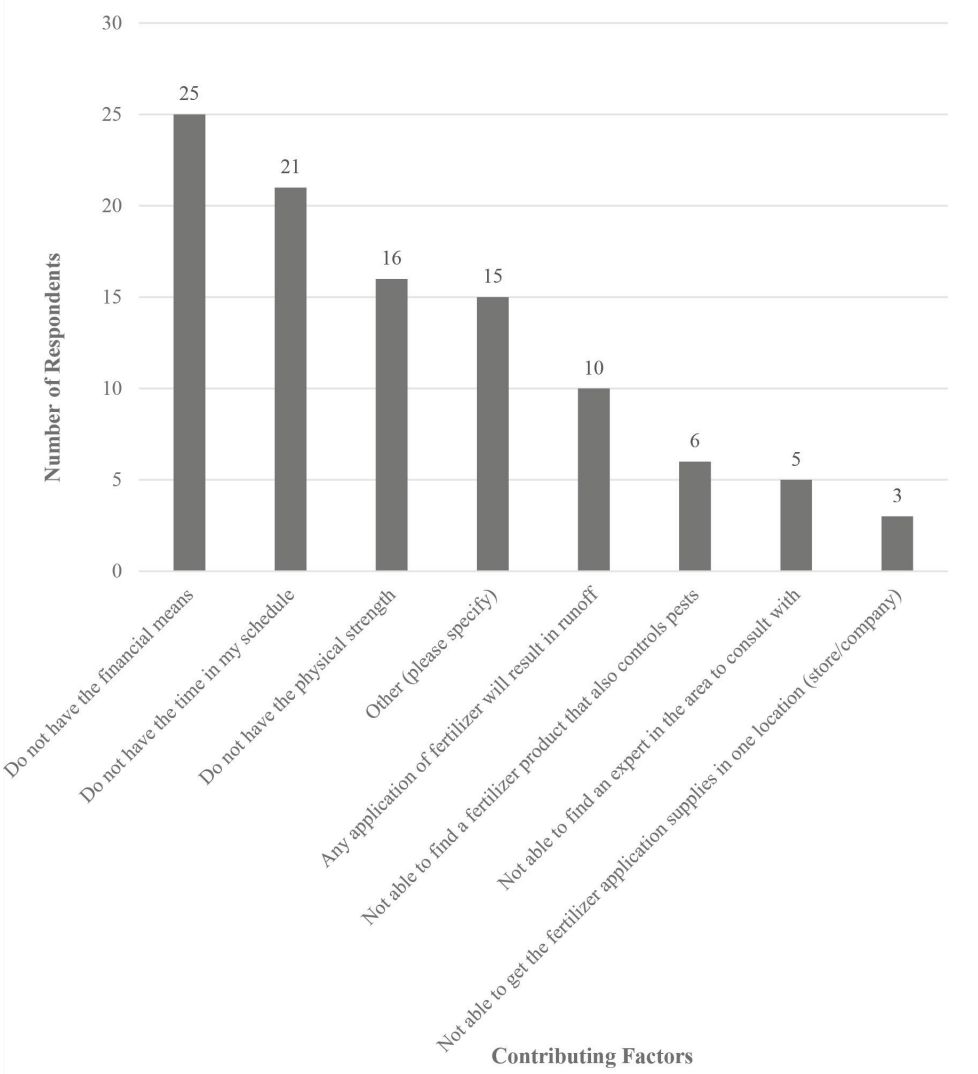

Figure 3. Factors that contribute to urban and suburban Louisiana homeowners not applying fertilizer. Responses totaled 101, as respondents were asked to select all of the factors that contributed to them not applying fertilizer. (a) The other factors specified were "never done this and would want to make sure I'm doing it right" and "not doing anything harmful to animals or environment" (n = 1), "Louisiana soil doesn't need fertilizer unless it's destroyed by commercial farming" (n = 1), "the patch of lawn I have isn't worth it" (n = 1), "done by lawn service – if at all" (n = 1), "someone else in my household does it" (n = 1), "do not do the lawn" (n = 1), "have never fertilized" (n = 1), "do not use fertilizer because I let my lawn grow wild and only cut it" (n = 1), "lawn grows without using it" (n = 1), "I do not need it" (n = 1), "do not fertilize my garden or grass" (n = 1), and "lack of interest" (n = 2). There were two respondents who selected "other" but did not specify the factor that contributed to them not applying fertilizers

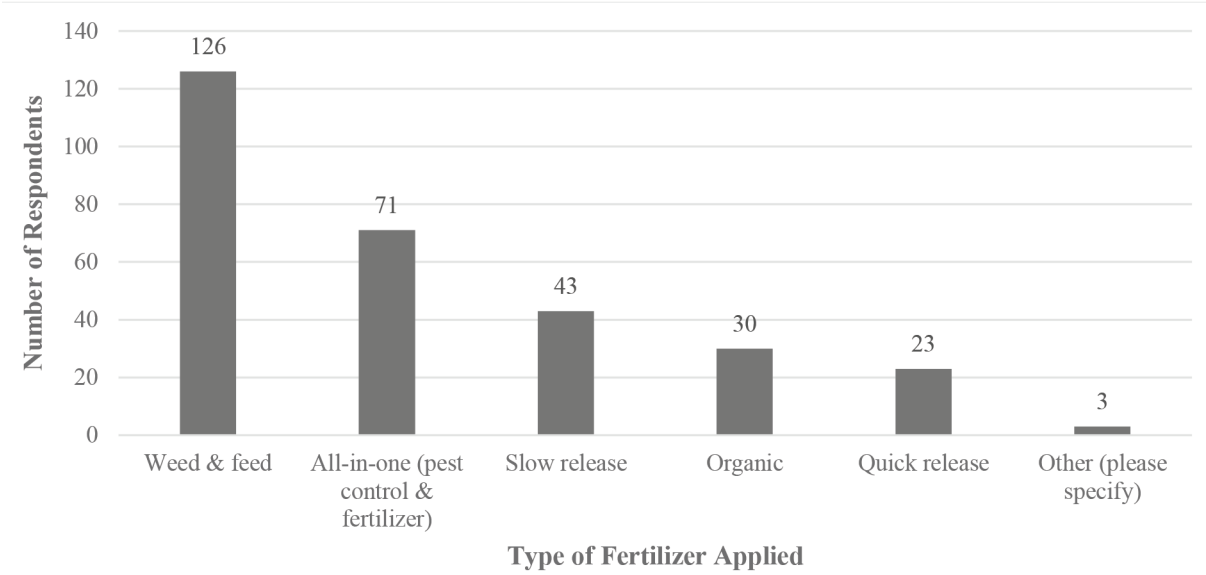

Figure 4. Types of fertilizer that have been applied to urban and suburban Louisiana homeowners' home lawns and/or landscapes.

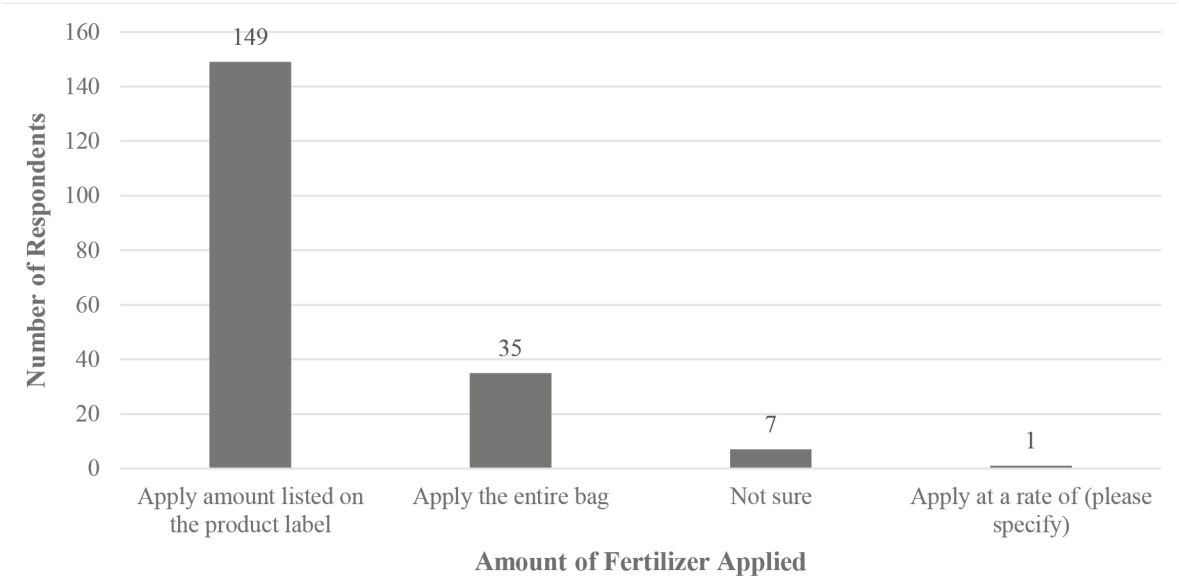

Figure 5. Amount of fertilizer that urban and suburban Louisiana homeowners would consider applying to their lawn in a single application.

Table 5. Descriptive Statistics of the TPB Constructs

TPB Construct	Cronbach's Alpha	FMP with Highest Mean (SD), Scale Interpretation	FMP with Lowest Mean (SD), Scale Interpretation
Attitude	.629	Calculating the area of lawn 6.25 (SD = 1.03), quite beneficial	Runoff from fertilizer spills 2.12 (SD = 1.68), quite harmful
Perceived Norm	.768	Following fertilizer product label directions 5.91 (SD = 1.17), quite agree	Runoff from fertilizer spills 2.48 (SD = 1.99), quite disagree
Perceived Control	.877	Calculating the area of lawn 6.14 (SD = 1.25), very large extent	Fertilizer application, no schedule 5.05 (SD = 1.92), to a large extent
Intention	.846	Following fertilizer product label directions 6.12 (SD = 1.15), probably do	Runoff from fertilizer spills 1.92 (SD = 1.64), probably do not
Past Behavior	.872	Following fertilizer product label directions 5.65 (SD = 1.40), frequently	Runoff from fertilizer spills 2.18 (SD = 1.62), rarely

Note. This is an abbreviated list of the construct means. The complete list of construct means for all 12 FMPs evaluated in this study are available upon request from the first author.

The other 11 tests analyzed had models with varying contributions of the three independent variables and are available upon request from the first author. The results for each FMP indicated which aspect of the behavior to target in an educational program to either change intention to perform a non-recommended practice or to enhance intention to perform a recommended practice.

Additionally, we completed 12 regression analyses to determine whether the independent variables, intention and perceived control, explained a significant portion of the variance in the dependent variable, past behavior. All 12 tests were significant, and the coefficient of determination (R2) for these tests ranged from .402 to .670. Of the 12 tests, only the "Following fertilizer product label directions" practice (Table 7) and the "Watering in lawn fertilizer, rain event" practice (Table 8) had a model in which both independent variables made a significant contribution.

The other 10 tests analyzed had a model in which only the independent variable intention made a significant contribution to the model. These tests are available upon request from the first author.

CONCLUSIONS AND RECOMMENDATIONS

The survey results informed which FMPs homeowners had been using and the TPB constructs that had the greatest potential to change behavior and enhance adoption of recommended practices (Fishbein & Ajzen, 2010). In our study, we found that perceived norm was the strongest determinant of intention to perform the "Soil testing," "Calculating the area of lawn," "Fertilizer best management," and the "Precision fertilizer application" practices, confirming their strong social component (Fishbein & Ajzen, 2010). Carey et al. (2012a) and Robbins and Sharp (2003) found that

Table 6. Summary of Regression Analysis of Variables Predicting Intention to Perform the Soil testing Practice (N = 260)

Variable	β	t
Attitude	.003	0.05
Perceived Norm	.275*	3.98
Perceived Control	.096	1.40

Note. R2= .103 and ΔF= 9.78 for the entire model. *p < 001.

Table 7. Summary of Regression Analysis of Variables Predicting Past Performance of the Following fertilizer product label directions Practice (N= 260)

Variable	β	t
Intention	.431*	8.20
Perceived Control	.370*	7.02

Note. R2= .493 and ΔF= 125.10 for the entire model. *p < 001.

Table 8. Summary of Regression Analysis of Variables Predicting Past Performance of the Watering in lawn fertilizer, rain event Practice (N= 260)

Variable	β	t
Intention	.735*	16.91
Perceived Control	.109	2.51

Note. RT= 6.29 and ΔF= 218.30 for the entire model.
*p < .001.

individuals are more likely to adopt fertilization practices if their neighbors are also implementing that practice. In an article by Shaw et al. (2011), the researchers found that the perceived norm significantly predicted participants' intention to install a rain garden and was subsequently targeted in Extension programming to increase that behavior.

Based on these findings, we recommend that perceived norms be targeted in an Extension nutrient management education program to strengthen communal support of important recommended FMPs. This recommendation is similar to the one made in the article by Chaudhary et al. (2017), which found perceived norms significantly predicted the water conservation behaviors of Florida residents. Using a communal or public space to teach residents the value of performing these four recommended practices can lead to these practices being accepted as social norms of the community (Israel & Hague, 2002). We recommend that County Extension agents or advanced master gardeners with nutrient management training develop community partnerships to establish demonstration sites in public/communal spaces in residential areas and routinely host field day events. Field day events should include tutorials on how to perform these recommended practices, as the communal performance may increase social acceptance and social obligation to use these recommended FMPs (Robbins et al., 2001).

From the results of the "Soil testing" FMP, we concluded that a soil test was a practice infrequently performed by this homeowner population. A soil test is a recommended FMP that provides a more accurate estimation of the types of nutrients to apply and in what amounts (LSU AgCenter, 2007). A perceived norm was the strongest determinant of intention to perform a soil test. However, in our study, the perceived norm only explained 10% of the variance in past behavior regarding the "Soil testing" practice. Hefner et al. (2009) studied why individuals participated in a lawn nutrient management program and found that 42% of the respondents indicated they participated specifically for the soil test rebate that was offered. Soil testing through a Cooperative Extension lab at a land grant university can cost an average of $10–$20 per sample to complete. The financial cost of completing a soil test could be an underlying barrier to the intention to perform this recommended practice within our study population. Future research should focus on how soil testing behavior may change when a soil test rebate is offered to this homeowner population through a lawn nutrient management program similar to the one discussed in Hefner et al. (2009).

We further concluded that the homeowners of our study may have intended to use a rain event to water in lawn fertilizer as they thought it was a beneficial practice they could control. The LSU AgCenter (2007) does not recommend that lawn fertilizer be watered in with rain, as this imprecise method can enhance fertilizer runoff. The results of our study indicated that homeowners have been experiencing uncertainty about intending to perform the "Watering in lawn fertilizer, rain event" practice and could be persuaded to change their behavior through a behavioral intervention (Fishbein & Ajzen, 2010). We recommend that homeowners' perceived control be targeted in an Extension nutrient management education program, as this construct was the strongest determinant of intention to water in fertilizer with a rain event. Educational outreach should teach homeowners how to use controlled irrigation such as sprinklers or hose attachments to evenly water in fertilizer to the lawn, and how these methods can reduce the potential for fertilizer runoff and the loss of product homeowners have purchased.

The most significant implication of our research was confirmation of the TPB's ability to identify determinants of a behavior to target for behavioral change. To improve the generalizability of future research on homeowners' FMPs, we recommend that a statewide random sample of urban and suburban residents be used to measure the TPB constructs of essential FMPs. Extension specialists could then use the results to design statewide nutrient management programming implemented through Cooperative Extension offices in urban/suburban regions. Lastly, in future research studies we recommend a mixed method approach that includes direct observations and interviews, in addition to collecting survey data, to more clearly understand the extent to which community aesthetics and judgments of neighbors are influencing the types of home lawn and landscape FMPs being used by residents (Nielson & Smith, 2005).

REFERENCES

Ajzen, I. (1991). The Theory of Planned Behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179–211.

Ajzen, I. (2017). *Behavioral interventions based on the Theory of Planned Behavior*. http://people.umass.edu/aizen/

pdf/tpb.intervention.pdf

Ajzen, I. (2019). *TPB diagram*. http://people.umass.edu/aizen/tpb.diag.html

Baker, R., Brick, J. M., Bates, N. A., Battaglia, M., Couper, M. P., Dever, J. A., Gile, K. J. and Tourangeau, R. (2013). *Report of the AAPOR task force on non-probability sampling*. American Association for Public Opinion Research. https://aapor.org/wp-content/uploads/2022/11/NPS_TF_Report_Final_7_revised_FNL_6_22_13-2.pdf

Carey, R. O., Hochmuth, G. J., Martinez, C. J., Boyer, T. H., Nair, V. D., Dukes, M. D., Toor, G., S., Shober, A. L., Cisar, J. L., Trenholm, L. E., & Sartain, J. B. (2012). A review of turfgrass fertilizer management practices: Implications for urban water quality. *HortTechnology*, *22*(3), 280–291.

Carey, R. O., Hochmuth, G. J., Martinez, C. J., Boyer, T. H., Dukes, M. D., Toor, G., S., and Cisar, J. L., (2013). Evaluating nutrient impacts in urban watersheds: Challenges and research opportunities. *Environmental Pollution*, *173*, 138–149.

Chaudhary, A. K., Warner, L. A., Lamm, A. J., Israel, G. D., Rumble, J. N., and Cantrell, R. A. (2017). Using the Theory of Planned Behavior to encourage water conservation among Extension clients. *Journal of Agricultural Education*, *58*(3), 185–202.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Lawrence Erlbaum Associates.

Cohen, D. & Crabtree, B. (2006). Qualitative research guidelines project: Semi-structured interviews. Robert Wood Johnson Foundation. http://www.qualres.org/HomeSemi-3629.html

Creswell, J. W. & Plano-Clark, V. L. (2011). *Designing and conducting mixed method research* (2nd ed.). SAGE Publications.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, *16*(3), 297–334.

Elo, S. & Kyngas, H. (2008). The qualitative content analysis process. *Journal of Advanced Nursing*, *62*(1), 107–115.

Fishbein, M. & Ajzen, I. (2010). Predicting and changing behavior: *The reasoned action approach*. Psychology Press.

Florida-Friendly Landscaping Program. (2015). *The Florida yards and neighborhoods handbook*. University of Florida Institute of Food and Agricultural Sciences. http://ffl.ifas.ufl.edu/materials/FYN_Handbook_2015_web.pdf

Hair, J. F. Jr., Black, W. C., Babin, B. J., and Anderson, R. E. (2010). *Multivariate data analysis*. (7th ed.). Prentice Hall.

Hefner, S. G., Robertson, C., Coulter, A., and Stevens, G. (2009). Engaging citizens to urban nutrient planning of lawns within a nutrient sensitive watershed. *Journal of Extension*, *47*(4). https://archives.joe.org/joe/2009august/iw5.php

Israel, G. D. & Hague, G. W. (2002). A recruiting challenge for Extension education: A comparison of nonparticipants and participants in homeowner landscaping programs. *Journal of Agricultural Education*, *43*(4), 76–87.

Louisiana Department of Environmental Quality (2016). *2016 Louisiana water quality inventory: Integrated report*. http://www.deq.louisiana.gov/page/469/

Louisiana Department of Environmental Quality (2017). *Nutrient reduction and management strategy*. http://deq.louisiana.gov/page/nutrient-management-strategy

Louisiana Department of Natural Resources (2008). *Urban storm water runoff: Best management practices for coastal Louisiana nonpoint source pollution*. http://dnr.louisiana.gov/assets/docs/coastal/interagencyaff/nonpoint/BMP-Publication-Urban-Final.pdf

Louisiana Nutrient Management Strategy Interagency Team (2014). Louisiana nutrient management strategy: *Protection, improvement, and restoration of water quality in Louisiana's water bodies*. Coastal Protection and Restoration Authority of Louisiana, Louisiana Department of Agriculture and Forestry, Louisiana Department of Environmental Quality, and Louisiana Department of Natural Resources.

Louisiana State University Agricultural Center (2007). *A guide to Louisiana-friendly landscaping*. http://www.lsuagcenter.com/nr/rdonlyres/f8ab47f4-acb4-4533-8fe8-5b3f91754996/40293/pub2993layardshighres.pdf

Louisiana State University Agricultural Center (2008). *Louisiana lawns best management practices* (BMPs). http://www.lsuagcenter.com/~/media/system/7/c/8/e/7c8e4b17a12a51839443d9296bd03edc/pub2940louisianalawnsmarch2008.pdf

National Research Council (2008). *Mississippi River water quality and the Clean Water Act: Progress, challenges, and opportunities*. National Academies Press. https://www.nap.edu/catalog/12051/mississippi-river-water-quality-and-the-clean-water-act-progress

National Research Council (2009a). *Nutrient control actions for improving water quality in the Mississippi River Basin and Northern Gulf of Mexico.* National Academies Press. https://www.nap.edu/catalog/12544/nutrient-control-actions-for-improving-water-quality-in-the-mississippi-river-basin-and-northern-gulf-of-mexico

National Research Council (2009b). *Urban stormwater management in the United States*. National Academies Press. https://www.nap.edu/catalog/12465/urban-stormwater-management-in-the-united-states

Natural Resources Conservation Service (2018). *Summary report: 2015 national resources inventory.* U.S. Department of Agriculture. https://www.nrcs.usda.gov/

Internet/FSE_DOCUMENTS/nrcseprd1422028.pdf
Nielson, L. & Smith, C. L. (2005). Influence on residential yard care and water quality: Tualatin Watershed, Oregon. *Journal of the American Water Resources Association*, *41*(1), 93–106.
Qualtrics (2014). *ESOMAR 28: 28 questions to help research buyers of online samples*. http://success.qualtrics.com/rs/qualtrics/images/ESOMAR%2028%202014.pdf
Robbins, P. & Birkenholtz, T. (2003). Turfgrass revolution: Measuring the expansion of the American lawn. *Land Use Policy*, *20*, 181–194.
Robbins, R., Polderman, A., & Birkenholtz, T. (2001). Lawns and toxins: An ecology of the city. *Cities*, *18*(6), 369–380
Steinmetz, H., Knappstein, M., Ajzen, I., Schmidt, P., & Kabst, R. (2016). How effective are behavior change interventions based on the Theory of Planned Behavior? *Zeitschrift für Psychologie*, *224*(3), 216–233
Shaw, B. R., Radler, B. T., Chenoweth, R., Heiberger, P., & Dearlove, P. (2011). Predicting intent to install a rain garden to protect a local lake: An application of the Theory of Planned Behavior. *Journal of Extension*, *49*(4). https://archives.joe.org/joe/2011august/pdf/JOE_v49_4a6.pdf
U.S. Census Bureau American FactFinder (2016a). *Louisiana population, housing units, area, and density: 2010 – State – County / County Equivalent*. http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?src=CF
U.S. Census Bureau American FactFinder (2016b). Urban and rural [6] Universe: Housing units 2000 census summary file 1. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_00_SF1_H002&prodType=table
U.S. Census Bureau American FactFinder (2016c). Urban and rural [6] Universe: Housing units 2010 census summary file 1. https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=DEC_00_SF1_H002&prodType=table
U.S. Environmental Protection Agency (2005). *National management measures to control nonpoint source pollution from urban areas* (EPA-841-B-05-004). https://www.epa.gov/sites/production/files/2015-09/documents/urban_guidance_0.pdf
U.S. Environmental Protection Agency (2014). *Nutrients: How much is too much?* https://www.epa.gov/sciencematters/epa-science-matters-newsletter-nutrients-how-much-too-much-published-january-2014
Wu, J., Stewart, T. W., Thompson, J. R., Kolka, R. K., & Franz, R. K. (2015). Watershed features and stream water quality: Gain insight through path analysis in a Midwest urban landscape, U.S.A. *Landscape and Urban Planning*, *143*, 219–229.