ASSESSING THE ROLE OF NORMS AND INFORMATION IN SHAPING RESIDENTS' INTENTIONS TO ADOPT WATER QUALITY IMPROVEMENT PRACTICES ACROSS URBAN-TO-RURAL LANDSCAPES

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ABSTRACT

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Nonpoint source (NPS) pollution refers to pollution entering receiving waterbodies from diffuse sources, and is one of the main causes of water pollution in the United States. Best management practices (BMPs) and low impact development (LID) strategies are water and land management practices geared at reducing the effect of NPS pollution. This research focused on residents in northwestern Indiana and assessed their interest in adopting BMPs and LID strategies across the urban-to-rural gradient. Resident groups of interest include medium/large-scale farmers, small-scale farmers, rural non-farming residents, suburban residents, and urban residents. Specifically, this research explored residents' awareness of and attitudes towards water quality improvement practices, their likelihood of adopting these practices, and factors that influence their likelihood of adoption. Data was collected through a household survey that was mailed to residents of Porter and LaPorte counties. In addition to survey questions measuring respondents' awareness, attitudes, perceptions, likelihood of adoption, and demographics, the survey also contained an experimental component in the form of an information page. By using descriptive, bivariate and multivariate statistical procedures to analyze survey data, this research found that respondents generally reported high levels of awareness of and positive attitudes towards BMPs and LID strategies. Despite this, 41% of respondents reported a likelihood of adopting any water quality improvement practices. This research found that resident groups differed in their awareness of water quality improvement practices, as well as their descriptive and subjective norms associated with adopting these practices. Respondents valued improved environmental quality and reduced flash flood risk as benefits of adopting water quality improvement practices, and identified not knowing enough about specific conservation practices and concerns about how to install and maintain the practices as main barriers to adoption. Generally, respondents who were younger, perceived more problems with various potential water pollution sources, were more aware of water quality improvement practices, had more positive attitudes, had a stronger sense of personal

responsibility, sought information in the past about water quality problems, or perceived stronger social expectations from peers (i.e., subjective norms) were more likely to be interested in adopting water quality improvement practices in the next year. The role of information was more ambiguous. While information about how to choose, install and maintain specific water quality improvement practices may be useful for residents, the information treatment about the responsibility of each resident group for NPS pollution did not seem to affect respondents' likelihood of adoption. However, this research did find that respondents reacted differently to the information provided based on their initial self-reported likelihood of adoption prior to receiving any information. Based on these results, this research suggests strategies that may be used by public and private entities to motivate residents' adoption of water quality improvement practices, including but not limited to: (1) developing education programs that highlight both the broader environmental quality benefits and geography-specific practical benefits of water quality improvement; (2) developing technical assistance programs that help residents identify appropriate conservation practices for their homes and properties and that facilitate installation and maintenance of such practices; (3) developing communication strategies to help residents establish a sense of self-responsibility and align their perceived water quality problems with their own actions; and, (4) developing outreach programs to help establish and facilitate descriptive and subjective norms in favor of adopting water quality improvement practices at the watershed scale.

CHAPTER 1: INTRODUCTION

Nonpoint source (NPS) pollution enters receiving waterbodies from many diffuse sources through surface runoff, subsurface runoff, or atmospheric deposition. As runoff moves over and through the ground, pollutants are picked up, carried away, and deposited into lakes, rivers, streams, wetlands, coastal waters, and ground waters. Pollutants associated with NPS pollution include sediment, nitrogen, phosphorus, and pathogens, among others. NPS pollution is one of the primary contributing factors to surface water impairment in the United States. Driven by population growth and land use changes, it is challenging to define and to regulate NPS pollution because of its diffuse nature (Carpenter et al., 1998; Howarth, Sharpley, & Walker, 2002; Kaushal et al., 2011). However, effective control of NPS pollution is essential to protect and maintain the ecological functioning of America's waterbodies.

Recognizing the need to focus on NPS pollution, Congress enacted Section 319(h) (§319) of the Clean Water Act in 1987 to establish a national program aimed at reducing NPS pollution. Through §319, the United States Environmental Protection Agency (EPA) provides guidance and grant funding to states, territories, and tribes to implement programs to reduce NPS pollution. From 2008 to 2013, roughly 1,968 agricultural projects and 1,507 urban projects took place with support from §319 (United States Environmental Protection Agency, 2016). However, in 2013, states reported that agricultural NPS pollution was still the leading source of water quality impacts on surveyed rivers and lakes (United States Environmental Protection Agency, 2016). In urban and suburban areas, significant challenges also exist due to mixed land ownership, diverse land uses, and large areas of impervious surfaces.

Best management practices (BMPs) and low impact development (LID) strategies are often used to control stormwater runoff and limit the movements of NPS pollutants (Chaubey, Chiang, Gitau, & Mohamed, 2010; Liu, Zhang, Wang, Chen, & Shen, 2013; Urbonas, 1994). In agricultural areas, nutrient management planning, livestock exclusion, conservation cropping, and riparian buffers are the most frequently used BMPs to offset NPS pollution. In urban settings, LID strategies include smaller-scale, on-site stormwater management practices that reduce the water quality impact of development, often through rain barrels, rain gardens, green roofs, porous pavements, vegetated swales, and bioretention systems (Dietz, 2007).

Local residents and land managers play a critical role in the effective control of NPS pollution. Since NPS pollution is fundamentally a human problem resulting predominately from agricultural practices and urbanization, it is essential to incorporate human dimensions into any endeavor to reduce NPS pollution. Without understanding how local residents and land managers make decisions to adopt (or not) BMPs and LID strategies and factors influencing their adoption decisions, it will be difficult to adequately assess the potential for water quality improvement practices to reduce NPS pollution. Ultimately, BMPs and LID strategies can only be effective if individuals within a watershed are willing to implement these practices. Substantial research has been conducted to model the biophysical potential for using various BMPs and LID strategies to reduce NPS pollution from urban and rural land uses (Engel, Storm, White, Arnold, & Arabi, 2008; Maringanti, Chaubey, & Popp, 2009; Shields et al., 2008; Veith, Wolfe, & Heatwole, 2003). There is a need to incorporate watershed residents' willingness to adopt these practices into these models in order to quantify the realistic, cumulative potential of various practices at the watershed scale. Results from integrated models will help inform watershed-focused public and private investment strategies to reduce NPS pollution across all land uses.

Giving the diversity of NPS pollutants and possible mitigation practices, as well as the various land uses often present within a watershed, an interdisciplinary approach is necessary to address the NPS pollution problem across mixed land uses. This research is situated within a larger interdisciplinary project at Purdue University and has been conducted in collaboration with colleagues from the Department of Agricultural and Biological Engineering and with support from the Illinois-Indiana Sea Grant. The overall goal of the larger project is to assess societal acceptance and biophysical potential of conservation practices for reducing nutrient, sediment, and pathogen loading from urban and agricultural sources in the East Branch-Little Calumet River Watershed and Trail Creek Watershed in northwest Indiana. These two watersheds are part of the larger Little Calumet-Galien Watershed, which is the only watershed in Indiana that drains directly to Lake Michigan. The larger project aims to (1) characterize current N, P, sediment, and *E. coli* loading to Lake Michigan from resident groups within the watershed through modelling to generate baseline loads, (2) determine the willingness of different resident groups to adopt conservation practices that reduce those pollutants in the watersheds and the role of information in shaping that willingness to adopt, and (3) aggregate potential N, P, sediment, and E.C coli removal at the watershed scale based upon the willingness of the different groups to adopt conservation practices.

Within this larger project, this research focuses primarily on the human dimensions of conservation efforts to improve water quality. The second chapter of this thesis (1) assesses watershed residents' awareness of water quality improvement practices, their attitudes towards these practices, and self-reported likelihood of adoption; (2) examines watershed residents' perceptions of water quality problems and sources of pollution; (3) explores the influence of personal, descriptive, and subjective norms on watershed residents' likelihood of adopting water quality improvement practices; and, (4) identifies potential benefits associated with and barriers to adoption of water quality improvement practices. Specifically, this chapter examines and compares these four aspects across five watershed resident groups. The third chapter focuses primarily on identifying and assessing factors that influence watershed residents' self-reported likelihood to adopt water quality improvement practices, with a particular focus on determining the role of information in shaping residents' perceptions. The final chapter synthesizes findings from previous chapters to discuss potential strategies that can be used by water quality programs to engage watershed residents in water quality improvement efforts across the urban-to-rural gradient.

References

Carpenter, S. R., Caraco, N. F., Correll, D. L., Howarth, R. W., Sharpley, A. N., & Smith, V. H. (1998). Nonpoint pollution of surface waters with phosphorus and nitrogen. *Ecological Applications*, *8*(3), 559–568. https://doi.org/10.1890/1051-0761(1998)008[0559:NPOSWW]2.0.CO;2

Chaubey, I., Chiang, L., Gitau, M. W., & Mohamed, S. (2010). Effectiveness of best management practices in improving water quality in a pasture-dominated watershed. *Journal of Soil and Water Conservation*, *65*(6), 424–437. https://doi.org/10.2489/jswc.65.6.424

Dietz, M. E. (2007). Low Impact Development Practices: A Review of Current Research and Recommendations for Future Directions. *Water, Air, and Soil Pollution*, *186*, 351–363. https://doi.org/10.1007/s11270-007-9484-z

Engel, B., Storm, D., White, M., Arnold, J., & Arabi, M. (2008). A hydrologic/water quality model application protocol. *Journal of American Water Resources Association*, *43*(5), 1223–1236.

Howarth, R., Sharpley, A., & Walker, D. (2002). Sources of Nutrient Pollution to Coastal Waters in the United States: Implications for Achieving Coastal Water Quality Goals. *Estuaries*, *24*(4b), 656–676. Retrieved from https://link.springer.com/content/pdf/10.1007%2FBF02804898.pdf

Kaushal, S. S., Groffman, P. M., Band, L. E., Elliott, E. M., Shields, C. A., & Kendall, C. (2011). Tracking Nonpoint Source Nitrogen Pollution in Human-Impacted Watersheds. *Environ. Sci. Technol*, *45*, 8225–8232. https://doi.org/10.1021/es200779e

Liu, R., Zhang, P., Wang, X., Chen, Y., & Shen, Z. (2013). Assessment of effects of best management practices on agricultural non-point source pollution in Xiangxi River watershed. *Agricultural Water Management*, *117*, 9–18. https://doi.org/10.1016/j.agwat.2012.10.018

Maringanti, C., Chaubey, I., & Popp, J. (2009). Development of a multiobjective optimization tool for the selection and placement of best management practices for nonpoint source pollution control. *Water Resources Research*, *45*, W06406.

Shields, C. A., Band, L. E., Law, N., Groffman, P. M., Kaushal, S. S., Savvas, K., Fisher, G.T., Belt, K. T. (2008). Streamflow distribution of non-point source nitrogen export from urban-rural catchments in the Chesapeake Bay watershed. *Water Resources Research*, *44*, W09501.

United States Environmental Protection Agency. (2016). *National Nonpoint Source Program: A Catalyst for Water Quality Improvements*.

Urbonas, B. (1994). Assessment of stormwater BMPs and their technology. *Water Science and Technology*, *29*(12), 347–353.

Veith, T. L., Wolfe, M. L., & Heatwole, C. D. (2003). Optimization procedure for cost effective BMP placement at a watershed scale. *Journal of American Water Resources Association*, *39*(6), 1331–1343.

CHAPTER 2: RESIDENTS' AWARENESS, ATTITUDES, NORMS AND BEHAVIORAL INTENTIONS: IMPLICATIONS FOR WATER QUALITY IMPROVEMENT PROGRAMS

Abstract

The effectiveness of best management practices (BMPs) and low impact development (LID) strategies in addressing nonpoint source (NPS) water pollution is dependent on residents' adoption of such practices. While studies have explored factors motivating the likelihood of adopting water quality improvement practices in either agricultural or urban contexts, few have compared residents' awareness, attitudes, perceptions, and norms associated with water quality improvement across the rural-to-urban gradient. By analyzing survey data from 1,066 residents in northwestern Indiana, we assess their perceptions of water quality problems, awareness of and attitudes towards water quality improvement practices, personal and social norms associated with taking actions to reduce NPS water pollution, and potential benefits and barriers associated with adopting water quality improvement practices. In particular, we examine the similarities and differences across five resident groups (i.e., urban residents, suburban residents, rural non-farming residents, small-scale farmers, large/medium-scale farmers). Despite general awareness and positive attitudes across all resident groups, less than half of respondents indicated a likelihood to adopt conservation practices in the near future. Differences exist in residents' perceptions of sources of water pollution problems, as well as their perceived descriptive and subjective norms associated with adopting water quality improvement practices. Generally, respondents valued improved environmental quality and reduced flash flood risk as benefits of adopting water quality improvement practices, and identified not knowing enough about specific conservation practices and concerns about how to install and maintain the practices as main barriers to adoption. Though our study focuses on intention to adopt water quality improvement practices rather than actual adoption, these results suggest challenges for future water quality improvement programs. Potential opportunities and strategies for overcoming these challenges are discussed, as well as the need for future research that encompasses the rural-to-urban gradient of mixed-land-use watersheds and landscapes.

Introduction

Nonpoint source (NPS) pollution refers to pollution that enters waterbodies from many diffuse sources through surface runoff, subsurface runoff, or atmospheric deposition. NPS pollution is a primary factor contributing to surface water impairment and is often driven by human activities such as agriculture and urbanization (Carpenter et al., 1998; Howarth, Sharpley, & Walker, 2002; Kaushal et al., 2011). Over the past 30 years, agricultural production in the U.S. and beyond has intensified—in general farmers are producing more food on less arable land and many agricultural inputs such as fertilizers and pesticides are being used, which are susceptible to processes that contribute to NPS pollution (Hoppe & Banker, 2010; Rudel et al., 2009). Likewise, the reduction in the amount of pervious surface associated with urbanization results in higher peak runoff rates that tend to increase sediment loads during development (Arnold & Gibbons, 1996; Hansen et al., 2005). Due to the diffuse nature of NPS pollution, defining and regulating NPS pollution is a challenge. However, effective control of NPS pollution is critical to the long-term ecological integrity of America's surface waterbodies as well as the economic and social values people place on surface waterbodies.

Best management practices (BMPs) and low impact development (LID) strategies have demonstrated effectiveness in controlling runoff and limiting the movement of pollutants (Chaubey, Chiang, Gitau, & Mohamed, 2010; Liu, Zhang, Wang, Chen, & Shen, 2013; Urbonas, 1994). BMPs are traditionally conservation practices which treat stormwater runoff before it reaches receiving waterbodies and include large-scale practices such as retention ponds, detention basins, grassed swales, and wetland basins (Gilroy & McCuen, 2009; Logan, 1990, 1993), as well as location-specific practices such as conservation tillage, nutrient management, cover crops, and integrated pest management (Logan, 1990). Low impact development strategies usually refer to smaller-scale on-site practices that reduce the water quality impact of development activities and preserve features of the development site through practices such as green roofs, rain barrels, bioretention systems, porous pavement, permeable patios, and wetland channels (Dietz, 2007). Though interchangeable, BMPs are often associated with agricultural water quality improvement efforts and LID strategies with urban or suburban efforts. In our research context, BMPs and LID strategies are collectively referred to as water quality improvement practices or conservation practices to improve water quality.

Several modelling tools exist to predict the impact of installing BMPs and LID strategies on a landscape by estimating the resulting water quality impacts due to their implementation (i.e., L-THIA-LID, SWAT, STEPL). Such tools are useful in demonstrating the biophysical potential of conservation practices to improve water quality under various objective functions and constraints as well as according to cost-effectiveness criteria (Ahiablame, Engel, & Chaubey, 2012; Baillie, Kaye-Blake, Smale, & Dennis, 2016; Liu, Bralts, & Engel, 2015; Liu, Theller, Pijanowski, & Engel, 2016). However, since NPS pollution results predominately from human activities, it is essential to incorporate human dimensions into any endeavor to reduce NPS (Perry-Hill & Prokopy, 2014). The potential for BMPs and LID strategies to reduce nutrient loads to receiving waterbodies is constrained by the actual adoption and maintenance of these practices. Without understanding factors related to willingness of residents, land managers, and municipalities to adopt water quality improvement practices, applications of only biophysical and hydrological models would lead to inaccurate estimate of the potential for water quality improvements from various BMPs and LID strategies.

Conservation Behavior Adoption

There are two closely related but different bodies of literature examining the adoption of conservation behaviors. One focuses on the actual adoption of conservation behaviors and factors influencing such behaviors, and the other focuses on willingness to adopt or likelihood of adoption. In the context of motivating behavioral change, both bodies of literature can be relevant to this study. Specifically, previous research that examines factors that influence people’s actual adoption of BMPs has focused mainly in the agricultural context (e.g., Baumgart-Getz, Prokopy, & Floress, 2012; Greiner, Patterson, & Miller, 2009; Reimer, Weinkauf, & Prokopy, 2012). In general, agricultural producers’ adoption of conservation practices have been found to be positively associated with their education, income, awareness of water quality impairments, causes and consequences, strong information and communication channels, and participation in outreach programs (e.g., Prokopy, Floress, Klotthor-Weinkauf, & Baumgart-Getz, 2008; Rezvanfar, Samiee, & Faham, 2009). Less certainty exists about the influence of age and financial incentives on producers’ adoption (Baumgart-Getz et al., 2012; Prokopy et al. 2008).

Many of the same factors influencing actual adoption of conservation practices to improve water quality also influence their likelihood of adoption. Previous research has found that farmers’ willingness to adopt water quality improvement practices is positively associated with the number of years farmers have been residents on their farm, their education level, and strong stewardship motivations (e.g., Edwards-Jones, 2017; Motallebi et al., 2016; Perry-Hill & Prokopy 2014). Agricultural producers' likelihood of adopting conservation practices are also positively associated with their positive attitudes towards water quality and specific water quality improvement practices, awareness of environmental problems and potential benefits of adoption, and perceiving interest of adoption among peers (Cook & Ma, 2014a; Perry-Hill & Prokopy 2014). Kalcic, Prokopy, Frankenberger, & Chaubey (2014) found that financial incentives are relevant and have a positive influence on people's willingness to adopt when there is a higher perceived risk associated with BMPs. Most demographic variables such as age, seem to have less conclusive effect on willingness to adopt (e.g., Cook & Ma, 2014a).

In comparison to agricultural producers, less is known about urban residents' awareness of water quality impairments, their knowledge of relevant water quality improvement practices, their willingness or actual behavior of adopting such practices, and factors influencing their willingness to adopt and actual adoption and maintenance of those practices. Recent studies indicate that urban residents' intentions and actual adoption of water conservation practices are generally positively associated with residents' knowledge of water quality improvement practices (Brehm, Pasko, & Eisenhauer, 2013; Gao et al., 2016), participation in education campaigns (Dietz, Clausen, & Filchak, 2004), engagement in flower or vegetable gardening, and their positive attitudes toward protecting water resources (Gao et al., 2016; Newburn, Alberini, Rockler, & Karp, 2014). Additional studies have identified aesthetic appeal and perceived neighborhood norms as important factors influencing the adoption or non-adoption of native landscape design and perceptions of stormwater ponds (Gao et al., 2018; Persaud et al., 2016; Peterson et al., 2012; Nassauer, Wang, & Dayrell, 2009).

While few studies have focused on urban residents, even fewer have examined people's awareness, behaviors, and preferences related to water quality improvement practices across the urban-to-rural gradient. As many watersheds and landscapes have mixed land uses, it is imperative for water quality professionals, watershed coordinators, and outreach specialists and educators to develop a more complete understanding of how various resident groups and communities perceive water quality problems and how they make decisions to adopt BMPs and LID strategies across the urban-to-rural landscape. Without such understanding, they may miss opportunities to engage segments of the population critical for effectively managing NPS pollution in their watersheds or targeted landscapes.

Norms in Conservation

Previous research has also explored the role of norms in motivating behavior. Norms broadly fall into two categories: social norms and personal norms. Schwartz (1997) described personal norms as “feelings of moral obligation” (p. 227). In other words, personal norms are internal standards of appropriate behavior that arise from a belief that something is morally right or wrong (Raymond & Schneider, 2014; Stern, Dietz, Abel, Guagnano, & Kalof, 1999). Social norms, conversely, are prevalent behaviors or perceptions of prevalent behaviors within a reference group (Interis, 2011). Social norms can be further categorized as descriptive norms and subjective norms. Descriptive norms refer to the observed prevalence of a behavior within a reference group, whereas subjective norms refer to “the perceived social pressure to engage or not to engage in a behavior” (Ajzen, 1991, p. 188). In other words, subjective norms are associated what we think important others expect us to do in a given situation (Ajzen & Fishbein, 1980; ; Cialdini, Kallgren, & Reno, 1991; Farrow, Grolleau, & Ibanez, 2017). Different types of social norms may create different types of social influence. Specifically, the desire of people to conform with descriptive norms is called “informational social influence” which tends to be “genuine and unstrained,” while the desire to conform with injunctive norms is called “normative group pressure” which tends to be “managed, ambivalent, less genuine, and often conflicted” (McDonald & Crandall, 2015, p.147).

Social norms have been widely utilized in exploring the adoption or non-adoption of a variety of behaviors such as underage drinking, prejudice, and energy use, to name just a few (McDonald & Crandall, 2015), although scholars still argue that “normative social influence is underdetected” (Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008). Here, normative social influence is defined as “the influence of other people that leads us to conform in order to be liked and accepted by them” (Aronson, Wilson, & Akert, 2010, p. 223). The Theory of Planned Behavior (TPB), a popular behavioral framework which emphasizes the influence of attitudes, subjective (social) norms, and perceived behavioral control on behavioral intention, has been used extensively in research on pro-environmental behaviors (Ajzen, 1991; Armitage & Conner, 2001), such as air pollution reduction (Cordano & Frieze, 2000), park-and-ride use (De Groot & Steg, 2007), and transportation, energy use, recycling and other pro-environmental behaviors (e.g., Cheung, Chan, & Wong, 1999; Harland, Staats, & Wilke, 1999; Heath & Gifford, 2002). These studies generally suggest that subjective norms are important factors influencing people's intention and actual behavior of adopting pro-environmental behaviors. The TPB has also been used to explore behaviors related specifically to natural resource management including landowner intentions to harvest timber, participate in riparian programs, undertake stand improvement practices, and engage in reforestation efforts (e.g., Bieling, 2004; Corbett, 2002; Floress et al., 2018; Karppinen, 2005; Karppinen & Berghäll, 2015). These studies have provided some evidence suggesting the role of subjective norms in shaping natural resource management decisions, though they also highlight the limited number of studies that have explored subjective norms in this context (Flores et al., 2018). A recent review by Liu, Bruins, & Heberling (2018) identified three additional empirical studies, which examined some aspects of subjective norms (mostly using the language of peer pressure and social conformity) in relation to soil and water management. Two of the three studies were about organic farming, both suggesting the important role of social conformity and related beliefs in farmers' decision to adopt organic agriculture (Läpple & Kelley, 2013; Wollni & Andersson, 2014). The third study was the only one with a focus on water quality, examining how subjective norms shape people's decisions to adopt BMPs to reduce NPS pollution in the Skaneateles Lake Watershed of New York (Welch & Marc-Aurele, 2001). Specifically, this study compared early versus late adopters of BMPs and suggested that early adopters within a community may contribute to establishing a community norm for BMP adoption which could motivate other community members to adopt BMPs later.

Like the TPB, the Norm Activation Model (NAM) has been used for understanding the influence of personal norms on altruistic behaviors (Schwartz, 1977). For example, De Groot and Steg (2009) explored five different conservation-related behaviors and policies including household reduction in car use and perceived acceptability of energy conservation policies aimed at reducing CO_2 emission, and concluded that personal norms strongly contributed to the adoption of and perceived acceptability of these behaviors and policies. Personal norms have also been examined in other conservation-related contexts such as green tourism (Han, 2015), consumer behaviors associated with purchasing environmentally friendly products and traveling in environmentally friendly ways (Onwezen, Antonides, & Bartels, 2013), residents' participating in a green electricity program (Clark, Kotchen, & Moore, 2003), usage of public transportation

(Bamberg, Hunecke, & Bloaum, 2007), and residents' recycling behavior (Guagnano, Stern, & Dietz, 1995). Collectively, these studies demonstrate that strong personal norms can lead to both behavioral intention and actual adoption of pro-environmental behaviors. However, in addressing the complex challenge of reducing NPS pollution and identifying strategies for promoting the adoption of water quality improvement practices, few studies have used both types of norms (particularly social norms) to examine adoption intentions or behaviors. More importantly, while both personal and social norms have the potential to influence the adoption of conservation behaviors (Onwezen et al., 2013; Park & Ha, 2014), it is important to better understand their relative importance in a single context to help inform future education, outreach and policy programs in terms of engaging target population in water quality improvements.

As such, this paper builds upon previous research on adoption of conservation behaviors and the role of personal and social norms to address the following three questions: (1) What are residents' awareness of and attitudes towards water quality problems and conservation practices to improve water quality? (2) What are the norms associated with water quality improvements along the rural-to-urban gradient? and (3) what are the perceived benefits and barriers associated with adoption of water quality improvement practices? Below is a description of our study site and methods used for data collection and analysis, followed by our survey results and implications.

Methods

Study Site

Our geographic focus is Porter and LaPorte counties in northwestern Indiana. These two counties contain the Trail Creek and the East Branch-Little Calumet River watersheds (Figure 1). The Trail Creek and East Branch-Little Calumet River watersheds are located within the larger Little Calumet Galien watershed (Hydrologic Unit Code (HUC): 04040001), which is the only watershed in Indiana that flows directly into Lake Michigan. An analysis of the 2011 National Land Cover Database (NLCD) revealed major land cover types in the East Branch-Little Calumet River watershed include developed lands (20%), agricultural lands such as cover crops and pasture/hay (28%), forests and grasslands (36%), and water and wetlands (15%) (Figure 2). Similarly, land cover types in the Trail Creek watershed include developed lands (24%), agricultural lands (17%), forests and grasslands (44%), and water and wetland (14%) (Figure 3).

The Indiana Dunes National Lakeshore is also contained within the Trail Creek watershed. Given the diversity of land cover types in these two watersheds, our two-county research area provides a unique opportunity to explore the likelihood of adopting water quality improvement practices in the context of mixed land uses. In both watersheds, NPS pollution has been broadly identified as the primary source of pollutant loads because of human activity in both rural and urban land uses (Indiana Lake Michigan Coastal Program, 2014a, 2014b).

Data Collection

Data for this study was collected through a household survey that was distributed to Porter County and LaPorte County residents from February to April 2018. To inform the development of the survey questionnaire, face-to-face, semi-structured interviews were conducted with water quality professionals who had experience working in the East Branch-Little Calumet and Trail Creek watersheds from October to November 2017 (Appendix A).

Resident Survey

Because we are interested in understanding willingness to adopt water quality improvement behaviors and the associated role of personal and social norms across the rural to urban gradient, we needed to define and sample our resident types of interest. To do so, we overlayed block groups from the 2010 U.S. Census and land cover types from the 2011 National Land Cover Data (NLCD) in the software program ArcGIS Pro 2.2. For each block group in Porter and LaPorte counties, we determined the majority land cover type excluding open water, grassland, wetland, forest, industrial, and commercial coverage. Once the majority land cover type was determined through zonal statistics, an overlay of small-agriculture, large/medium agriculture, and rural residential shapefiles was added. We were then able to categorize block groups from the 2010 U.S. Census into five resident groups of interest: urban residential, suburban residential, rural residential, small agriculture, and large/medium agriculture. The urban residential group was defined as individuals residing in medium intensity or low intensity developed areas according to the 2011 NLCD data. The suburban residential group included residents living in open space developed land, low intensity developed land, or barren land classes according to the 2011 NLCD data. Adapting definitions from Perry-Hill and Prokopy (2014), we defined medium/large agricultural residents as individuals who are rural and have at least 50 acres of cultivated crops or pasture/hay; small agricultural residents as individuals who are rural and have less than 50 acres of cultivated crops or pasture/hay; and, rural, non-farming residents as individuals who are rural but do not have crops or hay/pasture. Both agricultural groups were designated by the cultivated crops classification in the 2011 NCLD and county parcel data taken from the Indiana Department of Homeland Security (IDHS). To generate the rural residential group, the locations of houses outside of incorporated cities and towns were obtained from the 2015 IDHS County Address Points geodatabase for both LaPorte and Porter Counties. Each address point with a valid house number was considered a rural residential point and was given two-acre buffer around the residence. The two-acre buffer was determined by averaging the area of influence around the house as indicated by fencing, shrub lines, and mowed lawns across 120 houses over both watersheds. Based on the classification of each Census block and how we defined the five resident groups of interest, we were able to reclassify each Census block as part of the five resident groups.

Our calculated sample size was 2,600 across five groups based on power calculations for a small to medium effect size, so we decided to draw a stratified random sample of 560 individuals from each residential group containing all Census blocks classified as part of that resident group. To do so, we purchased mailing addresses of residents from SSI Global (https://www.surveysampling.com/) and Farm Market ID (http://www.farmmarketid.com/). SSI Global possesses an extensive list of residents in Porter and LaPorte counties. We provided SSI Global our classification of each Census block, and SSI Global made a complete list of addresses in all Census blocks that belong to each resident group and drew a random sample of 560 addresses from each list. Together, they drew a total sample of 2,800 individuals. To ensure sufficient representation of agricultural residents, an additional 816 individual records were purchased from FarmMarketID, which represents their available grower records for Porter and LaPorte counties. These addresses were added to the list of 2,800 addresses from SSI Global. We removed 750 addresses that were duplicates, invalid according to the U.S. Postal Service, or corporate farms for a final sample size of 2,866. Following a modified Tailored Design Method (Dillman, Smyth, & Christian, 2014), we sent five waves of mail (including three survey waves and two postcard waves) to all residents in our list, and included a $2 bill as a token of appreciation with our first survey packet. A total of 386 survey questionnaires were returned because of inaccurate addresses or deceased individuals, and 1,066 survey questionnaires were completed and returned, giving us a final response rate of 43%.

The development of the survey questionnaire was informed by our qualitative interview results and the TPB sample questions (Ajzen & Fishbein, 1980; Ajzen, 2005; Ajzen, 1991). We also drew on a number of existing survey items from *The Social Indicator Planning and Evaluation System (SIPES) for Nonpoint Source Management* (Genskow & Prokopy, 2011). The final survey questionnaire consisted of 26 binary, Likert-scale, and multiple choice questions spanning seven sections: (1) residential classification questions, (2) general knowledge of and attitudes towards surface water resources, (3) conservation practices to improve water quality, (4) attitudes towards conservation practices to improve water quality, (5) social motivations to improve water quality, (6) water quality improvement program incentives and barriers, and (7) demographics. In the first section, we asked survey respondents a series of questions to self-determine their resident group which we used as the actual resident group variable for subsequent analyses. The survey questionnaire can be found in Appendix B and Appendix C.

Data Analyses

Potential non-response bias was examined. As a proxy to detect differences between respondents and non-respondents, we compared responses from early first-wave survey respondents (n=63) and third-wave survey respondents (n=83) with respect to respondents' demographic characteristics, self-reported likelihood of adoption, attitudes toward conservation practices to improve water quality, and familiarity with such practices (Armstrong & Overton, 1977). No statistically significant differences ($p \leq 0.05$) were detected except for age; respondents in the third (last) wave were younger on average than those in the first wave. We also compared respondents' demographic characteristics with average characteristics of Porter and LaPorte county residents according to the 2010-2017 Census data. Our respondents on average were older, more often male, more often white, wealthier, and more educated (Table 1). This suggests potential non-response biases and a need for using caution when interpreting the survey results. Missing data was also examined to explore any systematic non-response. For variables of interest, the number and percentage of missing responses were calculated. In addition, we explored which, if any, variables were consistently missing in combination with other variables of interest. No systematic non-response was found.

Univariate descriptive statistics were calculated to assess variable distributions and determine if any outliers existed; none were found. Bivariate relationships were explored using (1)

Pearson chi-square test for associations between two categorical variables, (2) Fisher's exact test for associations between two categorical variables when chi-square assumptions were violated, and (3) Kruskal-Wallis H test for associations between variables as a non-parametric alternative to one-way ANOVA. Where Kruskal-Wallis H test was conducted, a Bonferroni corrected p-value is also provided for more conservative inference (R. A. Armstrong, 2014). Responses from the large/medium agriculture group and those from the small agriculture group were combined for Kruskal-Wallis H tests due to the low response rate of farmers (Pennings, Irwin & Good, 2002; Ridolfo, Boone, & Dickey, 2013). Three social norm variables were constructed by using a number of survey items that were designed to capture the different types of norms. Specifically, each social norm variable was created by averaging a set of survey items for a given norm. High internal reliability was confirmed by the fact that calculated Cronbach alpha values were well above 0.7 (Table 2). All data analyses were done using software packages Stata 12.0 and R 3.5.1.

Results

Profile of Respondents

The average age of respondents was 59 years old (SD=14, Min=21, Max=96) and over half of respondents (63%) were male. Of 1,042 respondents, 36% had obtained a Bachelor's or graduate degree (Table 3). The majority of respondents (91%) owned their home. Over half (57%) of respondents shared responsibility for making decisions about their property or home with someone else, and approximately 8% indicated that someone else was entirely responsible for making decisions about their property or home. Thirty percent of respondents reported an annual income before tax of less than $50,000. For those respondents who were farmers, the average farm size was 95.4 acres (SD=222.6, Min=0.25 acres, Max=1,500 acres).

Awareness, Attitudes, and Likelihood to Adopt

Across all resident groups, over half of respondents (55%) reported being somewhat aware or very aware of conservation practices to improve water quality on a four-point Likert scale (1=never heard of them, 2=slightly aware, 3=somewhat aware, 4=very aware). In general, large/medium-scale farmers reported the greatest awareness (somewhat or very aware: 84%) followed by small-scale farmers (somewhat or very aware: 64%) and rural residents (somewhat or very aware: 55%) (Figure 4). No significant associations were found between respondents' self-reported awareness of water quality improvement practices and their education (χ^2=12.12, p =0.059) or income (χ^2=6.22, p =0.399). There was, however, a strong association between self-reported awareness and resident group (χ^2=25.272, $p < 0.05$) such that large/medium-scale farmers had greater self-reported awareness than did any other resident groups.

When asked about interest in learning more about conservation practices to improve water quality, 68% of respondents reported they were interested in receiving more information, with small-scale farmers reporting the greatest interest (73%) (Figure 5). In general, a majority of respondents (82%) reported a somewhat or very positive attitude towards conservation practices to improve water quality on a five-point Likert scale (1=very negative, 2=somewhat negative, 3=neither negative nor positive, 4=somewhat positive, 5=very positive). This trend was observed across all resident groups (Figure 6), and there was no statistically significant difference across resident groups.

Despite the generally positive attitudes, less than half (41%) of respondents indicated that they were either likely or very likely to install any water quality improvement practice in the next year. By resident group, small- and large/medium-scale farmers reported greater likelihood of adopting any practice in the next year than other resident groups (53% and 54% likely and very likely, respectively; on a five-point Likert-scale with 1=very unlikely, 2=unlikely, 3=neither unlikely nor likely, 4=likely, 5=very likely; Figure 7). However, this difference was not statistically significant. In terms of demographics, a negative association existed between respondents' likelihood and age (χ^2=117.53, $p < 0.05$). Positive associations existed between respondents' likelihood of adoption and their education (χ^2=38.97, $p < 0.05$), income (χ^2=40.67, $p < 0.05$), and owning their home (χ^2=11.466, $p < 0.05$). Respondents' likelihood of adoption was also positively associated with their self-reported awareness of water quality improvement practices (χ^2=88.10, $p < 0.05$), although there was no statistically significant association between likelihood to adopt and general attitudes towards conservation practices.

Perceptions of Water Quality and Sources of Water Pollution

We asked respondents to indicate their agreement with two opposite statements about water quality in local waterbodies. Twenty percent of respondents agreed or strongly agreed with the statement "I think water quality in local waterbodies is excellent" (on a five-point Likert scale with

1=strongly disagree, 2=disagree, 3=neither disagree nor agree, 4=agree, 5=strongly agree), and the level of agreement was relatively consistent across all resident groups (Figure 8). Relatedly, 81% of respondents agreed or strongly agreed with the statement "I am concerned about water quality in local waterbodies" (also on a five-point Likert scale), with urban, suburban, and rural residents reporting greater levels of concern than farmer residents (Figure 9).

When asked about sources of water pollution, the top three problem sources were (1) use of fertilizers, manure, and/or pesticides for crop production with 70% of respondents who considered it a moderate or severe problem on a four-point Likert scale (1=not a problem, 2=minor problem, 3=moderate problem, 4=severe problem), (2) excessive use of lawn fertilizer and/or pesticides with 68% who considered it a moderate or severe problem, and (3) use of salt and sand on paved roads with 61% who considered it a moderate or severe problem (Figure 10). Perceptions of water pollution sources differed by resident group (Figure 11). For example, urban, suburban, and rural residents viewed the use of fertilizers, manure, and/or pesticides from crop production as the most problematic source of water pollution whereas small- and large/medium-scale farmers were less concerned about this source. Urban and suburban residents tended to consider improperly maintained septic tanks as a more problematic source of water pollution than rural residents.

Norm Influences Across Resident Groups

Norms by Resident Group

Summary statistics for individual norm survey items can be found in Table 2. Residents did not significantly differ in terms of their personal norms (χ^2=6.731, p=0.081; with Bonferroni correction, p=0.162). In terms of social norms, farmers perceived stronger descriptive norms than other resident groups (χ^2=19.761, p<0.05; with Bonferroni correction, p<0.05). Farmers also generally reported stronger subjective norms than other resident groups (χ^2=7.932, p=0.05; with Bonferroni correction, p=0.20). However, the significant association between being a farmer and perceiving subjective norms disappears when using a Bonferroni correction. There was also no statistically significant difference among resident groups in terms of their perceived normative social influence (χ^2=6.07, p=0.11; with Bonferroni correction, p=0.37).

Norms by Demographics (gender, income, education)

There was no statistically significant associations between gender normative social influence (χ^2=0.363, p=0.55). However, male respondents tended to perceive stronger subjective norms than female respondents (χ^2=7.487, p<0.05; with Bonferroni correction, p=0.0372). Male respondents also reported higher perceived descriptive norms (χ^2=29.558, p<0.05; with Bonferroni correction, p<0.05). Personal norms also differed by gender when utilizing raw p-value, but this difference disappeared when applying the Bonferroni correction (Fisher's exact=0.063; with Bonferroni correction, p=0.378). In terms of education, there was no statistically significant associations between level of education and personal norms (Fisher's exact=0.758), normative social influence (χ^2=1.735, p=0.8845), or subjective norms (χ^2=2.265, p=0.8115). Respondents with at least a high school degree or GED tended to perceive stronger descriptive norms than those who had less education (χ^2=27.925, p<0.05; with Bonferroni correction, p<0.05). With respect to income, no statistically significant associations were found between income and personal norms (Fisher's exact=0.082; with Bonferroni correction, Fisher's exact=0.492) or subjective norms (χ^2=7.479, p=0.1874). Respondents with lower income tended to perceive stronger normative social influence, but this significant relationship disappeared when applying the Bonferroni correction (χ^2=13.159, p<0.05; with Bonferroni correction, p=0.1314). Respondents with higher income tended to perceive stronger descriptive norms (χ^2=27.7128, p<0.05; with Bonferroni correction, p=0.005).

Awareness, Attitudes, and Norms

We found no statistically significant associations between respondents' self-reported awareness of water quality improvement practices and normative social influence (χ^2=2.173, p=0.5374). However, respondents who were more aware of water quality improvement practices were more likely to perceive stronger subjective norms (χ^2=12.911, p<0.05; with Bonferroni correction, p=0.0288), perceive stronger descriptive norms (χ^2=111.341, p<0.05; with Bonferroni correction, p<0.05), and possess stronger personal norms (χ^2=13.097, p<0.05; with Bonferroni correction, p=0.0264) than those who were less aware. Similarly, we found no statistically significant associations between respondents' attitudes towards water quality improvement practices and normative social influence (χ^2=7.039, p=0.1338). However, respondents with more favorable attitudes tended to report stronger subjective norms (χ^2=48.129, p<0.05; with Bonferroni correction, p=0.0006), stronger descriptive norms (χ^2=31.551, p<0.05; with Bonferroni correction, p<0.05), and stronger personal norms (χ^2=112.816, p<0.05; with Bonferroni correction, p=0.0006).

Potential Benefits and Barriers

When asked about the potential benefits associated with adopting conservation practices that help improve surface water quality, the most important benefit was in fact improved environmental quality in general with 92% of respondents considering it moderately or very important (on a five-point Likert scale: 1=not important, 2=slightly important, 3=somewhat important, 4=moderately important, 5=very important), followed by reduced likelihood of flash floods (77% considered it moderately or very important). Improved surface water quality was reported as the third benefit overall with 74% of respondents considering it moderately or very important. Less than 30% of respondents considered income or monetary benefits as moderately or very important (Figure 12). We also asked survey respondents what would make them less interested in adopting conservation practices to improve water quality (Figure 13). Respondents reported (1) not knowing enough about the practices (66%), (2) difficulty installing the conservation practices (59%), and (3) difficulty maintaining the conservation practices over time (58%) as the top three factors that would make them less interested in adoption (Figure 1.13). No other factor was reported by more than half of the respondents. In contrast, only 13% of respondents agreed with the statement “For me, conservation practices are too expensive to implement” (n=1,042), and 10% agreed with the statement “For me, conservation practices are too complicated to implement” (n=1,043). Twenty-four percent of respondents claimed that “None of the conservation practices I am familiar with are relevant or applicable to my property or my home” (n=1,043).

Discussion

Our results show that across all resident groups, the majority of respondents were aware of conservation practices to improve water quality, with large/medium-scale farmers being the most aware. The high level of awareness reported is consistent with results reported by Gao, Church, Peel, and Prokopy (2018), which suggests that public awareness of water quality issues has increased over time. The highest level of awareness among large/medium-scale farmers is also not surprising given that various federal, state, and local agencies, as well as non-profit organizations, have been targeting these farmers for soil and water conservation programs over the past few decades, providing information about specific practices, technical assistance, and financial incentives to promote adoption of a broad range of conservation practices (Claassen et al., 2001; Dowd, Press, & Los Huertos, 2008; Perry-Hill & Prokopy, 2014; Reimer & Prokopy, 2014). What is concerning, however, is the significantly lower level of awareness among other resident groups (i.e., small-scale farmers, rural residents, suburban residents, and urban residents) across watersheds with mixed land uses. As recently studies have pointed out (e.g., Gao et al., 2016; Gao, Church, Peel, & Prokopy, 2018; Vogel et al., 2015) more effort is needed to engage urban, suburban and rural residents to promote non-agricultural practices that people could adopt to manage their property in a way that reduce water quality impacts (e.g., Dietz, Clausen, & Filchak, 2004; Newburn, Alberini, Rockler, & Karp, 2014; Peterson, Thurmond, Mchale, et al., 2012; Shin & McCann, 2018; Shuster, Morrison, & Webb, 2008). More importantly, there is a need to go beyond individual households to consider water quality improvement efforts at the neighborhood and community scales as many LID strategies (e.g., porous pavement, bioretention ponds, wetland channels) may only be realistically implemented at those scales (Freni, Mannina, & Viviani, 2010). Our results also point to an opportunity to engage small-scale farmers in water quality improvement as only slightly more than half of them were aware of relevant practices, but three-quarters were the interested in learning more about such practices (Perry-Hill & Prokopy, 2014). Traditionally, public agricultural programs, including outreach and education programs, have been targeting large/medium-scale farmers while small-scale farmers have been often left on their own to obtain information about practices and assistance to support their own endeavors (Hoppe, MacDonald & Korb, 2010). Only in recent years, small-scale farms and their economic, social and environmental values have started to receive increasing attention from both researchers and policy makers (Ahearn, 2011; Iles, 2017; Meyer et al., 2011; Perry-Hill & Prokopy, 2014). As such, there is an opportunity to engage small-scale farmers by tailoring outreach efforts and assistance programs to address their needs and concerns. As Iles (2017) pointed out in her study in Indiana, small-scale farmers generally have strong social and environmental values associated with their farming operation and thus may be more susceptible to adopting water quality improvement practices.

Despite our survey respondents' general awareness of conservation practices for improving water quality and a vast majority of them reporting positive attitudes towards these practices, only 41% reported some intention to adopt a relevant practice in the next year. The discrepancy between respondents' awareness and attitude and their likelihood of adoption indicates the existence of mitigating factors affecting their willingness to take actions. Furthermore, not everyone who reported likelihood of adoption would actually adopt water quality improvement practices. Indeed, in a review of agricultural BMP adoption, Prokopy et al. (2008) found that overall attitude was largely insignificant in determining adoption. Many other factors may influence the adoption of a new behavior, including but not limited to cost, perceived lack of self-efficacy, perceived lack of response-efficacy, and difficulty in maintaining the behavior, among others (e.g., Blake, 1999; Gifford & Nilsson, 2014).

In our study, we found that most respondents across all resident groups were concerned about water quality in local waterbodies, although different resident groups had different opinions about what caused the water quality problems. Urban, suburban, and rural non-farming residents were more likely to view the use of fertilizers, manure, and pesticides from crop production as a problem than were their farming counterparts. Likewise, urban and suburban residents were more likely to consider improperly maintained septic tanks as a problem than were their rural counterparts. Conversely, rural residents (both farmers and non-farmers) were generally less concerned with problems than were their urban and suburban counterparts. In brief, these results suggest that rural residents may perceive urban sources of water pollution to be more of a problem whereas urban and suburban residents perceive rural sources of water pollution to be more problematic. Previous research has shown that individuals are concerned about their own well-being and that blaming other individuals, groups, or organizations for a negative outcome serves as a coping mechanism (Gerber & Cherneski, 2006). Although assigning blame to others is a natural process of human psychology (Shaver, 1985), it may be counter-productive in terms of motivating behavioral change among the blamers and the blamed (Fahlquist, 2009) because an individual's appraisal of responsible agent (self vs. others vs. circumstantial) would evoke different emotional and subsequent behavioral responses to the same phenomenon or problem (Roseman, 1996). As such, having a sense of self-responsibility can be an important factor motivating the adoption of pro-environmental behaviors when the self is perceived to be a responsible agent compared with others (Eden, 1993). For example, Cooper, Poe, and Bateman, (2004) showed that perceived personal responsibility for the provisioning of environmental goods was significantly associated with the willingness of students from a U.K. university to pay for water quality improvements in a lake located on campus. McGuire, Morton, and Cast (2013) suggested that environmental responsibility may be used to activate the "good farmer identity" that integrates productivity and conservation, which can lead to the adoption of soil and water conservation practices. Ultimately, beliefs that others rather than self are causing water quality problems could become a barrier to motivating individuals to take actions in their own homes and/or on their properties and to engaging different resident groups in collective watershed management across the urban-to-rural gradient in watersheds of mixed land uses. Effort is needed to strategically communicate with different resident groups about their own impacts and the relevant actions that can be taken to reduce their impacts.

We found no statistically significant difference across resident groups in respondents' personal norm, subjective norms or perceived normative social influence when utilizing the Bonferroni correction for multiple hypothesis tests. However, many argue that the Bonferroni is an overly conservative adjustment that lends itself to reject potentially significant results (Armstrong, 2014; Drezner & Drezner, 2016; Narum, 2006). Using raw p-values, statistically significant differences existed across resident groups in their composite scores of descriptive and subjective norms. Specifically, farmers reporting stronger descriptive and subjective norms suggests that they seem to be more perceptive of peer expectation to adopt conservation practices to improve water quality. Interestingly, farmer respondents (small and large/medium) also reported higher likelihood of adopting conservation practices in the next year than other resident groups. As such, it is important to further explore why farmers seem to perceive stronger descriptive and subjective norms. Is it because farmers are more aware of the social expectation on them to adopt water quality improvement practices than other resident groups due to the large number of federal, state and local programs that target farmers? More importantly, what can federal, state and local programs do to strengthen perceived descriptive and subjective norms among urban, suburban and non-farming rural residents to make them feel a stronger sense of obligation to take actions to improve water quality? As pointed out by Liu et al. (2018), few empirical studies have examined social norms in an agricultural context and even less has been done across the rural-to-urban gradient; as such, it is important to explicitly explore the role of social norms to help inform our understanding of how people decide to engage in water quality improvement efforts.

Overall, the ambiguity of our norms-related results speaks to the very nature of studying social norms and social influence. Both personal and social norms play important roles in theories of social psychology (Ajzen, 1991; Cialdini, Reno, & Kallgren, 1990; Lapinski & Rimal, 2005) and economics (Akerlof & Kranton, 2000; Bicchieri, 2006; Gintis, 2014). As concepts of interest that span across disciplines and that have been operationalized and measured in different ways, researchers have highlighted the need for more robust operational definitions and applications of norms in various research contexts (Interis, 2011; Thøgersen, 2014; Wallen & Romulo, 2017). According to a review by Farrow et al. (2017), norm interventions on pro-environmental behaviors are generally effective; however, additional research is necessary to further elucidate how different types of norms operate simultaneously to affect behavioral change and how norm interventions may work differently for different pro-environmental behaviors and across various groups of people. Such nuanced understanding is critical for incorporating personal and social norms into development of outreach strategies to motivate behavioral change for improving water quality.

This study also reveals potential benefits and barriers associated with the adoption of conservation practices to improve water quality. Of all the potential benefits, respondents across resident groups were most interested in improved general environmental quality and reduced flash flood risk, followed by improved surface water quality. This suggests the importance of connecting water quality improvement with improvement of general environmental quality, possibly by explaining how improved water quality could be beneficial for aquatic habitats, fish populations, and the cascading effect on other animal populations, as well as recreational opportunities for humans. This may seem obvious to water quality professionals; however, our results suggest that making such connections for the general public could be more persuasive than highlighting improved water quality alone. Likewise, it is possible that our respondents associated water quality improvement with reduced soil erosion, hence, better soil management, which they may have connected with reduced flash flood risk. Regardless of the scientific validity of such connections, it is important for educators and outreach specialists to highlight the practical benefits associated with adopting water quality improvement practices, something that directly benefit the target audience and address their needs and concerns (Cook & Ma, 2014b). In terms of barriers to adopting conservation practices, the main factor identified was not knowing enough about which practice to adopt. As such, it is important for educators, outreach specialists, watershed managers, and other types of water quality professionals to provide not only general information about water quality improvement practices to different residential groups, but specific information and examples about what practices are most appropriate for what types of properties and under what circumstances. In addition, it is important to provide continued support after installation of conservation practices to ensure that residents understand how to maintain the practices so that installed practices continue to function to achieve their intended water quality improvement potential.

Conclusion

As urbanization and agricultural intensification continue with time, promoting the adoption of conservation practices across different types of residents has important implications for reducing NPS pollution across the landscapes. Despite a generally high level of awareness and positive attitudes towards water quality improvement practices, residents' self-reported likelihood of adoption still seems low. Our study discussed strategies that may be used by public and private entities to motivate adoption. One strategy is developing education and outreach programs that highlight both broader environmental quality benefits and geography-specific practical benefits of water quality improvement. Another is developing technical assistance programs that help residents identify appropriate conservation practices for their homes and properties and facilitate installation and maintenance of such practices. Another important aspect of engaging residents along the rural-to-urban gradient in water quality improvement efforts relates to public and private entities' ability to strategically communicate with different types of residents, helping them strengthen their personal and social norms associated with water quality improvement and align their perceived water quality problems with their own actions. Establishing a sense of self-responsibility can be an important step towards motivating residents to change their behaviors that affect water quality. Engaging all resident groups (rather than urban residents or farmers alone) is necessary for successful reduction of NPS pollution in watersheds with mixed land uses.

Our study results need to be interpreted with caution since our survey respondents tended to be older, more often white, wealthier, and more educated than the average residents reported by the U.S. Census. As wealthier and more educated individuals tend to report higher likelihood to adopt water quality improvement practices, our reported likelihood of adoption may be higher than the actual likelihood of adoption among the general public. This suggests the need for future research to better understand how water quality-related awareness, perceptions, and behaviors differ based on resident demographics and across different land use types. There is also a need for additional research on the role of norms in shaping not only residents' behavioral intention to adopt conservation practices, but their actual behaviors over time and across the urban-to-rural landscapes. Although the geographic focus of this study was northern Indiana, residents elsewhere can also be categorized into similar resident groups. Therefore, the results presented here can be informative for understanding how different resident groups perceive water quality problems and factors associated with their likelihood of adopting water quality improvement practices in other watersheds or landscapes with mixed land uses.

Tables and Figures

Table 1. A comparison of demographic characteristics of survey respondents from 2017 to the 2010-2017 estimates for Porter and LaPorte counties based on 2010 Census data from the United States Census Bureau.

Characteristic	**Survey respondents**	**LaPorte County**	**Porter County**
Age (% 65 and over)	36.3%	17.5%	15.9%
Sex (% male)	62.5%	51.5%	49.5%
Education (% with a Bachelor's degree or higher)	35.5%	17.6%	26.1%
Annual income before tax (% above $49,999 or median)	69.9%	$48,165	$64,874
Race (% white)	95.1%	85.1%	92.3%

Table 2. Survey item constructs for personal norms, subjective norms, descriptive norms, and normative social influence, including operationalization. The number below the construct identifies how many survey items were combined to generate that construct. Cronbach's alpha is reported as measure of internal consistency of survey items. To generate construct values, averages for each individual were taken for the corresponding survey items. Percentages represent percentage of total respondents that reported the indicated level of agreement with the survey item.

Norm Construct (# of items)	**Operationalization**	**Survey items**	**% Strongly Disagree or Disagree**	**% Neither Agree or Disagree**	**% Strongly Agree or Agree**	**Cronbach's Alpha**
Personal Norm (1)	Feelings of moral obligation to engage in a given behavior (Schwartz, 1977)	*We should keep our local waterbodies clean because it is the right thing to do*	1%	2%	97%	NA
Subjective Norm (4)	Perceived social pressure to perform or not to perform the behavior in question (Ajzen, 1991, p. 188)	*My family would like to see me adopting conservation practices to improve water quality.*	16%	63%	21%	0.9145
		My friends would like to see me adopting conservation practices to improve water quality.	16%	67%	17%	
		My neighbors would like to see me adopting conservation practices to improve water quality.	16%	69%	15%	
		Others in my community would like to see me adopting conservation practices to improve water quality.	13%	67%	20%	
Normative Social Influence (4)	The influence of other people that leads us to conform in order to be liked and accepted by them (Aronson, Wilson, & Akert, 2005)	*I would feel the need to adopt conservation practices to improve water quality if others in my family did so*	26%	51%	23%	0.9368
		I would feel the need to adopt conservation practices to improve water quality if my friends did so	28%	51%	21%	
		I would feel the need to adopt conservation practices to improve water quality if my neighbors did so	25%	47%	28%	
		I would feel the need to adopt conservation practices to improve water quality if others in my community did so	22%	45%	33%	
Descriptive Norm (4)	Perceptions of performance or nonperformance of a behavior, i.e. what people are doing (Cialdini et al., 1991)	*What have you noticed in terms of people around you adopting conservation practices to improve water quality in your area?*	**% Nobody has adopted**	**% A few have adopted**	**% Most have adopted**	**% I do not know if anyone has adopted**
		1. Among my family	32%	29%	10%	29%
		2. Among my friends	28%	32%	6%	34%
		3. Among my neighbors	27%	30%	5%	38%
		4. Among people in my community	16%	38%	5%	41%

Table 3. Demographic characteristics of survey respondents (2017).

Demographic characteristics		**% or mean (standard deviation)**	**N**
Age (years)		59 (14)	1,021
Male		62.5%	1,040
Education	Less than High School/GED	2.1%	22
	High School/GED	26.5%	276
	Some College	24.7%	257
	Associate's degree	11.2%	117
	Bachelor's degree	22.6%	235
	Graduate degree	13.0%	135
Annual income before tax	Less than $25,000	10%	93
	$25,000-$49,999	20.1%	188
	$50,000-$99,999	38.1%	356
	$100,000-$149,999	20%	185
	$150,000-$199,999	7.5%	70
	$200,000 or more	4.5%	42
Home ownership		91.1%	953
Total farm size (acres)		95.4 (222.6)	69

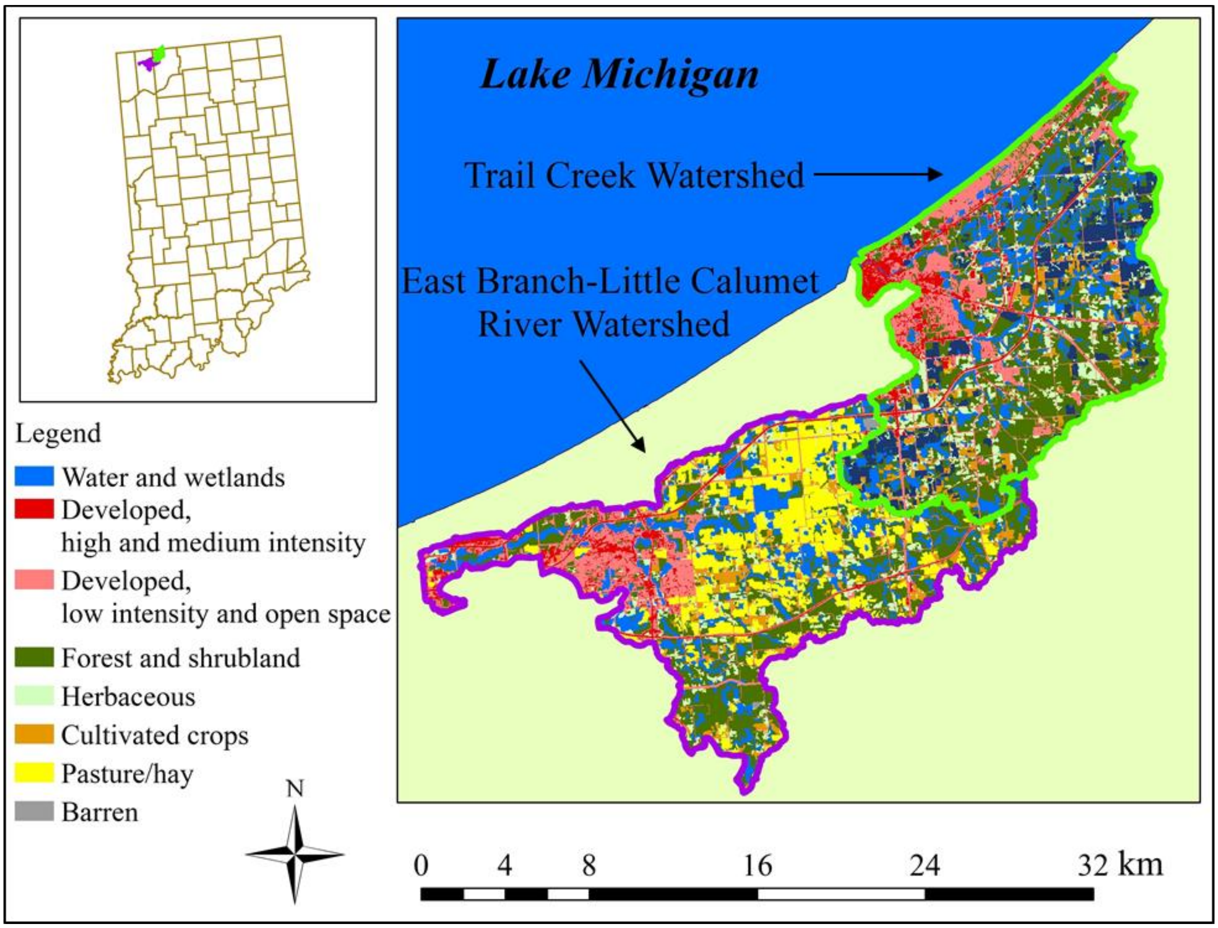


Figure 1. Overview of study site in northwestern Indiana. Land cover data taken from 2003 NLCD. Both watersheds are located within the larger Little Calumet-Galien (LCG) watershed.

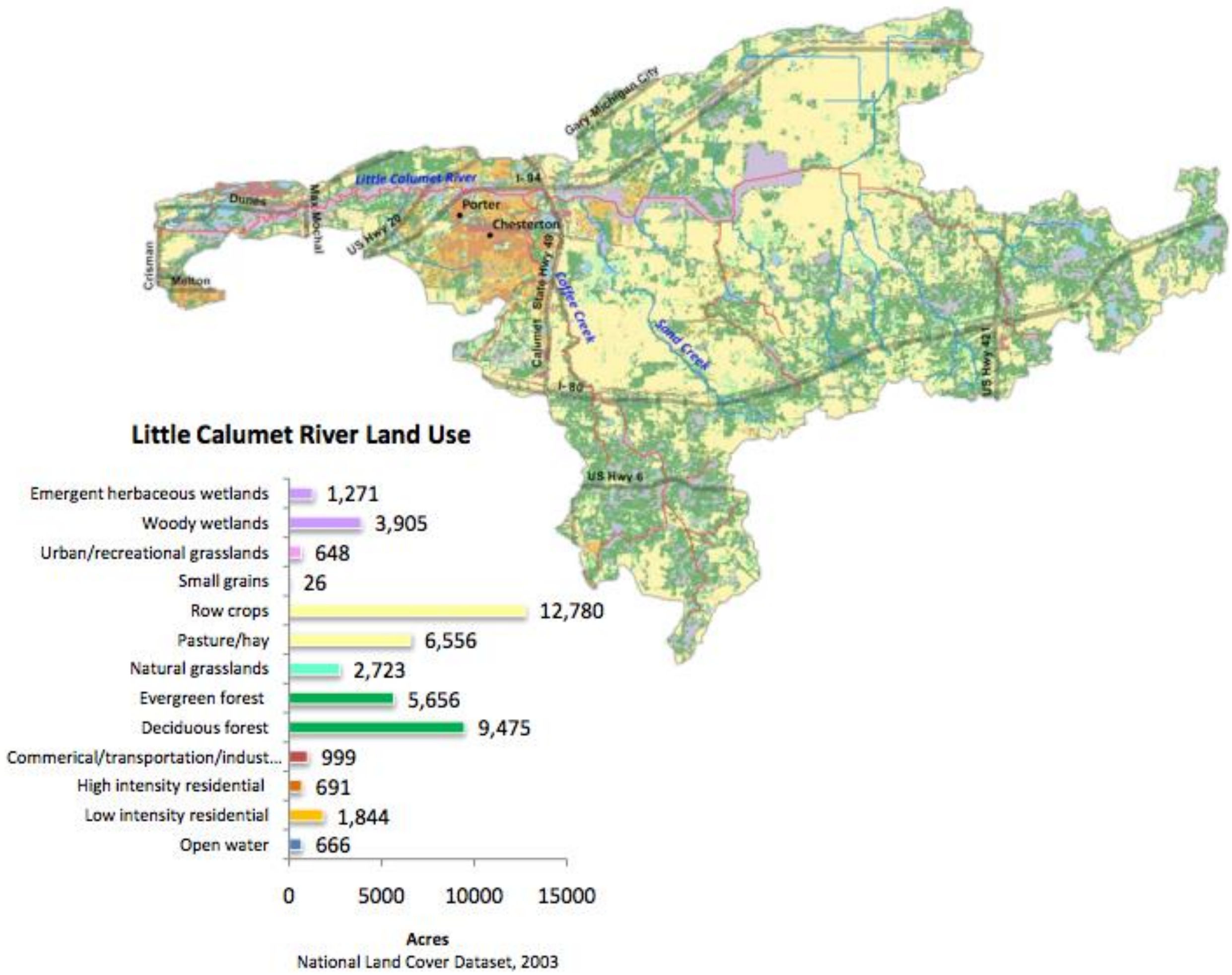


Figure 2. East Branch-Little Calumet Watershed land use map from Indiana Lake Michigan Coastal Program. Total watershed area encompasses 48,248 acres. Based on 2003 NLCD data.

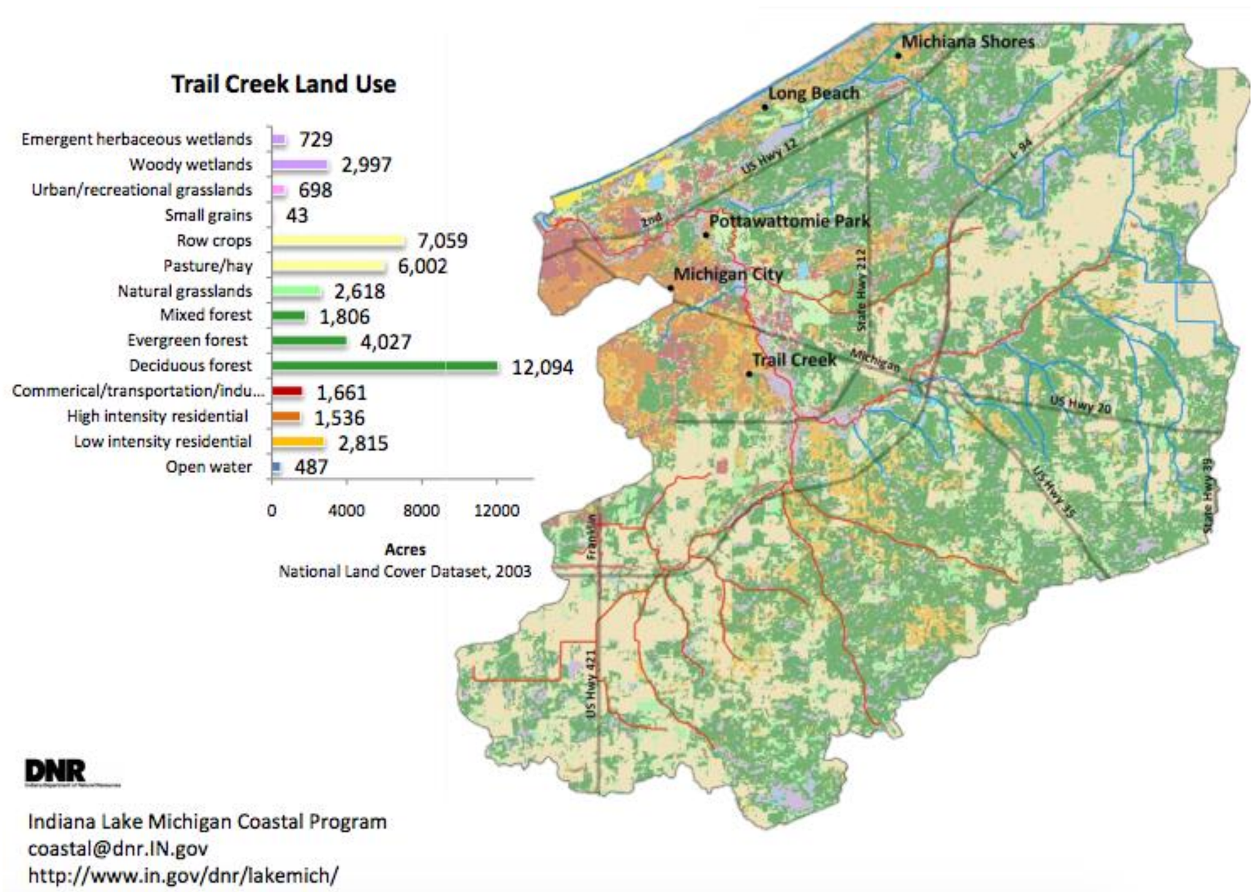


Figure 3. Trail Creek Watershed land use map from Indiana Lake Michigan Coastal Program. Total watershed area encompasses 47,330 acres. Based on 2003 NLCD data.

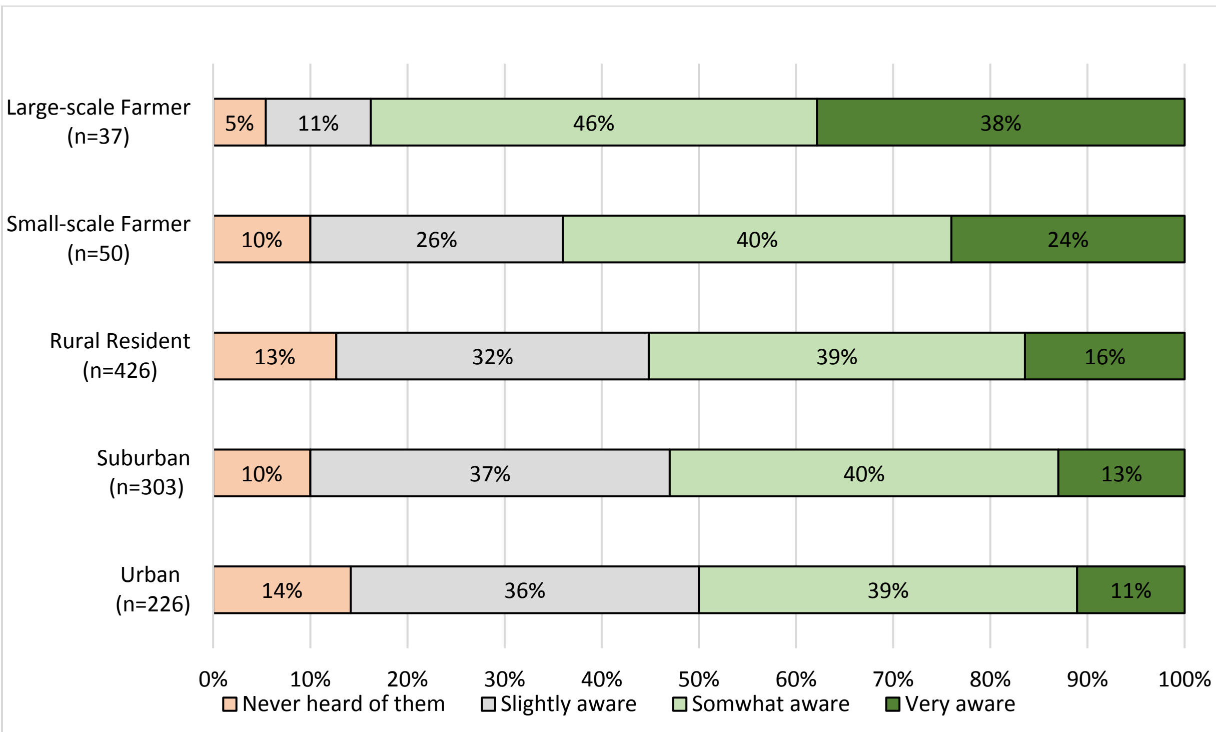


Figure 4. Respondents' self-reported awareness of conservation practices to improve water quality by resident group.

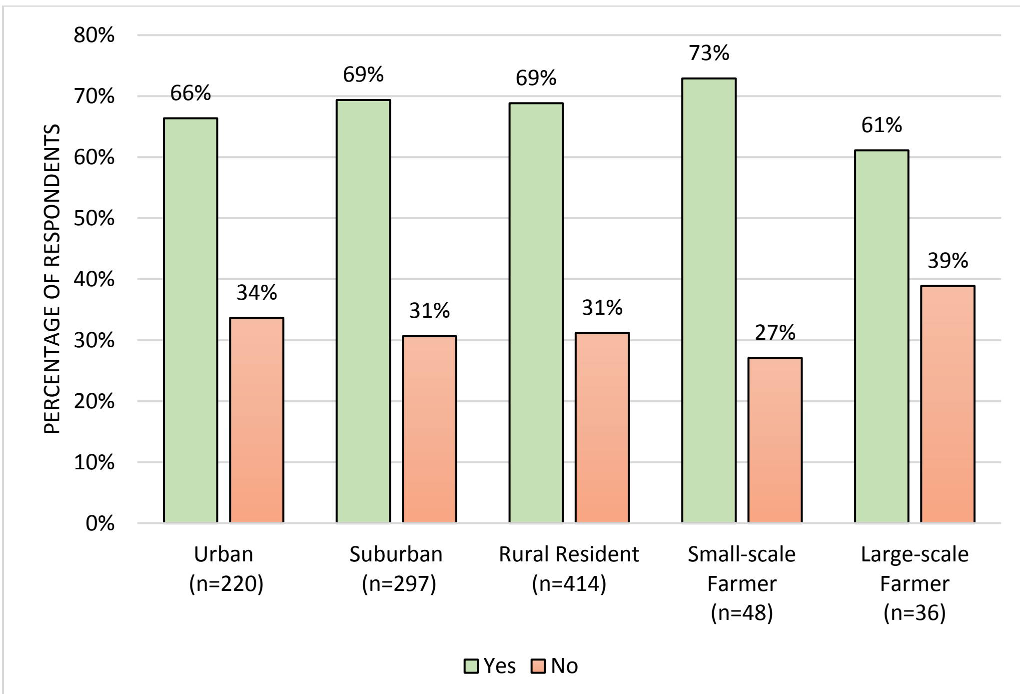


Figure 5. Respondents' self-reported interest in learning more about conservation practices to improve water quality by group.

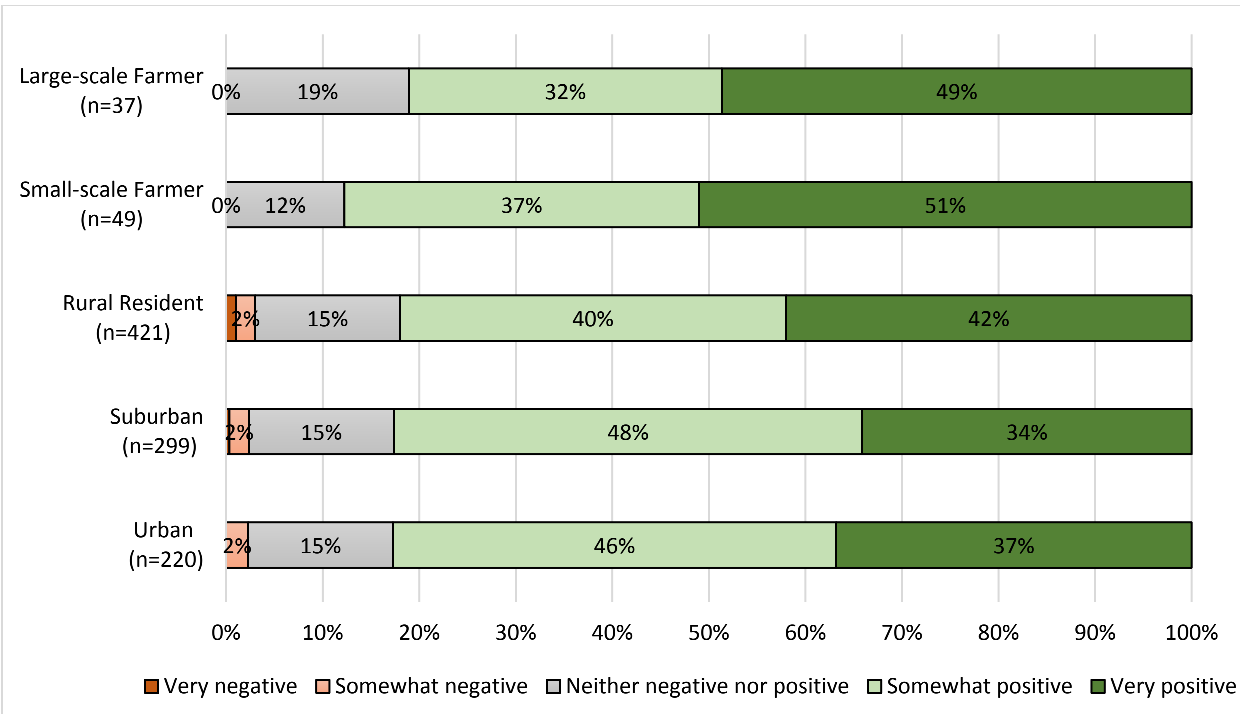


Figure 6. Respondents' self-reported attitude towards conservation practices to improve water quality by resident group.

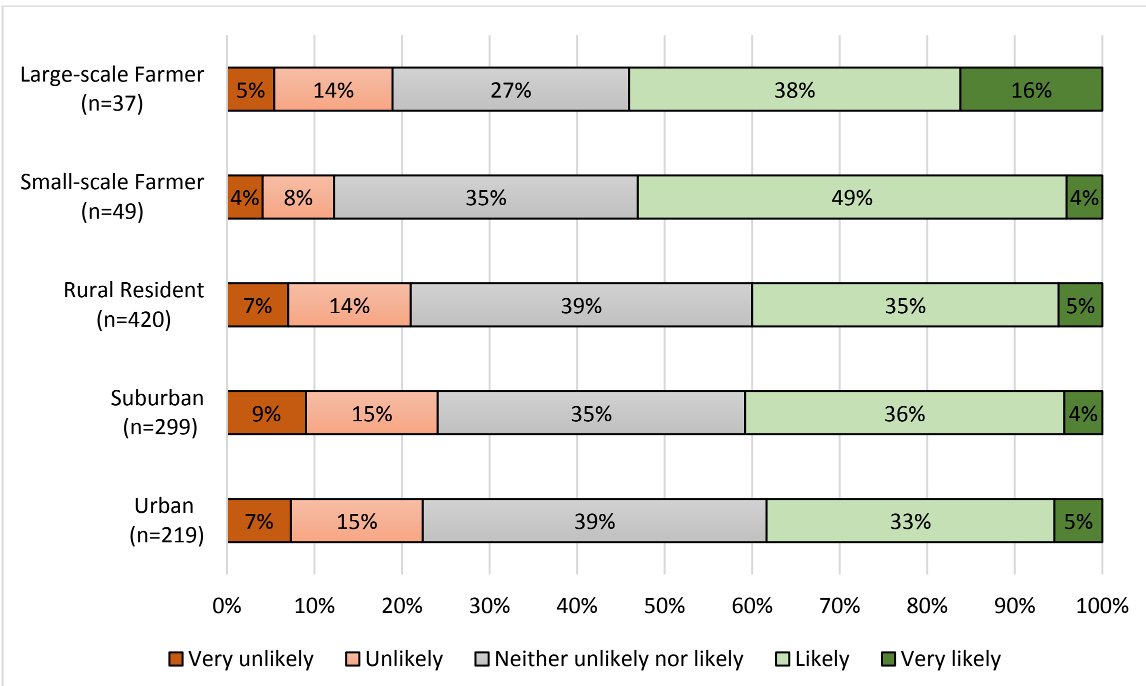


Figure 7. Respondents' self-reported likelihood of adopting any conservation practice in the next year.

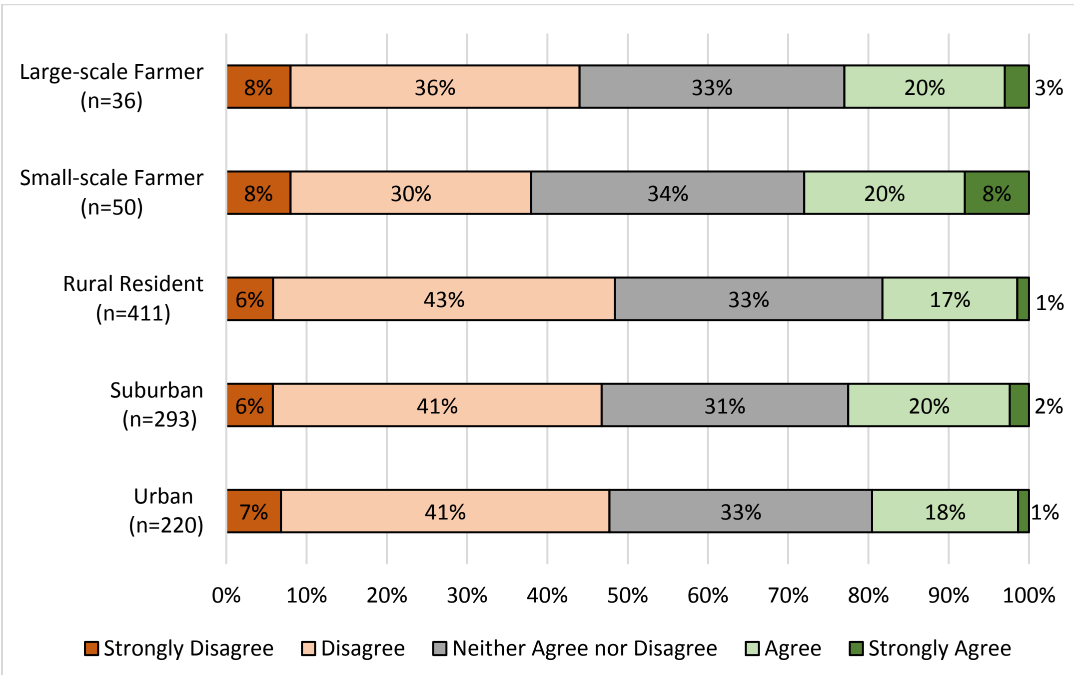


Figure 8. Respondents' perception of water quality. Measured as the level of agreement with the statement "I think water quality in local waterbodies is excellent."

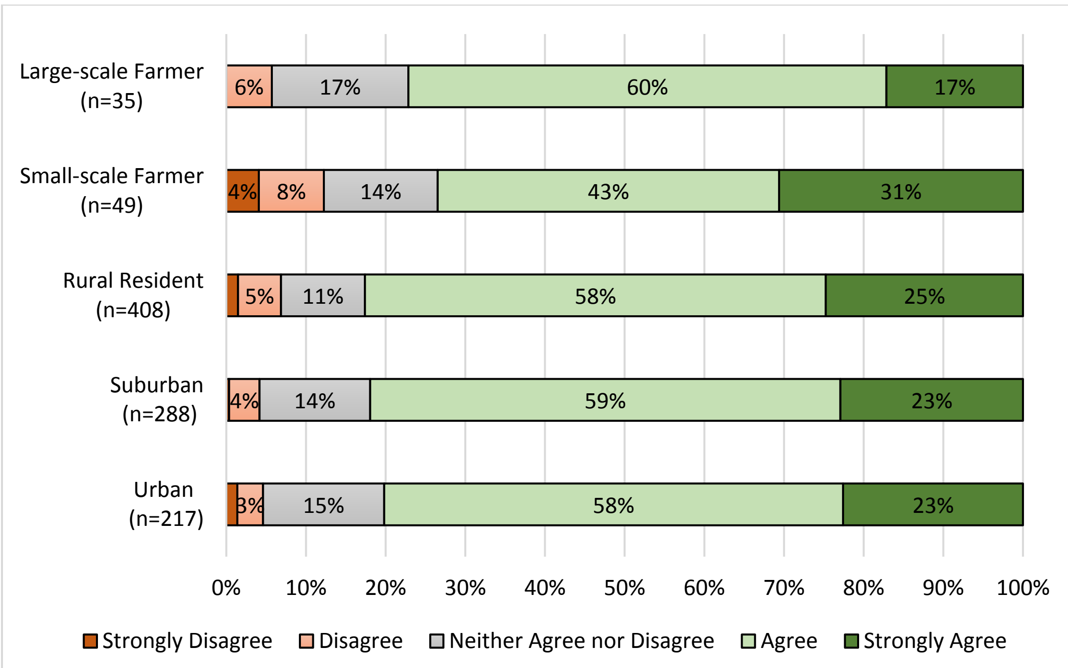


Figure 9. Respondents' self-reported concern about water quality. Measured as level of agreement with the statement "I am concerned about water quality in local waterbodies."

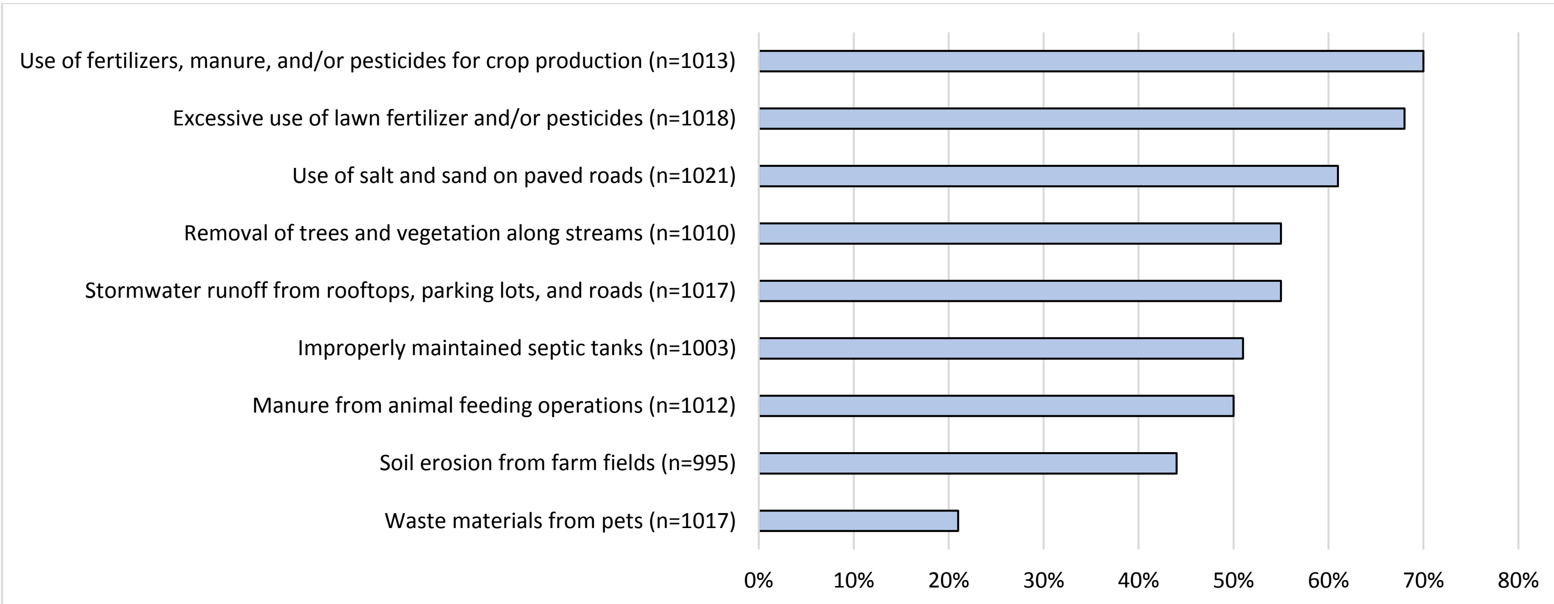


Figure 10. Respondents' perceptions of how much of a problem sources of water pollution are in their area. Percentages represent responses of "moderate problem" or "severe problem." N reflects the total number of individuals that responded to the survey item question.

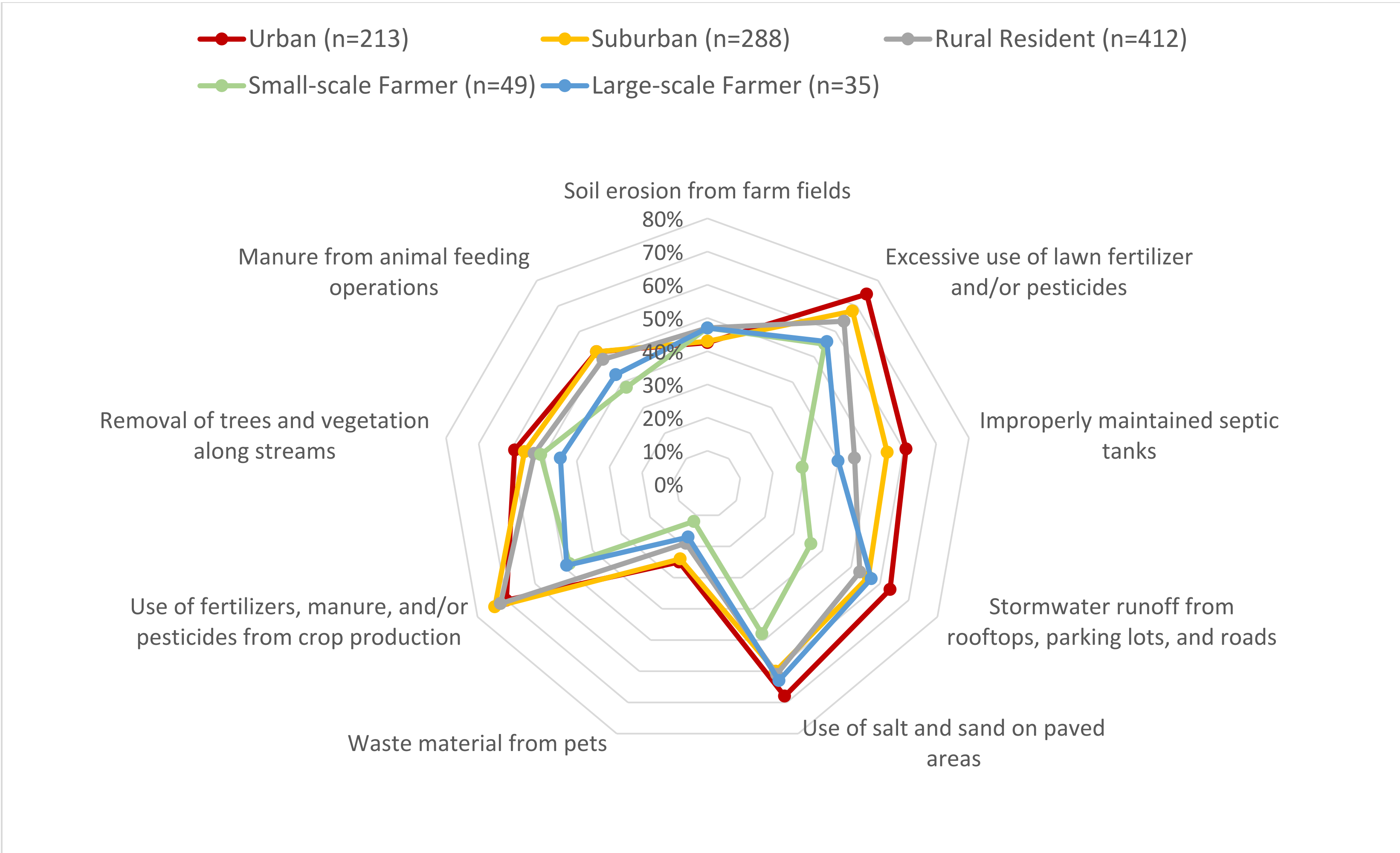


Figure 11. Respondents' perceptions of how much of a problem sources of water pollution are in their area by resident group. Percentages represent responses of "moderate problem" or "severe problem." N reflects the average number of individuals that responded across all nine items.

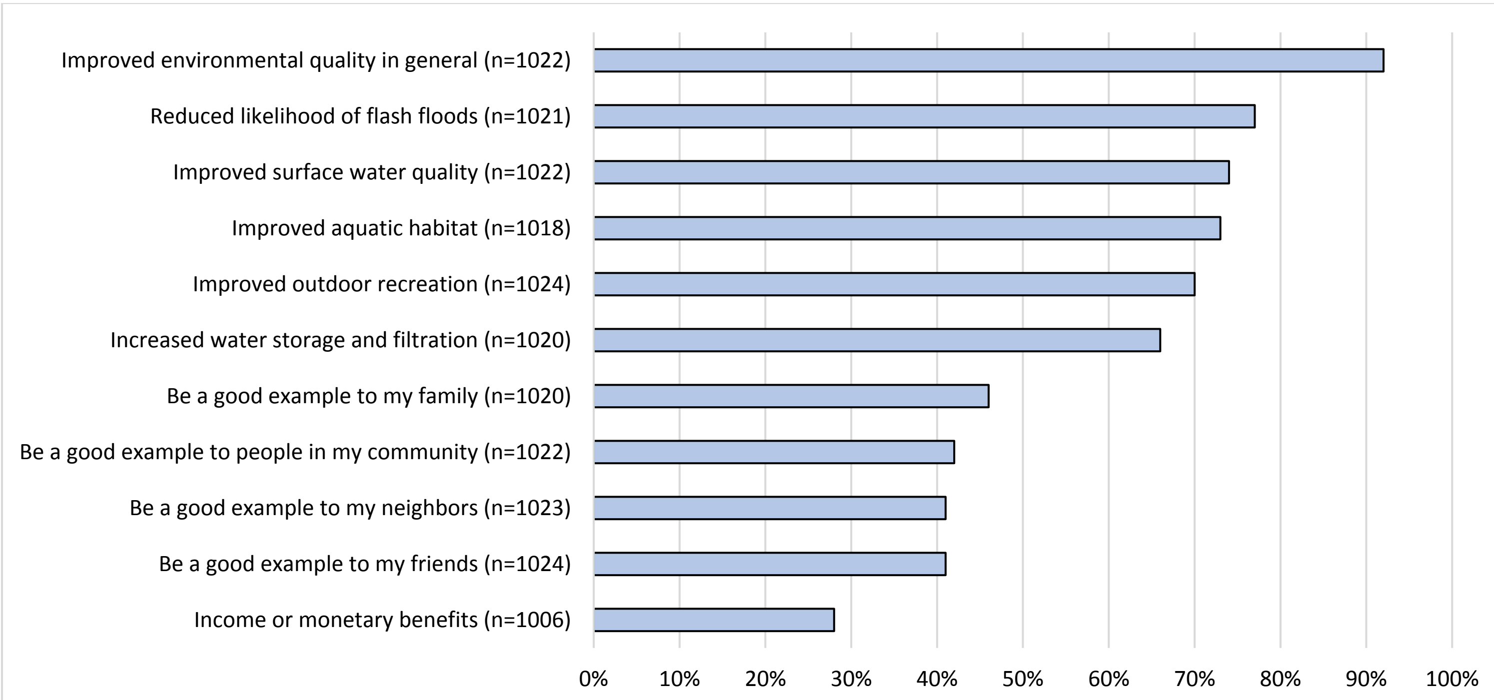


Figure 12. Importance respondents place on different potential benefits associated with adopting water quality improvement practices. Percentages represent responses of “moderately important” or “very important” of 944 complete responses.

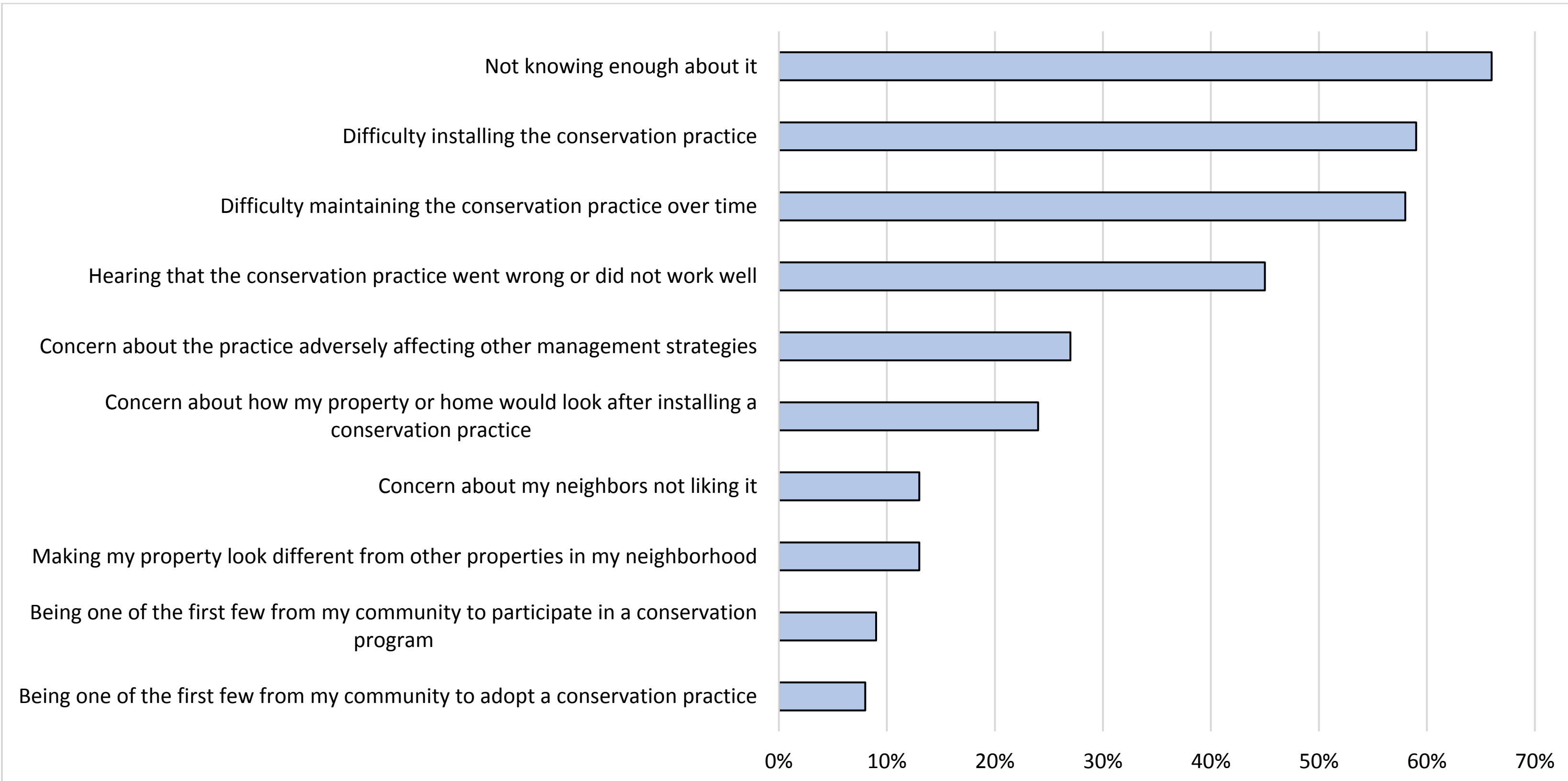


Figure 13. Percentage of respondents who indicated that a given reason would make them not interested or less interested in adopting conservation practices to improve water quality. N reflects the total number of individuals who responded to any of the potential reasons.

References

Ahearn, M. C. (2011). Potential challenges for beginning farmers and ranchers. *Choices*, *26*(2). Retrieved from https://core.ac.uk/download/pdf/6614895.pdf

Ahiablame, L. M., Engel, B. A., & Chaubey, I. (2012). Effectiveness of low impact development practices: Literature review and suggestions for future research. *Water, Air, and Soil Pollution*, *223*(7), 4253–4273. https://doi.org/10.1007/s11270-012-1189-2

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

Ajzen, I. (2005). Attitudes, Personality, and Behavior (2nd ed.). Milton-Keynes, England: Open University Press (McGraw-Hill).

Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Akerlof, G. A., & Kranton, R. E. (2000). Economics and Identity. *The Quarterly Journal of Economics*, *115*(3), 715–753.

Armitage, C. J., & Conner, M. (2001). Efficacy of the Theory of Planned Behaviour : A meta-analytic review. *British Journal of Social Psychology, 40,* 471–499.

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research*, *14*(3), 396–402.

Armstrong, R. A. (2014). When to use the Bonferroni correction. *Ophthalmic & Physiological Optics*, *34*, 502–508. https://doi.org/10.1111/opo.12131

Arnold, C. L., & Gibbons, C. J. (1996). Impervious surface coverage: The emergence of a key environmental indicator. *Journal of the American Planning Association*, *62*(2), 243–258.

Aronson, E., Wilson, T. D., & Akert, A. M. (2010). *Social Psychology* (7th ed.). Upper Saddle River, NJ: Prentice Hall.

Baillie, S., Kaye-Blake, W., Smale, P., & Dennis, S. (2016). Agricultural Water Management Simulation modelling to investigate nutrient loss mitigation practices. *Agricultural Water Management*, *177*, 221–228. https://doi.org/10.1016/j.agwat.2016.07.018

Bamberg, S., Hunecke, M., & Bloaum, A. (2007). Social context, personal norms and the use of public transportation: Two field studies. *Journal of Environmental Psychology*, *27*, 190–203. https://doi.org/10.1016/j.jenvp.2007.04.001

Baumgart-Getz, A., Prokopy, L. S., & Floress, K. (2012). Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature. *Journal of Environmental Management*, *96*(1), 17–25. https://doi.org/10.1016/j.jenvman.2011.10.006

Bicchieri, C. (2006). *The Grammar of Society: The Nature and Dynamics of Social Norms - Cristina Bicchieri - Google Books*. New York, NY: Cambridge University Press.

Bieling, C. (2004). Non-industrial private-forest owners: possibilities for increasing adoption of close-to-nature forest management. *European Journal of Forest Research*, *123*(4), 293–303. https://doi.org/10.1007/s10342-004-0042-6

Blake, J. (1999). Overcoming the "value-action gap" in environmental policy: Tensions between national policy and local experience Overcoming the "Value-Action Gap" in Environmental Policy: tensions between national policy and local experience. *Local Environment*, *4*(3), 257–278. https://doi.org/10.1080/13549839908725599

Brehm, J. M., Pasko, D. K., & Eisenhauer, B. W. (2013). Identifying Key Factors in Homeowner's Adoption of Water Quality Best Management Practices. *Environmental Management*, *52*, 113–122. https://doi.org/10.1007/s00267-013-0056-2

Carpenter, S. R., Caraco, N. F., Correll, D. L., Howarth, R. W., Sharpley, A. N., & Smith, V. H. (1998). Nonpoint pollution of surface waters with phosphorus and nitrogen. *Ecological Applications*, *8*(3), 559–568. https://doi.org/10.1890/1051-0761(1998)008[0559:NPOSWW]2.0.CO;2

Chaubey, I., Chiang, L., Gitau, M. W., & Mohamed, S. (2010). Effectiveness of best management practices in improving water quality in a pasture-dominated watershed. *Journal of Soil and Water Conservation*, *65*(6), 424–437. https://doi.org/10.2489/jswc.65.6.424

Cheung, S. F., Chan, D. K. S., & Wong, Z. S. Y. (1999). Reexamining the Theory Of Planned Behavior in Understanding Wastepaper Recycling. *Environment and Behavior*, *31*(5), 587–612. Retrieved from http://journals.sagepub.com/doi/pdf/10.1177/00139169921972254

Cialdini, R. B., Kallgren, C. A., & Reno, R. R. (1991). A focus theory of normative conduct: a theoretical refinement and reevaluation of the role of norms in human behavior. *Advances in Experimental Social Psychology*, *24*, 201–234.

Cialdini, R. B., Reno, R. R., & Kallgren, C. A. (1990). *A Focus Theory of Normative Conduct: Recycling the Concept of Norms to Reduce Littering in Public Places*. *Journal of Personality and Social Psychology* (Vol. 58).

Claassen, L. R., Hansen, M., Peters, V., Breneman, M., Weinberg, A., Cattaneo, P., … Morehart, M. S. (2001). *Agri-Environmental Policy at the Crossroads: Guideposts on a Changing Landscape*. Retrieved from https://www.ers.usda.gov/webdocs/publications/41216/32146_aer794_002.pdf?v=41484

Clark, C. F., Kotchen, M. J., & Moore, M. R. (2003). Internal and external influences on pro-environmental behavior: Participation in a green electricity program. *Journal of Environmental Psychology*, *23*, 237–246. https://doi.org/10.1016/S0272-4944(02)00105-6

Cook, S., & Ma, Z. (2014a). Carbon sequestration and private rangelands: Insights from Utah landowners and implications for policy development. *Land Use Policy*, *36*, 522–532.

Cook, S., & Ma, Z. (2014b). The interconnectedness between landowner knowledge, value, belief, attitude, and willingness to act: Policy implications for carbon sequestration on private rangelands. *Journal of Environmental Management*, *134*, 90–99. https://doi.org/10.1016/j.jenvman.2013.12.033

Cooper, P., Poe, G. L., & Bateman, I. J. (2004). The structure of motivation for contingent values: A case study of lake water quality improvement. *Ecological Economics*, *50*(1–2), 69–82.

Corbett, J. B. (2002). Motivations to Participate in Riparian Improvement Programs. *Science Communication*, *23*(3), 243–263. Retrieved from http://journals.sagepub.com.ezproxy.lib.purdue.edu/doi/pdf/10.1177/107554700202300303

Cordano, M., & Frieze, I. (2000). Pollution reduction preferences of U.S. environmental managers: applying Ajzen's Theory of Planned Behavior. *Academy of Management Journal*, *43*(4), 627–641.

De Groot, J. I. M., & Steg, L. (2009). Morality and Prosocial Behavior: The Role of Awareness, Responsibility, and Norms in the Norm Activation Model Morality and Prosocial Behavior: The Role of Awareness, Responsibility, and Norms in the Norm Activation Model. *The Journal of Social Psychology*, *1494*, 425–449. https://doi.org/10.3200/SOCP.149.4.425-449doi.org/10.3200/SOCP.149.4.425-449

De Groot, J., & Steg, L. (2007). General beliefs and the theory of planned behavior: The role of environmental concerns in the TPB. *Journal of Applied Social Psychology*, *37*(8), 1817–1836. https://doi.org/10.1111/j.1559-1816.2007.00239.x

Dietz, M. E. (2007). Low Impact Development Practices: A Review of Current Research and Recommendations for Future Directions. *Water, Air, and Soil Pollution*, *186*, 351–363. https://doi.org/10.1007/s11270-007-9484-z

Dietz, M. E., Clausen, J. C., & Filchak, K. K. (2004). Education and Changes in Residential Nonpoint Source Pollution. *Environmental Management*, *34*(5), 684–690. https://doi.org/10.1007/s00267-003-0238-4

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, phone, mail, and mixed-mode surveys: The tailored design method*. Hoboken, NJ: John Wiley & Sons, Inc.

Dowd, B. M., Press, D., & Los Huertos, M. (2008). Agricultural nonpoint source water pollution policy: The case of California's Central Coast. *Agriculture, Ecosystems and Environment*, *128*, 151–161. https://doi.org/10.1016/j.agee.2008.05.014

Drezner, Z., & Drezner, T. D. (2016). A Remedy for the Overzealous Bonferroni Technique for Multiple Statistical Tests. *The Bulletin of the Ecological Society of America*, *97*(1), 91–98. https://doi.org/10.1002/bes2.1214

Eden, S. E. (1993). Individual environmental responsibility and its role in public environmentalism. *Environment and Planning A: Economy and Space*, *25*(12), 1743–1758.

Edwards-Jones, G. (2017). Modelling farmer decision-making: concepts, progress and challenges. *Animal Sciences*, *92*, 783–790. https://doi.org/10.1017/ASC2006112

Fahlquist, J. N. (2009). Moral responsibility for environmental problems—Individual or institutional? *Journal of Agricultural and Environmental Ethics*, *22*(2), 109–124.

Farrow, K., Grolleau, G., & Ibanez, L. (2017). Social Norms and Pro-environmental Behavior: A Review of the Evidence. *Ecological Economics*, *140*, 1–13. https://doi.org/10.1016/j.ecolecon.2017.04.017

Floress, K., Huff, E. S., Snyder, S. A., Koshollek, A., Butler, S., & Allred, S. B. (2018). Factors associated with family forest owner actions: A vote-count meta-analysis. *Landscape and Urban Planning*. https://doi.org/10.1016/j.landurbplan.2018.08.024

Freni, G., Mannina, G., & Viviani, G. (2010). Urban Storm-Water Quality Management: Centralized versus Source Control. *Journal of Water Resources Planning and Management*, *136*(2), 268–278. https://doi.org/10.1061/ASCE0733-94962010136:2268

Gao, Y., Babin, N., Turner, A. J., Hoffa, C. R., Peel, S., & Prokopy, L. S. (2016). Understanding urban-suburban adoption and maintenance of rain barrels. *Landscape and Urban Planning*, *153*, 99–110. https://doi.org/10.1016/j.landurbplan.2016.04.005

Gao, Y., Church, S. P., Peel, S., & Prokopy, L. S. (2018). Public perception towards river and water conservation practices: Opportunities for implementing urban stormwater management practices. https://doi.org/10.1016/j.jenvman.2018.06.059

Genskow, K., & Prokopy, L. S. (Eds.). (2011). *The Social Indicator Planning and Evaluation System (SIPES) for Nonpoint Source Management: A Handbook for Watershed Projects* (3rd ed.). Great Lakes Regional Water Program.

Gerber, G. L., & Cherneski, L. (2006). Sexual aggression toward women: Reducing the prevalence. *Annals of the New York Academy of Science*, *1087*, 35–46.

Gifford, R., & Nilsson, A. (2014). Personal and social factors that influence pro- environmental concern and behaviour: A review. *International Journal of Psychology*, *49*, 141–157.

Gilroy, K. L., & McCuen, R. H. (2009). Spatio-temporal effects of low impact development practices. *Journal of Hydrology*, *367*, 228–236. https://doi.org/10.1016/j.jhydrol.2009.01.008

Gintis, H. (2014). *The Bounds of Reason: Game Theory and the Unification of the Behavioral Sciences*. Princeton, NJ: Princeton University Press. Retrieved from https://muse.jhu.edu/book/30711

Greiner, R., Patterson, L., & Miller, O. (2009). Motivations, risk perceptions and adoption of conservation practices by farmers. *Agricultural Systems*, *99*(2–3), 86–104. https://doi.org/10.1016/j.agsy.2008.10.003

Guagnano, G. A., Stern, P. C., & Dietz, T. (1995). Influences on Attitude-Behavior Relationships A Natural Experiment with Curbside Recycling. *Environment and Behavior*, *27*(5), 699–718.

Han, H. (2015). Travelers' pro-environmental behavior in a green lodging context: Converging value-belief-norm theory and the theory of planned behavior. *Tourism Management*, *47*, 164–177. https://doi.org/10.1016/j.tourman.2014.09.014

Hansen, A. J., Knight, R. L., Marzluff, J. M., Powell, S., Brown, K., Gude, P. H., & Jones, K. (2005). Effects Of Exurban Development on Biodiversity: Patterns, Mechanisms, and Research Needs. *Ecological Applications*, *15*(6), 1893–1905. https://doi.org/10.1890/05-5221

Harland, P., Staats, H., & Wilke, H. A. M. (1999). Explaining Proenvironmental Intention and Behavior by Personal Norms and the Theory of Planned Behavior1. *Journal of Applied Social Psychology*, *29*(12), 2505–2528. https://doi.org/10.1111/j.1559-1816.1999.tb00123.x

Heath, Y., & Gifford, R. (2002). Extending the Theory of Planned Behavior: Predicting the Use of Public Transportation. *Journal of Applied Social Psychology*, *32*(10), 2157–2189.

Hoppe, R. A., & Banker, D. E. (2010). Structure and Finances of US Farms: Family Farm Report. Economic Information Bulletin 66. U.S. Department of Agriculture, Economic Research Service.

Hoppe, R.A., MacDonald, J.M., Korb, P. (2010). Small Farms in the United States: Persistence Under Pressure. Economic Information Bulletin No. 63. U.S. Department of Agriculture, Economic Research Service.Howarth, R., Sharpley, A., & Walker, D. (2002). Sources of Nutrient Pollution to Coastal Waters in the United States: Implications for Achieving Coastal Water Quality Goals. *Estuaries*, *24*(4b), 656–676. Retrieved from https://link.springer.com/content/pdf/10.1007%2FBF02804898.pdf

Iles, K. (2017). *Transitioning towards small-scale: Insights from Indiana*. Purdue University.

Interis, M. (2011). On Norms: A Typology with Discussion. *The American Journal of Economics and Sociology*, *70*(2), 424–438. Retrieved from http://www.jstor.org/stable/41329193

Kalcic, M., Prokopy, L., Frankenberger, J., & Chaubey, I. (2014). An In-depth Examination of Farmers' Perceptions of Targeting Conservation Practices. *Environmental Management*, *54*, 795–813. https://doi.org/10.1007/s00267-014-0342-7

Karppinen, H. (2005). Forest owners' choice of reforestation method: an application of the theory of planned behavior. *Forest Policy and Economics*, *7*, 393–409. https://doi.org/10.1016/j.forpol.2003.06.001

Karppinen, H., & Berghäll, S. (2015). Forest owners' stand improvement decisions: Applying the Theory of Planned Behavior. *Forest Policy and Economics*, *50*, 275–284. https://doi.org/10.1016/j.forpol.2014.09.009

Kaushal, S. S., Groffman, P. M., Band, L. E., Elliott, E. M., Shields, C. A., & Kendall, C. (2011). Tracking Nonpoint Source Nitrogen Pollution in Human-Impacted Watersheds. *Environ. Sci. Technol*, *45*, 8225–8232. https://doi.org/10.1021/es200779e

Lapinski, M. K., & Rimal, R. N. (2005). An Explication of Social Norms. *Communication Theory*, *15*(2), 127–147. Retrieved from https://academic.oup.com/ct/article-abstract/15/2/127/4110785

Läpple, D. & Kelley, H. (2013).Understanding the uptake of organic farming: Accounting for heterogeneities among Irish farmers. *Ecol. Econ*, *88*, 11–19.

Liu, R., Zhang, P., Wang, X., Chen, Y., & Shen, Z. (2013). Assessment of effects of best management practices on agricultural non-point source pollution in Xiangxi River watershed. *Agricultural Water Management*, *117*, 9–18. https://doi.org/10.1016/j.agwat.2012.10.018

Liu, T., Bruins, R., & Heberling, M. (2018). Factors Influencing Farmers' Adoption of Best Management Practices: A Review and Synthesis. *Sustainability*, *10*(2), 432. https://doi.org/10.3390/su10020432

Liu, Y., Bralts, V. F., & Engel, B. A. (2015). Evaluating the effectiveness of management practices on hydrology and water quality at watershed scale with a rainfall-runoff model. *Science of the Total Environment*, *511*, 298–308. https://doi.org/10.1016/j.scitotenv.2014.12.077

Liu, Y., Theller, L. O., Pijanowski, B. C., & Engel, B. A. (2016). Optimal selection and placement of green infrastructure to reduce impacts of land use change and climate change on hydrology and water quality: An application to the Trail Creek Watershed, Indiana. *Science of the Total Environment*, *553*, 149–163. https://doi.org/10.1016/j.scitotenv.2016.02.116

Logan, T. J. (1990). Agricultural best management practices and groundwater protection. *Journal of Soil and Water Conservation*, *45*(2), 201–206.

Logan, T. J. (1993). Agricultural best management practices for water pollution control: current issues. *Ecosystems and Environment Elsevier Science Publishers B.V*, *46*, 223–231.

McDonald, R. I., & Crandall, C. S. (2015). Social norms and social influence. *Current Opinion in Behavioral Science*, *3*, 147–151.

McGuire, J., Morton, L. W., & Cast, A. D. (2013). Reconstructing the good farmer identity: Shifts in farmer identities and farm management practices to improve water quality. *Agriculture and Human Values*, *30*, 57–69. https://doi.org/10.1007/s10460-012-9381-y

Meyer, L., Hunter, J., Katchova, A., Lovett, S., Thilmany, D., Sullins, M., & Card, A. (2011). Approaching beginning farmers as a new stakeholder for extension. *Choices*, *26*(2). Retrieved from http://buildingfarmersinthewest.org/

Motallebi, M., O'Connell, C., Hoag, D., Osmond, D., Motallebi, M., O'Connell, C., Osmond, D. L. (2016). Role of Conservation Adoption Premiums on Participation in Water Quality Trading Programs. *Water*, *8*(6), 245. https://doi.org/10.3390/w8060245

Narum, S. R. (2006). Beyond Bonferroni: Less conservative analyses for conservation genetics. *Conservation Genetics*, *7*, 783–787. https://doi.org/10.1007/s10592-005-9056-y

Nassauer, J. I., Wang, Z., & Dayrell, E. (2009). What will the neighbors think? Cultural norms and ecological design. *Landscape and Urban Planning*, *92*(3–4), 282–292. https://doi.org/10.1016/j.landurbplan.2009.05.010

Newburn, D., Alberini, A., Rockler, A., & Karp, A. (2014). *Adoption of household stormwater best management practices*. College Park. Retrieved from http://drum.lib.umd.edu/handle/1903/14974

Nolan, J. M., Schultz, P. W., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2008). Normative social influence is underdetected. *Personality and Social Psychology Bulletin*, *34*, 913–923.

Onwezen, M. C., Antonides, G., & Bartels, J. (2013). The Norm Activation Model: An exploration of the functions of anticipated pride and guilt in pro-environmental behaviour. *Journal of Economic Psychology*, *39*, 141–153. https://doi.org/10.1016/j.joep.2013.07.005

Park, J., & Ha, S. (2014). Understanding Consumer Recycling Behavior: Combining the Theory of Planned Behavior and the Norm Activation Model. *Family and Consumer Sciences Research Journal*, *42*(3), 278–291. https://doi.org/10.1111/fcsr.12061

Pennings, J. M. E., Irwin, S. H., & Good, D. L. (2002). Surveying Farmers: A Case Study. *Review of Agricultural Economics*, *24*(1), 266–277.

Perry-Hill, R., & Prokopy, L. S. (2014). Comparing different types of rural landowners: Implications for conservation practice adoption. *Journal of Soil and Water Conservation*, *69*(3), 266–278. https://doi.org/10.2489/jswc.69.3.266

Persaud, A., Alsharif, K., Monaghan, P., Akiwumi, F., Morera, M. C., & Ott, E. (2016). Landscaping practices, community perceptions, and social indicators for stormwater nonpoint source pollution management. *Sustainable Cities and Society*, *27*, 377–385. https://doi.org/10.1016/j.scs.2016.08.017

Peterson, M. N., Thurmond, B., Mchale, M., Rodriguez, S., Bondell, H. D., & Cook, M. (2012). Predicting native plant landscaping preferences in urban areas. *Sustainable Cities and Society*, *5*, 70–76. https://doi.org/10.1016/j.scs.2012.05.007

Peterson, M. N., Thurmond, B., McHale, M., Rodriguez, S., Bondell, H. D., & Cook, M. (2012). Predicting native plant landscaping preferences in urban areas. In *Sustainable Cities and Society* (Vol. 5, pp. 70–76). https://doi.org/10.1016/j.scs.2012.05.007

Prokopy, L. S., Floress, K., Klotthor-Weinkauf, D., & Baumgart-Getz, A. (2008). Determinants of agricultural best management practice adoption: Evidence from the literature. *Journal of Soil and Water Conservation, 63*(5), 300–311. https://doi.org/10.2489/jswc.63.5.300

Raymond, L., & Schneider, L. (2014). Personal Moral Norms and Attitudes Toward Endangered Species Policies on Private Land. *Conservation and Society*, *12*(1), 1. https://doi.org/10.4103/0972-4923.132115

Reimer, A. P., & Prokopy, L. S. (2014). Farmer Participation in U.S. Farm Bill Conservation Programs. *Environmental Management*, *53,* 318–332. https://doi.org/10.1007/s00267-013-0184-8

Reimer, A. P., Weinkauf, D. K., & Prokopy, L. S. (2012). The influence of perceptions of practice characteristics: An examination of agricultural best management practice adoption in two Indiana watersheds. *Journal of Rural Studies*, *28*(1), 118–128. https://doi.org/10.1016/j.jrurstud.2011.09.005

Rezvanfar, A., Samiee, A., & Faham, E. (2009). Analysis of Factors Affecting Adoption of Sustainable Soil Conservation Practices among Wheat Growers. *World Applied Sciences Journal*, *6*(5), 644–651.

Ridolfo, H., Boone, J. and Dickey, N. (2013). *Will They Answer the Phone if They Know It's Us? Using Caller ID to Improve Response Rates*. Research Report No. RDD-13-01. U.S. U.S. Department of Agriculture, National Agricultural Statistics Service.

Rudel, T. K., Schneider, L., Uriarte, M., Turner, B. L., DeFries, R., Lawrence, D., … Grau, R. (2009). Agricultural intensification and changes in cultivated areas, 1970–2005. *Proceedings of the National Academy of Sciences*, *106*(49), 20675–20680.

Schwartz, S. H. (1977). Normative influences on altruism. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (pp. 221–279). New York: Academic Press.

Shaver, K. G. (1985). *The Attribution of Blame: Causality, Responsibility, and Blameworthiness*. New York, NY: Springer-Verlag.

Shin, D. W., & McCann, L. (2018). Analyzing differences among non-adopters of residential stormwater management practices. *Landscape and Urban Planning*, *178*, 238–247. https://doi.org/10.1016/J.LANDURBPLAN.2018.06.003

Shuster, W. D., Morrison, M. A., & Webb, R. (2008). Front-loading urban stormwater management for success – a perspective incorporating current studies on the implementation of retrofit low-impact development. *Cities and the Environment*, *1*(2).

Stern, P. C., Dietz, T., Abel, T., Guagnano, G. A., & Kalof, L. (1999). A Value-Belief-Norm Theory of Support for Social Movements: The Case of Environmentalism. *Human Ecology Review*, *6*(2), 81–97.

Thøgersen, J. (2014). The mediated influences of perceived norms on pro-environmental behavior. *Revue D Economie Politique*, *124*(2), 179–193. https://doi.org/10.3917/redp.242.0179

Urbonas, B. (1994). Assessment of stormwater BMPs and their technology. *Water Science and Technology*, *29*(12), 347–353.

Vogel, J. R., Moore, T. L., Coffman, R. R., Rodie, S. N., Hutchinson, S. L., Mcdonough, K. R., Mcmaine, J. T. (2015). Critical Review of Technical Questions Facing Low Impact Development and Green Infrastructure: A Perspective from the Great Plains. *Water Environment Research*, *87*, 849–862. https://doi.org/10.2175/106143015X14362865226392

Wallen, K. E., & Romulo, C. L. (2017). Social norms: More details, please. *Proceedings of National Academy of Sciences*, *114*(27), E5283–E5284. https://doi.org/10.1073/pnas.1704451114

Welch, E. W., & Marc-Aurele, F.J., J. (2001). Determinants of Farmer Behavior: Adoption of and Compliance with Best Management Practices for Nonpoint Source Pollution in the Skaneateles Lake Watershed. *Lake and Reservoir Management*, *17*(3), 233–245. https://doi.org/10.1080/07438140109354133

Wollni, M. & Andersson, C. (2014).Spatial patterns of organic agriculture adoption: Evidence from Honduras. *Ecol. Econ*, *97*, 120–128.

CHAPTER 3: ASSESSING WATERSHED RESIDENTS' LIKELIHOOD TO ADOPT WATER QUALITY IMPROVEMENT PRACTICES AND THE ROLE OF INFORMATION

Abstract

Nonpoint source (NPS) pollution threatens water quality in the United States. The effectiveness of best management practices (BMPs) and low impact development (LID) strategies in mitigating NPS pollution is dependent on watershed residents' adoption of such practices. While extant literature has assessed factors influencing the adoption of water quality improvement practices in agricultural settings, few studies have explored watershed residents' decisions to adopt (or not) across the urban-to-rural gradient. We conducted a survey of watershed residents in Porter and LaPorte counties in Indiana, which included a survey experiment, to assess urban and rural residents' likelihood of adoption and to identify factors influencing their likelihood of adoption, particularly the role of information about responsibility. By analyzing survey data from 1,066 respondents, we found that about 40% of respondents were likely or very likely to adopt water quality improvement practices in the next year. Generally, older respondents were less likely to report an adoption plan. Respondents who perceived more severe problems from potential water pollution sources in their area, had more awareness of conservation practices, had more positive attitudes, felt a sense of responsibility, or sought water quality-related information in their area, were more likely to report an adoption plan. Importantly, our results show that social norms, including descriptive norm about what others are doing and subjective norm about what others' expectations are, were significant factors shaping watershed residents' self-reported likelihood of adoption. We also found that self-reported likelihood did not differ based on to which resident group respondents belong (i.e., urban, suburban, rural residential, small-scale agriculture, large/medium-scale agriculture), nor based on the type of information about responsibility (i.e., generic vs. specific) they received. However, we did observe information about responsibility affecting respondents differently based on their initial self-reported likelihood of adoption prior to receiving information. Together, these findings suggest that water quality programs should be aware of the limited effect of using information to instill a sense of responsibility to motivate behavioral change and consider incorporating social norms into their outreach and communication.

Introduction

According to the Environmental Protection Agency (EPA), a majority of Americans live within two miles of a polluted lake, river, stream or costal area (United States Environmental Protection Agency, 2016). Indeed, across all waterbodies in the nation that have been assessed and where a possible source of impairment has been identified, 85% of rivers and streams and 80% of lakes and reservoirs are polluted by nonpoint sources specifically. Nonpoint source (NPS) pollution refers to pollution that entered receiving waterbodies from diffuse sources such as surface runoff, subsurface runoff, or atmospheric deposition. NPS is driven primarily by human activities such as urbanization and agricultural intensification (Carpenter et al., 1998; Howarth, Sharpley, & Walker, 2002; Kaushal et al., 2011). From 1949 to 2012, urban land has nearly tripled in area and the reduction in pervious surface area associated with urbanization results in higher peak runoff rates that tend to increase sediment loads during development (Arnold & Gibbons, 1996; Bigelow & Borchers, 2017; Hansen et al., 2005). During the same time period, agricultural land use has declined by nearly 10% (Bigelow & Borchers, 2017). Related to this decline, farmers have intensified agricultural production so that they can produce food and feed on a smaller land base overall. Many agricultural inputs such as fertilizers and pesticides are susceptible to processes that contribute to NPS pollution (Hoppe & Banker, 2010). NPS pollution from both urbanization and agricultural intensification is diffused in nature, making regulation a challenge.

Research has shown some level of effectiveness of best management practices (BMPs) and low impact development (LID) strategies in controlling stormwater runoff and limiting the movements of pollutants (Chaubey, Chiang, Gitau, & Mohamed, 2010; Liu, Zhang, Wang, Chen, & Shen, 2013; Urbonas, 1994). BMPs refer to conservation practices that capture stormwater runoff before it reaches receiving waterbodies and include large-scale practices such as retention ponds, detention basins, grassed swales, and wetland basins (Gilroy & McCuen, 2009; Logan, 1990, 1993). BMPs can also include location-specific practices such as conservation tillage, nutrient management, cover crops, and integrated pest management (Logan, 1990). Similarly, LID strategies include smaller-scale on-site stormwater management practices that reduce the water quality impact of development by preserving features of the construction site, often through green roofs, rain barrels, bioretention systems, porous pavement, and wetland channels (Dietz, 2007). Though often interchangeable, BMPs are traditionally associated with agricultural water quality improvement efforts and LID strategies with urban or suburban efforts. In our research context, we use conservation practices to improve water quality or water quality improvement practices to collectively refer to BMPs and LID strategies.

Over the past decades, various modelling tools with different levels of complexity, data requirements, time step, and simulation techniques (i.e., L-THIA-LID, SWAT, STEPL) have been developed to assess the effectiveness of installing BMPs and LID strategies in reducing NPS pollution (Nejadhashemi et al., 2011). These tools are useful in demonstrating the biophysical and hydrological potential of conservation practices to improve water quality under various objective functions, constraints, and cost-effectiveness criteria (Ahiablame, Engel, & Chaubey, 2012; Baillie, Kaye-Blake, Smale, & Dennis, 2016; Liu, Bralts, & Engel, 2015; Liu, Theller, Pijanowski, & Engel, 2016). However, as the potential for BMPs and LID strategies to reduce NPS pollution is constrained by residents' actual implementation of these practices, it will be difficult if not impossible to realistically model potential improvements without understanding residents' decisions to adopt (or not) various water quality improvement practices.

Residents' Willingness and Actual Decisions to Adopt Water Quality Improvement Practices

Understanding how private individuals and residents view and act upon water quality issues is important, partly because 60% of land in the United States is privately owned (Bigelow & Borchers, 2017). There has been an increase in urban land uses by a factor of 4.7 from 1945 to 2012 (Bigelow & Borchers, 2017) and an increase in rural residential land uses by 3 million acres from 2007 to 2013 (Bigelow & Borchers, 2017). As such, what people do to manage their lawns, gardens, and properties has an increasing impact on the overall water quality of the nation. In Indiana where our study was conducted, 58% of the land is devoted to crop production and the state's population growth occurs primarily in urban centers as evident by the fact that 76% of Indiana's total population growth in 2017 occurred in cities and towns (Kinghorn, 2018; U.S. Department of Commerce, 2012). Given the significance of both urban development and agricultural production in the state, the importance of understanding the relationship between residents' property management decisions and water quality cannot be overstated. Generally speaking, extensive research has been conducted to examine agricultural producers' actions to improve soil and water quality and to explore factors that motivate their BMP adoption (e.g., see a review conducted by Baumgart-Getz, Prokopy, & Floress, 2012). In contrast, less is known about urban and suburban residents' interest in water quality improvement and factors motivating their adoption of relevant practices. Below we provide a brief summary of factors that influence different types of residents' willingness and actual decisions to adopt water quality improvement practices, which lead to the research questions of this study.

Demographics (more rural than urban)

For urban and suburban residents, research has found that being a male (Shin & McCann, 2018) and having a higher household income (Brehm, Pasko, & Eisenhauer, 2013) are both positively associated with willingness to adopt and actual adoption of water quality improvement practices. Partly due to the small number of studies on urban and suburban residents' perceptions and behaviors related to water quality, few other demographic variables have been identified as consistently significant for understanding residents' willingness and actions. In a rural context, a larger body of literature exists exploring how the demographic characteristics of rural residents, especially agricultural producers, influence their adoption of water quality improvement practices. For example, Perry-Hill and Prokopy (2014) found that, rural residents, small-scale agricultural producers, and those who self-identified as farmers, were more likely to implement BMPs than were their counterparts. Rural residents and farmers with longer land tenure and higher education are also more likely to report willingness to adopt BMPs than are their counterparts (e.g., Cook & Ma, 2014; Motallebi et al., 2016; Perry-Hill & Prokopy, 2014). Meanwhile, greater uncertainty exists about how gender and age relate to adoption among rural residents and farmers (Liu et al., 2018).

Awareness, Knowledge, and Attitudes (both urban and rural)

In urban and suburban studies of LID strategy adoption, research has shown that residents with a positive attitude towards the environment and those with a positive attitude toward protecting water resources adopt water quality improvement practices more often than their counterparts (Gao et al., 2016; Newburn, Alberini, Rockler, & Karp, 2014). Awareness of and knowledge about specific water quality improvement practices are also positively associated with adoption (Brehm et al., 2013; Gao et al., 2016;). Shin and McCann (2018) found that awareness of and knowledge about water quality improvement practices was also positively associated with intention to adopt. Similar results have been found for rural residents and agricultural producers in terms of their awareness, knowledge, and attitudes. In general, greater awareness of BMPs, knowledge about installation, and positive attitudes towards the environment in general and towards protecting water resources in particular, are significant predictors of rural residents' and farmers' willingness to adopt water quality improvement practices (e.g., Perry-Hill & Prokopy, 2014). Several studies have also explored specific aspects of awareness and have found that greater awareness of environmental threats, of issues of water quality, and of positive impacts of BMPs are positively associated with people's willingness to improve water quality (Knowler & Bradshaw, 2007; Liu et al., 2018; Rezvanfar et al., 2009).

Social Norms

Social norms have been widely utilized in exploring the adoption or non-adoption of pro-environmental behaviors such as recycling, energy conservation, use of public transportation, consumer purchasing decisions, and residents' landscaping decisions (e.g., Guagnano, Stern, & Dietz, 1995; Han, 2015; Onwezen, Antonides, & Bartels, 2013; Persaud et al., 2016; Peterson et al., 2012; Schwartz, 1977). Social norms describe prevalent behaviors or behavioral expectations within a reference group (Interis, 2011). Social norms can be divided into descriptive norms and subjective norms. Descriptive norms are the perceived prevalence of a behavior within a reference group whereas subjective norms refer to expectations from important others in our lives about what to do in a given situation (Ajzen, 2005; Ajzen & Fishbein, 1980; Cialdini, Kallgren, & Reno, 1991; Farrow, Grolleau, & Ibanez, 2017). In other words, subjective norms describe our perceptions of what other important people expect us to do and descriptive norms are our perceptions of what other people do. In the context of land and natural resource management, social norms, particularly subjective norms, have been mostly examined as part of the Theory of Planned Behavior (TPB; adapted to become the Reasoned Action Approach in 2010), a popular framework which emphasizes the influence of behavior attitudes, subjective norms, and perceived behavioral control on behavioral intention (Ajzen, 1991; Armitage & Conner, 2001; Fishbein & Ajzen, 2010). Specifically, the TPB has been applied to examine landowner behavioral intentions to harvest timber, participate in riparian improvement programs, undertake stand improvement, and engage in reforestation (e.g., Bieling, 2004; Corbett, 2002; Floress et al., 2018; Karppinen, 2005; Karppinen & Berghäll, 2015; Pouta & Rekola, 2001; Vogt, Winter, & Fried, 2005; Young & Reichenbach, 1987). These studies provide evidence suggesting the importance of subjective norms for natural resource management, but also emphasize the need for further research into subjective norms in this context (Floress et al., 2018). Few studies have incorporated social norms more comprehensively to compare the role of descriptive and subjective norms in shaping people's behaviors, and little is known about the role of social norms in influencing the adoption of water quality improvement practices specifically.

In their recent review, Liu et al. (2018) identified three empirical studies as having examined some aspects of social norms (mostly using the language of peer pressure and social conformity) in the context of soil and water management. Specifically, Wollni and Andersson (2014) provided preliminary support for the important role of social conformity concerns in the decision to adopt organic agriculture among Honduran hillside farmers. Läpple and Kelley (2013) explicitly examined the role of belief-based subjective norm in farmers' decisions to pursue organic farming and concluded that such decisions are dependent on the opinion of fellow farmers or information sources. The only study that examined the role of social norms in the context of adopting BMPs to reduce NPS pollution was conducted by Welch and Marc-Aurele (2001) in the Skaneateles Lake Watershed of New York. They suggested that early BMP adopters within a community may contribute to establishing a "community norm" for BMP adoption which could motivate other community members to adopt BMPs later (p.242). Overall, as Liu et al. (2018) pointed out, few empirical papers have examined social norms in an agricultural management context; however, it is important to directly assess the impacts of social norms and peer pressure in order to incorporate these factors into understanding farmers' decision-making processes.

Sense of Responsibility and Personal Norms

Personal norms are internal standards of appropriate behavior that arise from a belief that something is morally right or wrong (Raymond & Schneider, 2014; Schwartz, 1977; Stern, Dietz, Abel, Guagnano, & Kalof, 1999). The Norm Activation Model (NAM) has been used for understanding how awareness leads to a sense of responsibility, which then activates an individual's personal norm to engage in a given behavior. Existing research has demonstrated positive relationships between personal norms and intention or actual decision to undertake pro-environmental behaviors (Clark, Kotchen, & Moore, 2003; Bamberg, Hunecke, & Bloaum, 2007; Guagnano, Stern, & Dietz, 1995; Onwezen, Antonides, & Bartels, 2013). Onwezen et al. (2013) also found that ascribed responsibility had a significant effect on personal norms, as well as attitudes towards the environment and towards pro-environmental behaviors. For farmers, often personal norms that favor conservation practices manifest in terms of stewardship identity (Wallace & Clearfield, 1997). Indeed, stewardship has been described in many ways and has often incorporated a sense of responsibility to manage property because it is the right thing to do (Chouinard et al., 2008; McGuire, Morton, & Cast, 2013; Sheeder & Lynne, 2011). As such, many studies have reported the significant positive influence of stewardship on willingness to adopt conservation practices for improving water quality without explicitly connecting the concept of stewardship with personal norms (Davies & Hodge, 2006; Liu et al., 2018; Reimer, Thompson, & Prokopy, 2012; Rezvanfar et al., 2009).

Information and Attribution of Responsibility

The role of information generally in shaping pro-environmental behavior has been broadly studied. Traditionally, information campaigns have focused on the top-down model of communication which presumes that a deficit in public knowledge is the primary source of non-adoption of a behavior and that if individuals were provided with information from an expert, they would adopt desired pro-environmental behaviors (e.g., Burgess & Harrison, 1998). This information-deficit model of communication has proven to have little success at motivating behavioral change, though information and material incentives may be used together to have a synergistic effect (Steg & Vlek, 2008; Stern, 1999, 2000).

As Stern (1999) summarized, information and education have the potential to motivate behavioral change if and only if the information about a behavior: (1) is presented where the behavior will occur and has been validated by the audience, (2) models behavior by individuals who similar to the target audience, (3) comes from a trusted source, (4) is accompanied by a request for public commitment to the behavior, (5) reminds people of social norms supporting the behavior, and (6) captures the attention of the audience. For example, in the context of water quality management, access to credible and technical general information on BMPs, participation in conservation education programs, and strong information and communications channels have been shown to result in greater likelihood of adoption among rural residents and farmers (Liu et al., 2018; Rezvanfar et al., 2009). Additionally, Takahashi et al. (2016) found that some farmers in New York were reluctant to adopt climate change adaptation strategies, in part due to the perceived lack of "dependable, apolitical, and objective" sources of information. Further, it is critical to present any information in an understandable way (e.g., using pictures and graphs), and information is likely to be more effective if it elicits an emotional response from the target audience (Kollmuss & Agyeman, 2002). Generally and empirically, Blackstock et al. (2010) found in their review paper that messages are more persuasive when they are personally relevant so that individuals recognize they are the target of the message; they also found that the informational content may not be as important as the source of information and how it is communicated.

It is important to keep in mind that even carefully designed and delivered information often fails to motivate pro-environmental behavior due to a number of contextual factors (Stern, 1999). For example, cost and convenience associated with behavioral change is an important consideration of potential adopters (Rogers, 2003). Kahan et al. (2011) also suggested that even when faced with persuasive scientific evidence, individuals maintain their stance on controversial issues based on their understanding of what their social group thinks about the issue. In the natural resource context, research has documented the influence of cultural cognition of risk on beliefs related to climate change (Kahan et al., 2011). Therefore, even if people are made aware of an environmental problem and the possible actions that they can take to address the problem, and are presented with information that is considered reliable, the social context can still inhibit the effectiveness of the information in motivating behavioral change.

Another aspect of how information can be perceived and used to motivate behavioral change relates to the attribution of responsibility, which is closed related to the aforementioned idea of sense of responsibility. As previously mentioned, awareness of personal environmental responsibility has been shown to be associated with pro-environmental behaviors across multiple land uses (Cooper, Poe, & Bateman, 2004; Eden, 1993; McGuire et al., 2013). However, when facing a problem or negative outcome, people often assign blame (i.e., responsibility for the problem or negative outcome) to other individuals, groups, or organizations, and such attribution of responsibility serves as a psychological mechanism for people to process and cope with the problem or negative outcome (Gerber & Cherneski, 2006; Shaver, 1985). As such, people may have a false sense of own responsibility and disproportionally attribute responsibility to others, hence expecting solutions to be identified and carried out by others as well (Fahlquist, 2009; Roseman, Antoniou, & Jose, 1996). In this context, it would be important to know what role information about responsibility may play in shaping people's sense of responsibility—whether providing information to clearly explain what and who are causing a problem would strengthen people's sense of responsibility and/or help align their sense of responsibility with reality, potentially motivating behavioral change (Eden, 1993). So far, little research has been done to examine the role of different types of information in shaping people's perceptions and behaviors towards environmental conservation in general and water quality improvement in particular, and even less is known about how information about responsibility may be perceived and used across the urban-to-rural gradient.

Building upon previous research on factors influencing people's willingness and actions to adopt conservation practices in general and water quality improvement practices in particular, this study addresses the following questions: (1) What is the likelihood of residents in northwest Indiana to install conservation practices to improve water quality in the next year? (2) What factors motivate residents in northwest Indiana to adopt conservation practices to improve water quality? and (3) What role does different types of information play in shaping residents' willingness to adopt water quality improvement practices? Below is a description of our study site, a survey experiment on types of information offered, and methods used for data collection and analysis, followed by our survey results and implications.

Methods

Study Site

In Indiana, there has been serious water quality concerns that need to be addressed: 75% of rivers and streams in Indiana do not support full body contact and 61% do not support fishable use. Our research is focused specifically in Porter and LaPorte counties, two counties in northwestern Indiana which encompass the Trail Creek watershed and the East Branch Little Calumet River watershed. These two watersheds are part of the larger Little Calumet Galien watershed (Hydrologic Unit Code: 04040001), which is the only watershed in Indiana that flows directly into Lake Michigan (Figure 14). The major land cover types for the East Branch-Little Calumet River watershed are developed lands (20%), agricultural lands such as cover crops and pasture/hay (28%), forests and grasslands (36%), and water and wetlands (15%) according to the 2011 National Land Cover Database (NLCD) (Figure 15). The major land cover types for the Trail Creek include developed lands (24%), agricultural lands (17%), forests and grasslands (44%), and water and wetland (14%) (Figure 16). This means both watersheds have mixed land uses along a clear urban-to-rural gradient. The Trail Creek watershed also contains the Indiana Dunes National Lakeshore, a National Park unit located along the southern shores of Lake Michigan. NPS pollution has been identified in both watersheds as a primary source of pollution due to human activity in rural and urban land uses (Indiana Lake Michigan Coastal Program, 2015a, 2015b).

Data Collection

Data for this study was collected through a household survey that was administered to residents of Porter County and LaPorte County from February to April 2018. Prior to developing the survey instrument, face-to-face, semi-structured interviews were conducted with 12 water quality professionals who had experience working in the East Branch-Little Calumet and Trail Creek Watersheds. Insights from these interviews informed the development of the survey instrument. The interview protocol can be found in Appendix A.

Resident Survey

As we are interested in understanding willingness to adopt water quality improvement practices and the role of information across the rural-to-urban gradient, we first had to define our resident groups of interest. To begin, we divided the two counties into block groups according to the 2010 U.S. Census and overlayed land cover types from the 2011 National Land Cover Database (NLCD) using software program ArcGIS Pro 2.2. Majority land cover type was determined for each block group in Porter and LaPorte counties using zonal statistics and excluding open water, grassland, wetland, forest, industrial, and commercial coverage. Once majority land cover type was determined, we added an overlay of small-agriculture, medium/large agriculture, and rural residential shapefiles. By doing so, we were able to categorize each block group from the 2010 U.S. Census into five resident classifications of interest: urban residential, suburban residential, rural residential, small agriculture, and large/medium agriculture. The urban residential group consisted of individuals who resided in medium intensity or low intensity developed areas according to the 2011 NLCD. The suburban residential was defined as all residents living on open space developed land, low intensity developed land, or barren land according to the 2011 NLCD. Using adapted definitions from Perry-Hill & Prokopy (2014), we defined the following groups: medium/large agricultural residents as individuals living in a rural area who have at least 50 acres of cultivated crops or pasture/hay; small agricultural residents as individuals living in a rural area who have less than 50 acres of cultivated crops or pasture/hay; and rural, non-farming residents as individuals who live in a rural area but have no crops or hay/pasture. Agricultural groups were identified according to the cultivated crops classification in the 2011 NLCD and county parcel data taken from the Indiana Department of Homeland Security (IDHS). The rural residential group was generated by identifying the locations of houses outside of incorporated cities or towns. The location of houses was obtained from the 2015 IDHS County Address Points geodatabase for LaPorte and Porter counties. Each address point with a valid house number constituted a rural residence that was buffered with a two-acre area around the point. Two-acres was determined to be the average area of influence around houses as indicated by fencing, shrub lines, and mowed lawns across 120 houses over both counties. Based on these operationalized classifications of the five resident groups of interest, we were able to reclassify each Census block into each of the five resident groups.

Our calculated sample size was 2,600 across the five resident groups based on measuring a small to medium effect size, so we drew a stratified random sample of 560 individuals for each resident group. SSI Global (https://www.surveysampling.com) possesses an extensive list of resident addresses in Porter and LaPorte counties. We provided SSI Global our reclassified Census block list for each county and SSI Global made a complete list of all addresses in all Census blocks that belong to each resident group and drew a random sample of 560 address from each group. We purchased this list of 2,800 individuals. To ensure sufficient representation of agricultural residents, an additional 816 individual records were purchased from Farm Market ID (http://www.farmmarketid.com/), which represents their available grower records for Porter and LaPorte counties. These addresses were added to the list of 2,800 address from SSI Global. We removed 750 addresses were because they were either duplicates, invalid according to the U.S. Postal Service, or corporate farmers. Our final sample size was 2,866. Five waves of mail (including three survey waves and two postcard waves) were sent to all residents in our sample using a modified Tailored Design Method (Dillman, Smyth, & Christian, 2014) and a $2 bill was included with our first survey packet as a token of appreciation. A total of 386 survey questionnaires were returned due to inaccurate addresses or deceased individuals. We received a total of 1,066 completed surveys for a final response rate of 43%.

The survey questionnaire included 26 binary, Likert-scale, and multiple choice questions across seven topics: (1) residential classification questions, (2) general knowledge of and attitudes towards surface water resources, (3) conservation practices to improve water quality, (4) attitudes towards conservation practices to improve water quality, (5) social motivations to improve water quality, (6) water quality improvement program incentives and barriers, and (7) demographics. These survey questions were informed by our qualitative interview results and the Theory of Planned behavior (Ajzen, 1988, 1991; Fishbein & Ajzen, 2010). In addition, we drew on a number of existing survey items from *The Social Indicator Planning and Evaluation System (SIPES) for Nonpoint Source Management* (Genskow & Prokopy, 2011). Responses to residential classification questions in Section 1 of the survey were used to determine resident group for subsequent data analyses.

Information Experiment

In addition to the 26 survey questions, the survey instrument contained an experimental component in the form of an information page in the survey booklet. Individual residents in the final sample were randomly assigned into either a treatment or control group and were sent the corresponding survey questionnaire. The control information page was designed to mimic a type of commonly used flyer or information sheet about NPS pollution that would be given out by federal, state and local water resource professionals in the region. This page included general information organized in four sections: (1) a definition of NPS pollution, (2) what contributes to NPS pollution (i.e., general causes), (3) what issues are associated with NPS pollution (i.e., impacts), and (4) what I can do to help (i.e., suggested practices individuals can use to reduce NPS pollution (see Appendix B). The treatment information page provided the exact same information in the aforementioned four sections as did the control information page, with the addition of a section that provided a short statement about a recent study conducted by Purdue University and five pie charts from this study. The short statement explained that a study in the East Branch-Little Calumet and Trail Creek watersheds found exactly how much each of the five major land uses (i.e., small agriculture, large agriculture, rural residential, suburban, urban) in the two watersheds contributes to each of four NPS pollutants (i.e., nitrogen, phosphorus, sediment, *E. coli*). This treatment information page also contained four pie charts each showing the percentage of each NPS pollutant coming from each land use, with an additional pie chart showing the percentage of land area in each land use across the two watersheds. The purpose of the information treatment was to determine if providing specific information to residents about their contribution to pollution would trigger a sense of personal responsibility that would ultimately lead to intention to adopt water quality improvement practices. The exact percentages used in the pie charts were drawn from the modelling results of NPS pollution produced by our collaborators from the Department of Agricultural and Biological Engineering at Purdue University (see Appendix C). The treatment and control information pages were designed to be visually identical with the same layout, same background picture, and same font style and size. The only difference between the two was the aforementioned section about the Purdue study. An identical question about likelihood to adopt water improvement practices was asked before the information page in the survey booklet and immediately after the information page for both treatment and control groups.

Statistical Analyses

Potential non-response bias was examined. As a proxy for detecting difference between respondents and non-respondents, responses from early first-wave respondents (n=63) and responses from third-wave respondents (n=83) were compared with respect to respondents' demographic characteristics, self-reported likelihood of adoption, attitudes toward conservation practices to improve water quality, and familiarity with such practices (Armstrong & Overton, 1977). No statistically significant differences ($p \leq 0.05$) were detected with the exception of age: respondents from the third wave of the survey were younger than those form the first wave. We also compared respondents' demographic characteristics with average characteristics of Porter and LaPorte county residents according to the 2010-2017 Census data. Our respondents on average were older, more often male, more often white, wealthier, and more educated (Table 4). This suggests potential non-response biases and a need for using caution when generalizing our study results. Missing data was explored to determine if any systematic non-response was present. For each variable of interest, the number and percentage of missing responses were calculated. We also explored if any variables were consistently missing in combination with other variables of interest. We found no systematic non-response. Univariate descriptive statistics were calculated to assess variable distributions and determine if any outliers existed. No outliers were found. In addition, t-tests and diagnostic plots were used to determine if respondents in the information treatment and control groups were different in terms of their demographic characteristics, self-reported awareness of NPS pollution, self-reported awareness of water quality improvement practices, attitudes towards water quality improvement practices, and self-reported likelihood to adopt water quality improvement practices before reading the information page. No statistically significant differences were found between treatment and control groups.

We first constructed an empirical model to assess factors influencing respondents' likelihood to adopt water quality improvement practices. The response variable (ADOPTBEFORE) was the self-reported likelihood of adoption before the information page. ADOPTBEFORE took value 1 if a respondent reported "likely" or "very likely" to adopt any conservation practice to improve water quality in the next year and 0 otherwise (on a five-point Likert scale with 1=very unlikely, 2=unlikely, 3=neither unlikely nor likely, 4=likely, 5=very likely). ADOPTBEFORE was modeled as a function of 20 explanatory variables informed by the literature and our specific interest in different types of social norms (Table 5). Three of these explanatory variables were composite scores measuring three types of norms: descriptive norm, subjective norm, and normative social influence. In the survey, each type of norm was measured using a number of survey questions. As shown in Table 6, responses to each set of norm-focused survey questions were highly correlated according to the Cronbach alpha tests. Therefore, we generated a composite score for each type of norm by averaging responses across each set of survey questions. Four additional composite scores were calculated and used as explanatory variables, measuring perceptions of personal impact on water pollution, perceptions of humans' impact on water quality, perceived severity of potential water pollution sources, and self-reported importance of being a good example to others (Table 6). They were also generated by averaging responses across each set of internally consistent survey questions.

To estimate this empirical model, binary logistic regression was used and probabilities were assigned to each of the two possible outcomes of ADOPTBEFORE. For a binary response variable Y and a vector of explanatory variables X, these probabilities are:

$$P(Y\mathrm{i} = 1) = P\mathrm{i} = \frac{e^{\beta Xi}}{1 + e^{\beta Xi}}$$

$$P(Y\mathrm{i} = 0) = 1 - P\mathrm{i} = 1 - \frac{e^{\beta Xi}}{1 + e^{\beta Xi}} = \frac{1}{1 + e^{\beta Xi}}$$

where Pi represents the probability of a respondent reporting likely or very likely to adopt a water quality improvement practice in the next year, β is a vector of regression coefficients, and βXi is a standard notation representing the right-hand side of a regression model. Without transformation, binary logistic regression results are often reported in terms of odds ratios which is the relative odds of occurrence of an outcome given a variable of interest (Szumilas, 2010). As such, the coefficient estimates in a logistic regression do not carry the implication of per unit impact of individual explanatory variables as in the case of ordinary least squares regression (Mehmood & Zhang, 2005). To draw such implications, marginal effects for each explanatory variable were calculated and reported as follows: $dPi/dXi = Pi(1-Pi)\beta$. For the purpose of this study, the interpretation of the logistic regression results is mainly focused on the identification of significant explanatory variables and their associated signs.

To determine the role of information on respondents' self-reported likelihood to adopt water quality improvement practices, we constructed an empirical model that was similar to the one just described, but with a different response variable and two additional explanatory variables. The response variable for this model was the self-reported likelihood of adoption after the information page (ADOPTAFTER). Similar to ADOPTBEFORE, ADOPTAFTER also took value 1 if a respondent reported "likely" or "very likely" to adopt any conservation practice to improve water quality in the next year and 0 otherwise. The two additional explanatory variables were TREATMENT, indicating whether a respondent was in the treatment or control group, and ADOPTBEFORE, as previously defined. For both logistic regression models, variance inflation factor (VIF) was also calculated. The VIF for both the ADOPTBEFORE model and the ADOPTAFTER model was 1.34, which is well below 10, the standard for detecting multicollinearity in regressions.

We also explored changes in residents' self-reported likelihood of adoption before and after the information page (regardless of which information page). To do so, we created a new variable (ADOPTCHG) by subtracting the before-information self-reported likelihood of adoption from the after-information self-reported likelihood of adoption. As such, ADOPTCHG was an ordinal variable with an interval of 1, ranging from -4 to 4. Pearson chi-square tests were used to explore bivariate relationship between ADOPTCHG and other categorical variables. When assumptions for Pearson chi-square tests were violated, Fisher's exact tests were used instead. All analyses were conducted in software packages Stata 12.0 and R 3.5.1.

Results

The average age of respondents was 59 years old (SD=14, Min=21, Max=96), over half of respondents (63%) were male, and 36% had obtained a Bachelor's or graduate degree (Table 7). The majority of respondents (91%) owned their home. Over half of the respondents (57%) shared responsibility for making decisions about their property or home and approximately 8% of respondents indicated that someone else is responsible for making decisions about their property or home. Thirty percent of respondents reported an annual household income before tax of less than $50,000. For those respondents who were farmers, the average farm size was 95.4 acres (SD=222.6, Min=0.25 acres, Max=1,500 acres). Our respondents on average were slightly older, more often male, more often white, wealthier, and more educated compared to the average characteristics of Porter and LaPorte county residents when comparing our results to the 2010-2017 Census data (Table 4).

Less than half of respondents (41%) reported that they were either likely or very likely to adopt some conservation practice(s) to improve water quality in the next year (Figure 17). Across resident groups, large/medium- and small-scale farmers indicated the highest likelihood of adoption compared to other resident groups (54% and 53% respectively reported likely or very likely) (Figure 18). Rural residents and suburban residents reported similar likelihood (41% and 40% reported likely or very likely, respectively). Urban residents reported the lowest likelihood (38% reported likely or very likely).

The logistic regression model for assessing factors influencing residents' likelihood of adoption (ADOPTBEFORE) was significant overall (χ^2=234.94, p<0.001) (Table 8). Among all the demographic variables, age was the only significant one (p<0.001). Older respondents tended to report lower likelihood to adopt conservation practices to improve water quality than did younger respondents. When controlling for all the other factors, respondents' resident group had no effect on their self-reported likelihood of adoption. Generally, respondents who perceived more problems with water pollution in their area, who were more aware of water quality improvement practices, and who had more positive attitudes towards these practices were more likely to report intention to adopt a practice in the next year (p=0.013, p=0.004, and p=0.023, respectively). Likewise, respondents who felt a sense of responsibility to adopt conservation practices to improve water quality tended to report greater likelihood of adoption (p<0.001). Additionally, respondents who had noticed more of their family, friends, neighbors, or others in their community adopting water quality improvement practices (i.e., perception of descriptive norm) were more likely to report intention to adopt themselves (p=0.067). Those who perceived stronger subjective norm associated with the adoption of water quality improvement practices (i.e., perceived expectation from family, friends, neighbors, and others in community to adopt) also reported higher likelihood of adoption (p<0.001). Finally, respondents who had previously looked for information about water quality problems in their local waterbodies were also more likely to report intention to adoption (p=0.012).

The logistic regression model for understanding the role of information on respondents' self-reported likelihood to adopt water quality improvement practices was also significant overall (χ^2=389.17, p<0.001) (Table 9). Similar to the ADOPTBEFORE model, significant explanatory variables in the ADOPTAFTER model included respondent's age (p<0.001), attitude towards water quality improvement practices (p=0.001), a sense of responsibility for adopting these practices (p=0.065), and perception of descriptive norm (p=0.020). Valuing being a good example to family, friends, neighbors, and others in their community was also a significant variable in the ADOPTAFTER model (p<0.001). Perceiving more problems with water pollution in their area and being aware of water quality improvement practices were no longer significant, nor was having previously looked for information about water quality problems in their local waterbodies. While perception of subjective norm also became insignificant, having a stronger personal norm for keeping water clean became negatively associated with reporting a higher likelihood of adoption after reading the information page (p=0.017). Importantly, TREATMENT was not a statistically significant predictor in the model whereas ADOPTBEFORE (i.e., respondents' self-reported likelihood of adoption prior to reading the information page) was a statistically significant predictor of ADOPTAFTER (i.e., respondents' self-reported likelihood of adoption after reading the information page; p<0.001).

We further explored the change of self-reported likelihood of adoption before and after respondents read the information page. Overall, ADOPTCHG ranged from -4 to 4, with a mean of -0.03 (SD=0.88; Figure 19a). Using a Fisher's Exact Test, we found that ADOPTCHG was not associated with respondents reading either the treatment or control information page (Fisher's exact=0.911; Figure 19b). Further, ADOPTCHG did not differ based on respondents' income (χ^2=13.5383, p=0.195), education (χ^2=9.1279, p=0.520), or whether they rented or owned their home (Fisher's exact=0.509). ADOPTCHG did, however, differ between male and female respondents (Fisher's exact=0.034). Although the difference was small, male respondents were slightly more likely to report decreased likelihood of adoption (mean=-0.04; SD=0.81) than were female respondents (mean=-0.01; SD=0.98). Additionally, there was a statistically significant association between ADOPTCHG and respondents' self-reported likelihood of adoption before they read the information page (χ^2=123.6263, p<0.001). Specifically, for respondents who reported being very unlikely or unlikely to adopt water quality improvement practices before the information page, 51% reported the same likelihood after the information page while 40% reported higher likelihood of adoption; for those who reported being likely or very likely to adopt before the information page, 64% reported the same likelihood after the information page while 30% reported lower likelihood of adoption; and for those who reported being neither unlikely nor likely to adopt before the information page, 62% remained the same while 18% reported less likely and 20% reported more likely (Table 10).

Discussion

More respondents reported being likely to adopt water quality improvement practices than those who reported unlikely. However, it is important to keep in mind that behavioral intention is not the same as actual adoption and external constraints may exist that ultimately deter individuals from transitioning to a favorable intention to adoption (Blackstock et al., 2010; Dutcher, Finley, Luloff, & Johnson, 2004; Quimby & Angelique, 2011; Wall, 1995). Ajzen (2005) referred to such external constraints as actual behavioral control, including the skills, resources, and other prerequisites that are necessary for a person to adopt a behavior of interest. As summarized by (Steg & Vlek, 2008), generally individuals are more likely to adopt pro-environmental behaviors when the behavior is convenient and not too costly in terms of money, time, and effort. Similar points were made by Rogers (2003) regarding the importance of ease and simplicity in facilitating behavioral change. Additionally, new practices that are compatible with how individuals live their lives would be more prone to adoption (Rogers, 2003). This means that although our study found that 41% of watershed residents reported a favorable intention, more effort would be needed to help them take the necessary steps to transition from having this favorable intention to actual adoption. Many water quality improvement practices can be labor intensive (e.g., rain gardens), require modifying an individual's property significantly (e.g., riparian buffers, detention basins), and can be costly to install (e.g., porous pavement, green roof). Reducing these barriers to adoption will be essential for water quality programs. Another important finding is that roughly a third of our respondents reported being neither unlikely nor likely to adopt. This may represent a potential opportunity for water quality professionals. Rather than writing these individuals off, the question remains what can be done to motivate these seemingly indifferent individuals.

Similar to previous literature, our study suggests that older age may be a deterring factor to the adoption of water quality improvement practices (Liu et al., 2018). However, in our study, the effect of age compared to other factors was small. Regardless, targeting the younger population may be important for water quality programs (e.g., Mattia, Lovell, & Davis, 2018; Pierce & Frye, 1998); however, home or land ownership is often associated with older than younger people (Houle & Berger, 2015; Houle & College, 2014). Thus, it might not be effective for water quality programs to only target the younger population of their watersheds; rather, it is important to further explore why older people may be less likely to engage in water quality improvements and what strategies may be developed to help older watershed residents overcome these challenges. Unlike what has been found in several previous farmer studies, our study does not show significant association between self-reported likelihood to adopt water quality improvement practices and level of education or income among farmers or generally (Brehm et al., 2013; Liu et al., 2018; Motallebi et al., 2016; Wilson et al., 2018). This may be because our respondents were wealthier and more educated compared to the general population in the two counties. As such, our results about the effect of education and income may be inconclusive.

Our study shows that having a positive attitude towards water quality improvement practices and having a strong sense of responsibility for keeping water clean are associated with people's self-reported likelihood to take action to improve water quality. In addition, a sense of responsibility had the highest marginal effect on respondents' likelihood of adopting water quality improvement practices compared to other significant variables in our models. However, personal norm was not a significant variable in our ADOPTBEFORE model and was in fact negatively associated with self-reported likelihood of adoption in our ADOPTAFTER model. This is rather puzzling as the Norm Activation Model has suggested the sequential chain of events moving from awareness to responsibility to personal norm to pro-environmental behavior (e.g., Bamberg, Hunecke, & Bloaum, 2007; De Groot & Steg, 2009; Milfont, Sibley, & Duckitt, 2010; Onwezen, Antonides, & Bartels, 2013; Park & Ha, 2014; Steg & Groot, 2010). As such, it is important to further investigate and contrast the role of sense of responsibility and the role of personal norm in the context of water quality improvement—is having a sense of responsibility a necessary first step for someone to form strong personal norm about water quality improvement? Does a sense of responsibility trigger people's behavioral intention through the effect of personal norm? Could a sense of responsibility and personal norm act differently towards generating a favorable intention and the eventual adoption of a desirable behavior?

Our study also highlights the importance of social norms, both descriptive and subjective, in shaping watershed residents' likelihood to engage in water quality improvements. Indeed, subjective norms had the second largest marginal effect on respondents' likelihood of adopting water quality improvement practices. These results, together with the previously discussed result about personal norm, suggest that having a personal norm (i.e., feeling a sense of moral obligation) for keeping water clean may not be necessary for someone to want to take action to improve water quality; rather, watershed residents are subject to the social influence of important others—what their family, friends, neighbors, and community members do and what these important others expect of them—have a significant effect on how watershed residents view and act upon water quality problems. As such, to promote water quality improvements in a watershed, it may be more important to facilitate the development of water quality-friendly social norms or make existing favorable social norms more explicit than investing resources to convince individuals that adopting relevant practices is the right thing to do. So far, the role of descriptive norms has been mostly examined in the context of pro-environmental behavior (e.g., Armitage & Conner, 2001; Cordano & Frieze, 2000; De Groot & Steg, 2007; Cheung, Chan, & Wong, 1999; Harland, Staats, & Wilke, 1999; Heath & Gifford, 2002), while subjective norms have been mostly examined in the context of land and forest/vegetation management (e.g., Bieling, 2004; Corbett, 2002; Floress et al., 2018; Karppinen, 2005; Karppinen & Berghäll, 2015; Läpple & Kelley, 2013; Niemiec, Ardoin, Wharton, & Asner, 2016; Wollni & Andersson, 2014). In contrast, relatively little is known about the role of social norms in water quality management, particularly how descriptive and subjective norms may have similar or different effects on behavioral change (Liu et al., 2018). Our results shed light on the importance of incorporating social norms into future water quality studies to identify opportunities for and barriers to engaging watershed residents across land uses.

We expected that specific information clearly explaining what and who are causing water pollution problems in local watersheds would strengthen people's sense of responsibility, help align their sense of responsibility with reality, and potentially motivate them to take action (e.g., Cooper et al., 2004; Eden, 1993; McGuire et al., 2014). However, we found through our survey experiment that providing such specific information had no effect on self-reported likelihood of adopting water quality improvement practices compared to providing generic information about

NPS pollution. Several considerations may help shed light on this result. First, Stern (1999) argued that the extent to which behavior might be changed by an intervention depends on the strength of contextual forces rather than the intervention itself, and that there are always times when interventions are likely to be effective and other times when they will fail. Especially when there are important barriers to action such as cost or inconvenience, the effectiveness of an information-based intervention may be very limited (Steg & Vlek, 2008; Stern, 1999). Second, although we designed both treatment and control information pages using pictures and graphs, it is doubtful that our information pages triggered the kind of emotional response that is often important for people to engage in pro-environmental behavior (Kollmuss & Agyeman, 2002). Even though our treatment information was about each resident group's contribution to water quality problems, this level of specificity (i.e., providing information at the group level across two watersheds) may still be not sufficient, and more individualized information may be necessary to elicit emotional response. Finally, it is possible that the information we provided provoked cognitive dissonance in respondents. Festinger (1957) described cognitive dissonance as the phenomenon where people selectively pay attention to information that reinforces their beliefs and discard information that contradicts their beliefs. Cognitive dissonance implies that people may neglect information about environmental problems because such information threatens their basic assumptions about problem severity, responsible parties, and what need to be done (Kollmuss & Agyeman, 2002). As such, if our respondents felt that our treatment information about each resident group's contribution to water pollution threatened their beliefs about what caused water pollution problems and who should be responsible and even possibly suggested they were in fact responsible, they may have disregarded the information. This may help explain the lack of effect on their self-reported likelihood of adoption in comparison to the control information.

Looking beyond the effect of providing specific information about NPS pollution responsibility of each resident group versus generic information about NPS pollution, we also found that, overall, general information had no effect; in other words, on average, there was no change in respondents' self-reported likelihood of adoption before and after they read any information page. However, a closer look at change in self-reported likelihood of adoption revealed sub-sample level patterns that deserve further attention. Specifically, our results show that change in self-reported likelihood of adoption was more negative for those who started with a more favorable intention (before reading any information page) and was more positive for those who started with a less favorable intention. In other words, reading either the treatment or control information reduced the negativity of respondents with less favorable intention (before reading the information), but also reduced the posivity of respondents with more favorable intention (before reading the information). One may argue this is because of regression to the mean. However, we did observe a statistically significant association between respondents' self-reported likelihood of adoption before the information and the change in their self-reported likelihood after the information. As such, there is reason to believe, based on our results, that information affects watershed residents differently depending on their predisposition. While it is encouraging that an information intervention may help watershed residents reduce their less favorable intention to engage in water quality improvements, it is concerning that the same information intervention may also reduce favorable intention in the watershed. Therefore, it may be critical to tailor information to target favorable and less favorable watershed residents using different information content, types, formats, and/or sources. By doing so, water quality programs may be able to generate positive effect from their information intervention while minimizing negative effect. Overall, our results about the role of information strongly suggest a need for further investigation to explore how information works similarly or differently across different segments of the watershed resident population.

While this study contributes to the existing body of literature in multiple ways, several limitations also exist. First, we detected some non-response bias in terms of survey respondents being older, more often white, more often male, more educated, and wealthier when compared to the U.S. Census data. Although this may limit our ability to generalize our findings to populations with different characteristics, our findings are particularly insightful for identifying opportunities for and barriers to engaging different groups of residents across the rural-to-urban gradient in landscapes and watersheds with mixed land uses. Second, how we defined small-, medium- and large-scale farms was appropriate for northwestern Indiana; however, it may not be representative of all farms in the Midwest, which are generally larger than those found in our study area. Nonetheless, our findings are relevant in discussing factors influencing people's likelihood to adopt water quality improvement practices across different land uses encompassed in our study area and across urban, suburban, rural non-farming, and farming resident groups. A third limitation relates to the information page used for the survey experiment. Although we did test the information page during our pilot testing phase of the survey development, we had no way of knowing if respondents actually read the treatment or control information page or had a clear understanding of the information presented to them. If respondents did not take the time to comprehend the information being presented to them, the informational treatment would have had little to no effect on motivating behavioral change. Finally, responses to our personal norm survey item were overwhelmingly skewed, indicating that the majority of respondents reported strong personal norms related to water quality improvement with little variations. Similarly, responses to our survey question about the value respondents placing on protecting water quality was also skewed. Thus, regression results indicating the effects of personal norm and water quality protection value on respondents' likelihood of adoption need to be interpreted with caution. To be able to more accurately determine the relationship between likelihood of adoption and personal norm or water quality protection value, better measures of these two variables would be necessary to be less leading and to provide more variance across respondents.

Conclusion

NPS pollution remains a pervasive problem in the United States. As such, motivating the adoption of conservation practices to improve water quality is important to the overall ecological wellbeing of America's waterways as well as the economic and social prosperity of watershed residents. Understanding residents' decision-making processes and the factors influencing their likelihood of adoption can help promote water quality improvement practices in ways that are more salient, relevant, relatable, and accessible to watershed residents. Our study suggests a significant role of descriptive and subjective norms in shaping watershed residents' likelihood to engage in water quality improvements. Water quality programs could benefit from targeting community leaders and well-connected community members to establish and facilitate descriptive and subjective norms favoring the adoption of water quality improvement practices. Community-based, social marketing campaigns may be another way to shape watershed residents' perceptions of what others in their communities are doing to improve water quality and what they are expected to do by their peers (Geller, 1989; McKenzie-Mohr, 2000; McKenzie-Mohr & Smith, 1999). More research is needed to further develop and assess outreach and communication strategies that utilize social norms to catalyze behavioral change in the context of water quality management. Another important learning from our study relates to the role of information. Information alone is not likely to be effective in motivating people to change behaviors. There is a great need to carefully examine the role of different types of information in shaping people's perceptions, intentions and actions related to water quality management as well as environmental conservation broadly. It is also important to keep in mind that information may not work the same way on different people, as highlighted in our study. Research on the role of social norms and on the role of information about responsibility as well as information more broadly, will not only contribute to knowledge building around how people engage in water quality management specifically and environmental conservation generally, but provide practical insights to inform future development of environmental management and conservation messages and programs

Tables and Figures

Table 4. A comparison of demographic characteristics of survey respondents from 2017 to the 2010-2017 estimates for Porter and LaPorte counties based on the 2010 Census data from the United States Census Bureau.

Characteristic	**Survey respondents**	**LaPorte County**	**Porter County**
Age (% 65 and over)	36.3%	17.5%	15.9%
Sex (% male)	62.5%	51.5%	49.5%
Education (% with a Bachelor's degree or higher)	35.5%	17.6%	26.1%
Annual income before tax (% above $49,999 or median)	69.9%	$48,165	$64,874
Race (% white)	95.1%	85.1%	92.3%

Table 5. Variables used in binary logistic models for estimating residents' self-reported likelihood to adopt water quality improvement practices in the next year before and after they read an information page about NPS pollution.

Explanatory variable	**Description**
TREAMENT	Binary – 1 if received treatment information, 0 if control information
AGE	Continuous (years)
SEX	Binary – 1 if male, 0 if female
OWN	Binary – 1 if own the home where they live, 0 if rent
EDUCATION	Ordinal – highest level of school attained; 1 if less than high school/GED, 2 if high school/GED, 3 if some college, 4 if Associate's degree, 5 if Bachelor's degree, 6 if Graduate degree
INCOME	Ordinal – annual household income before tax; 1 if less than $25,000, 2 if $25,000 to $49,999, 3 if $50,000 to $99,999, 4 if $100,000 to $149,000, 5 if $150,000 to $199,999, 6 if $200,000 or more
RESIDENT	Nominal – 1 if urban, 2 if suburban, 3 if rural non-farming, 4 if small-scale farmer, 5 if large/medium-scale farmer
ATTITUDE	Ordinal – respondents' attitudes towards conservation practices to improve water quality; 1 if very negative, 2 if somewhat negative, 3 if neither negative nor positive, 4 if somewhat positive, 5 if very positive
PERSONAL_IMPACT	Continuous – composite score measuring respondents' levels of agreement with a set of two statements about their personal impacts on water quality; see Table 6
HUMAN_IMPACT	Continuous – composite score measuring respondents' levels of agreement with a set of two statements about human's impacts on water quality; see Table 6
PERSONAL_RESPONSIBILITY	Ordinal – measure of how strongly respondent agrees they have a responsibility to adopt conservation practices; 1 if strongly disagree to 5 if strongly agree
INFOSEEK	Ordinal – respondents' level of agreement with the statement "I have looked for information about water quality problems in local waterbodies in the past"; 1 if strongly disagree, 2 if disagree, 3 if neither disagree nor agree, 4 if agree, 5 if strongly agree
CONCERN	Ordinal – respondents' level of agreement with the statement "I am concerned about water quality in local waterbodies"; 1 if strongly disagree, 2 if disagree, 3 if neither disagree nor agree, 4 if agree,5 if strongly agree

Table 5 (continued)

Explanatory variable	Description
VALUE	Ordinal – respondents' level of agreement with the statement "Protecting water quality is important to me"; 1 if strongly disagree, 2 if disagree, 3 if neither disagree nor agree, 4 if agree, 5 if strongly agree
AWARE	Ordinal – respondents' self-reported awareness of conservation practices to improve water quality; 1 if never heard of them, 2 if slightly aware, 3 if somewhat aware, 4 if very aware
PERCEIVEDPROB	Continuous – composite score measuring respondents' perceptions of potential sources of water pollution in their area; see Table 6
GOODEXAMPLE	Continuous – composite score measuring respondents' importance ratings of four items (i.e., being a good example to friends, family, neighbors, and others in the community) related to the potential benefits associated with adopting conservation practices to help improve surface water quality; see Table 6
PERSONAL_NORM	Ordinal – respondents' level of agreement with the statement "We should keep our local waterbodies clean because it is the right thing to do;" 1 if strongly disagree, 2 if disagree, 3 if neither disagree nor agree, 4 if agree, 5 if strongly agree
SUBJECTIVE_NORM	Continuous – composite score measuring respondents' levels of agreement with four statements about perceived expectations of others on adoption of conservation practices to improve water quality; see Table 6
DESCRIPTIVE_NORM	Continuous – composite score measuring respondents' perceptions of others adopting or not adopting conservation practices to improve water quality; see Table 6
NORMSOCINFL	Continuous – composite score measuring respondents' levels of agreement with four statements about feeling the need to adopt conservation practices to improvement water quality if others have done so; see Table 6

Table 6. Composite explanatory variables used in the binary logistic models. Note that the number after each construct identifies how many survey items were combined to generate that construct. Cronbach's alpha is reported as a measure of internal consistency of survey items used to generate each construct. To calculate the value for each construct, averages were taken for responses to the corresponding survey items.

Explanatory variable	**Construct (# of items)**	**Survey item**	**Cronbach's Alpha**
PERSONAL_IMPACT	Personal impact on water quality (2)	*If I am not careful, what I do on my property or in my home could harm water quality in my area*	0.7285
		I believe what I do on my property or in my home could improve water quality in my area	
HUMAN_IMPACT	Humans' impact on water quality (2)	*I think water quality in local waterbodies is affected by all residents living in my area*	0.7410
		I think water quality in local waterbodies is affected by residents living outside of my area, for example, upstream of where we live	
PERCEIVEDPROB	Perceived problem severity of pollution sources (9)	*Soil erosion from farm fields*	0.8572
		Excessive use of lawn fertilizer and/or pesticides	
		Improperly maintained septic tanks	
		Stormwater runoff from rooftops, parking lots, and roads	
		Use of salt and sand on paved areas	
		Waste materials from pets	
		Use of fertilizers, manure, and/or pesticides for crop production	
		Removal of trees and vegetation along streams	
		Manure from animal feeding operations	
GOODEXAMPLE	Importance of being a good example to others (4)	*Be a good example to my family*	0.9735
		Be a good example to my friends	
		Be a good example to my neighbors	
		Be a good example to people in my community	

Table 6 (continued)

Explanatory variable	**Construct (# of items)**	**Survey item**	**Cronbach's Alpha**
SUBJECTIVE_NORM	Subjective norm (4)	*My family would like to see me adopting conservation practices to improve water quality.*	0.9145
		My friends would like to see me adopting conservation practices to improve water quality.	
		My neighbors would like to see me adopting conservation practices to improve water quality.	
		Others in my community would like to see me adopting conservation practices to improve water quality.	
DESCRIPTIVE_NORM	Descriptive norm (4)	*What have you noticed in terms of people around you adopting conservation practices to improve water quality in your area?* *1. Among my friends* *2. Among my friends* *3. Among my neighbors* *4. Among people in my community*	0.8528
NORMSOCINFL	Normative social influence (4)	*I would feel the need to adopt conservation practices to improve water quality if others in my family did so*	0.9368
		I would feel the need to adopt conservation practices to improve water quality if my friends did so	
		I would feel the need to adopt conservation practices to improve water quality if my neighbors did so	
		I would feel the need to adopt conservation practices to improve water quality if others in my community did so	

Table 7. Demographic characteristics of survey respondents (2017).

Demographic characteristics		**% or mean (standard deviation)**	**N**
Age (years)		59 (14)	1,021
Male		62.5%	1,040
Education	Less than High School/GED	2.1%	22
	High School/GED	26.5%	276
	Some College	24.7%	257
	Associate’s degree	11.2%	117
	Bachelor’s degree	22.6%	235
	Graduate degree	13.0%	135
Annual income before tax	Less than $25,000	10%	93
	$25,000-$49,999	20.1%	188
	$50,000-$99,999	38.1%	356
	$100,000-$149,999	20%	185
	$150,000-$199,999	7.5%	70
	$200,000 or more	4.5%	42
Home ownership		91.1%	953
Total farm size (acres)		95.4 (222.6)	69

Table 8. Binary logistic regression estimates for estimating residents' self-reported likelihood of adopting conservation practices to improve water quality in the next year before they read the information (ADOPTBEFORE). Standard errors reported are for the marginal effects.

Explanatory variable	**Odds ratio**	**Marginal effects (dy/dx)**	**Standard error**
SEX	0.829578	-0.03408	0.034552
PERSONAL_NORM	0.90098	-0.01902	0.032005
AGE * **	**0.958297**	**-0.00777**	**0.00113**
HUMAN_IMPACT	0.979957	-0.00369	0.021233
NORMSOCINFL	0.982014	-0.00331	0.021142
CONCERN	0.998822	-0.00022	0.022003
DESCRIPTIVE_NORM	1.002293	0.000418	0.032822
VALUE	1.053264	0.009466	0.022508
EDUCATION	1.077698	0.013649	0.01142
RESIDENT: LARGE_MED_SCALE_FARM	1.07959	0.013822	0.092702
INCOME	1.08482	0.01485	0.014599
GOODEXAMPLE	1.161839	0.027361	0.014124
RESIDENT: SUBURBAN	1.176753	0.029501	0.043525
RESIDENT: SMALL_SCALE_FARM	1.212479	0.034969	0.077937
**INFOSEEK ** **	**1.220076**	**0.036282**	**0.016177**
PERSONAL_IMPACT	1.231888	0.03804	0.024807
OWN	1.240343	0.039287	0.057869
RESIDENT: RURAL RESIDENT	1.248633	0.040353	0.041277
**ATTITUDE ** **	**1.338213**	**0.05314**	**0.022507**
AWARE * **	**1.377219**	**0.058381**	**0.020351**
**PERCEIVEDPROB ** **	**1.443175**	**0.066913**	**0.028387**
SUBJECTIVE_NORM * **	**1.788322**	**0.106026**	**0.029474**
RESPONSIBILITY * **	**1.895526**	**0.116645**	**0.026436**
RESIDENT: URBAN (used as baseline)	N/A	N/A	N/A
		Number of observations	807
		LR chi-squared	230.48 ***
		Pseudo R^2	0.2086

** $p < 0.05$, *** $p < 0.01$

Table 9. Binary logistic regression estimates for estimating residents' self-reported likelihood of adopting conservation practices to improve water quality in the next year after they read the information (ADOPTAFTER). Standard errors reported are for the marginal effects.

Explanatory variable	**Odds ratio**	**Marginal effects (dy/dx)**	**Standard error**
PERSONAL_NORM **	**0.656844**	**-0.0594962**	**0.028689**
TREATMENT	0.728353	-0.0448682	0.027001
RESIDENT: SMALL_SCALE_FARM	0.84285	-0.0241899	0.068183
RESIDENT: SUBURBAN	0.872852	-0.0192587	0.038429
RESIDENT: RURAL RESIDENT	0.921665	-0.0115685	0.036513
INCOME	0.937545	-0.0091288	0.012983
EDUCATION	0.965797	-0.0049264	0.010124
AGE ***	**0.974238**	**-0.0036945**	**0.001061**
SEX	1.034114	0.0047484	0.030751
AWARE	1.042748	0.0059253	0.018191
NORMSOCINFL	1.045464	0.0062936	0.018478
INFOSEEK	1.085352	0.0115939	0.014577
SUBJECTIVE_NORM	1.10728	0.0144252	0.026213
PERCEIVEDPROB	1.109845	0.0147528	0.025062
HUMAN_IMPACT	1.116421	0.015589	0.018964
VALUE	1.132626	0.017629	0.019963
OWN	1.141971	0.018792	0.050544
RESIDENT: LARGE_MED_SCALE_FARM	1.193832	0.0252753	0.086171
PERSONAL_IMPACT	1.214075	0.027459	0.022276
CONCERN	1.230853	0.0294017	0.020289
RESPONSIBILITY	1.307542	0.0379575	0.023468
GOODEXAMPLE ***	**1.390515**	**0.0466666**	**0.012109**
ATTITUDE ***	**1.612613**	**0.0676421**	**0.019343**
DESCRIPTIVE_NORM ***	**1.787972**	**0.0822542**	**0.028679**
BEFORE***	**8.954679**	**0.3103103**	**0.018948**
RESIDENT: URBAN (used as baseline)	N/A	N/A	N/A
		Number of observations	803
		LR chi-squared	389.36 ***
		Pseudo R^2	0.3535

** $p < 0.05$, *** $p < 0.01$

Table 10. Change in respondents' self-reported likelihood to adopt water quality improvement practices measured as the difference between likelihood rating after reading information page and likelihood rating before reading information, based on their self-reported likelihood of adoption prior to reading any information page. Negative values of change indicate decreased self-reported likelihood of adoption after reading any information page, zero indicates no change, and positive values indicate increased self-reported likelihood of adoption after reading any information page.

		Change in self-reported likelihood of adoption								
		-4	-3	-2	-1	0	1	2	3	4
Self-reported likelihood of adoption prior to reading any information page	Unlikely or very unlikely	0%	0%	0%	***9%***	***51%***	***25%***	***10%***	***3%***	***2%***
	Neither unlikely nor likely	0%	0%	***5%***	***13%***	***62%***	***19%***	***1%***	0%	0%
	Likely or very likely	0%	***2%***	***5%***	***23%***	***64%***	***6%***	0%	0%	0%

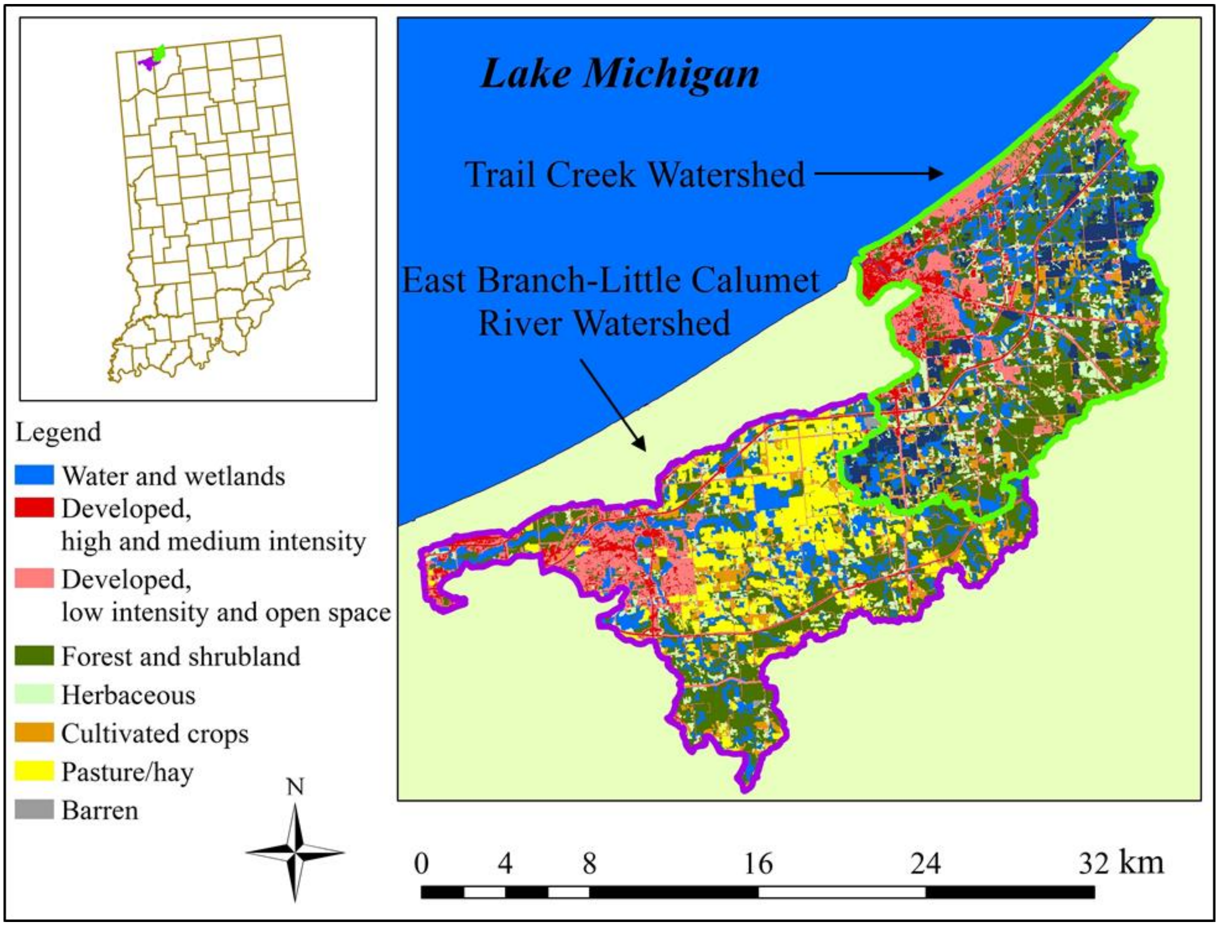


Figure 14. Overview of study site in northwestern Indiana. Land cover data taken from 2003 NLCD. Both watersheds are located within the larger Little Calumet-Galien (LCG) watershed.

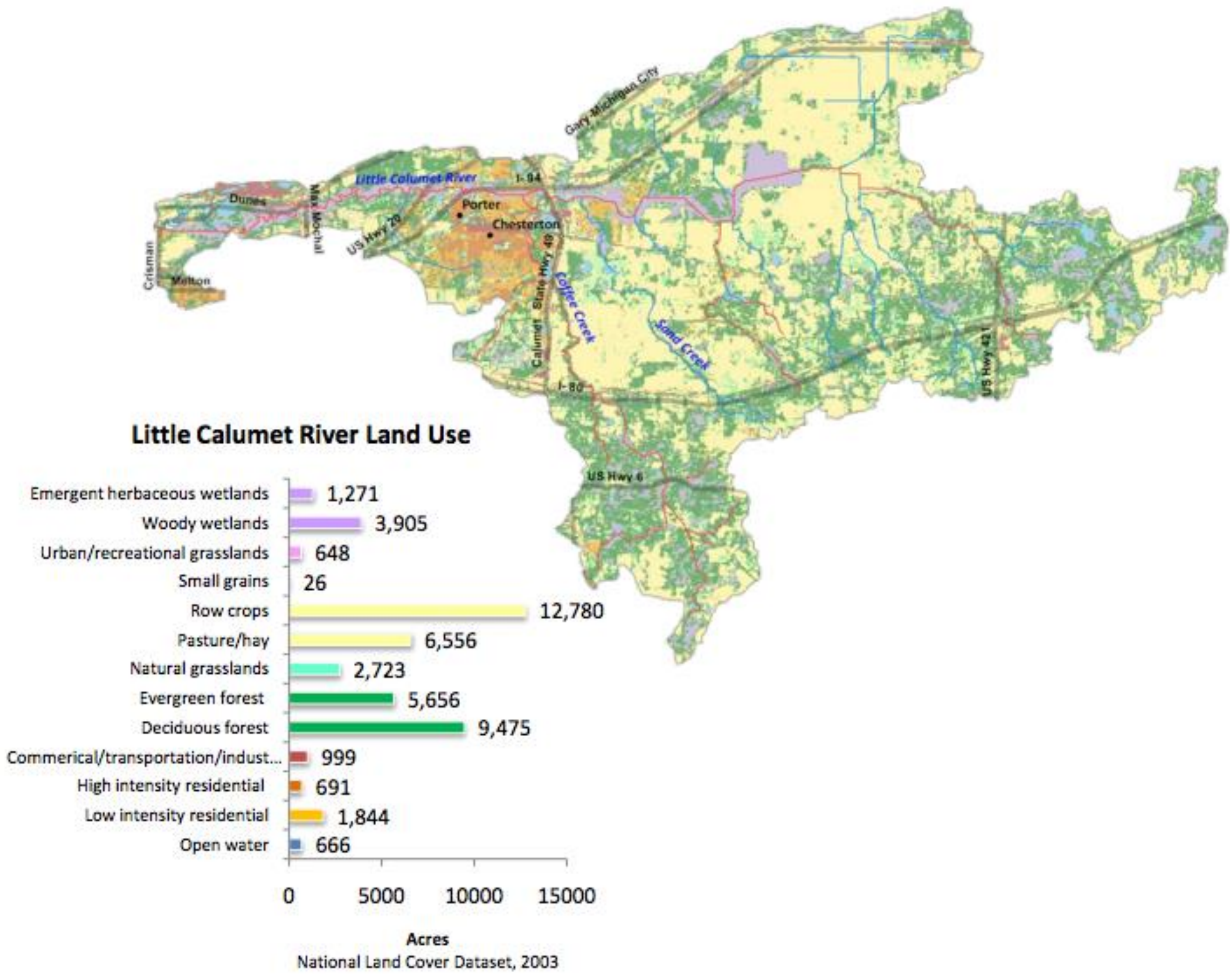


Figure 15. East Branch-Little Calumet Watershed land use map from Indiana Lake Michigan Coastal Program. Total watershed area encompasses 48,248 acres. Based on 2003 NLCD data.

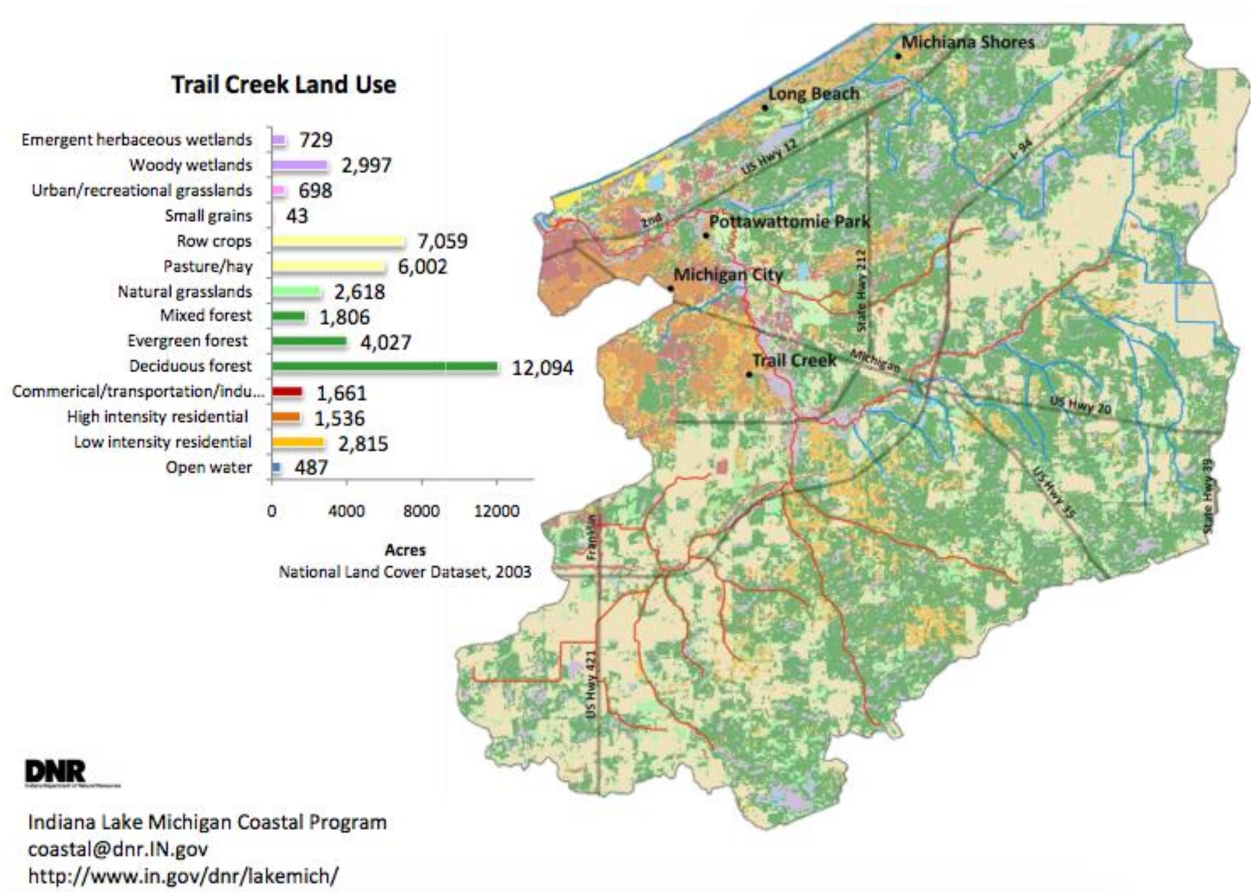


Figure 16. Trail Creek Watershed land use map from Indiana Lake Michigan Coastal Program. Total watershed area encompasses 47,330 acres. Based on 2003 NLCD data.

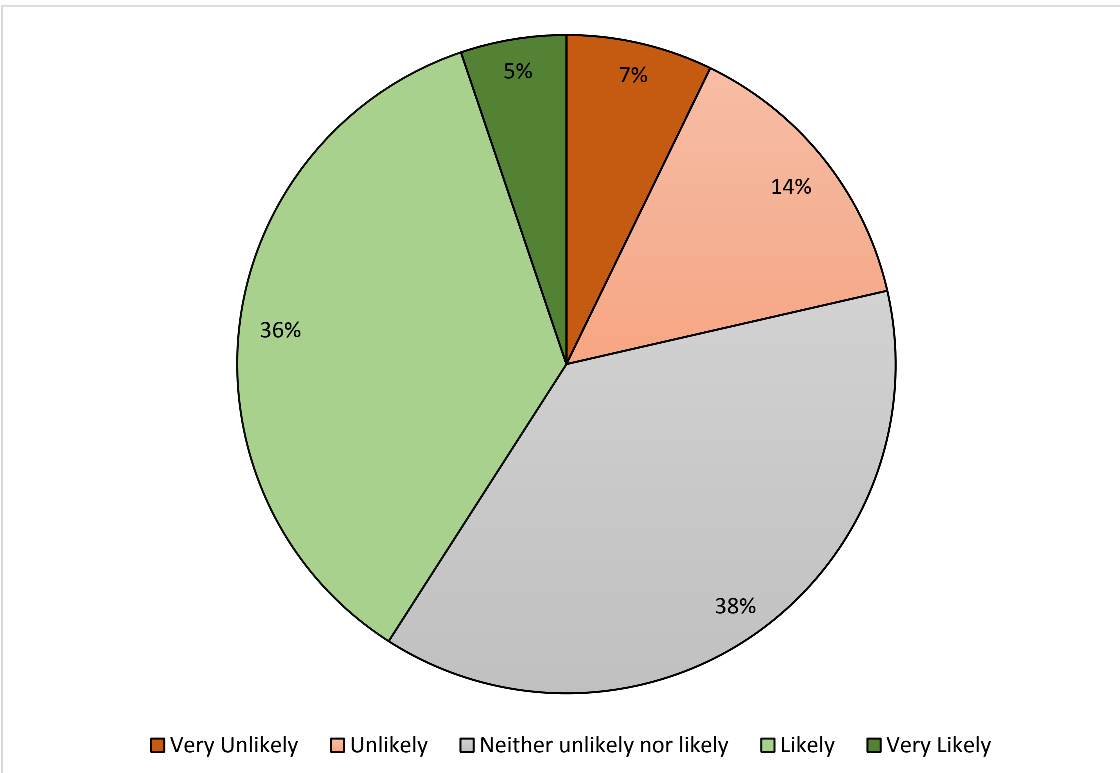


Figure 17. Respondents' self-reported likelihood of adopting any conservation practices to improve water quality in the next year prior to viewing the information page.

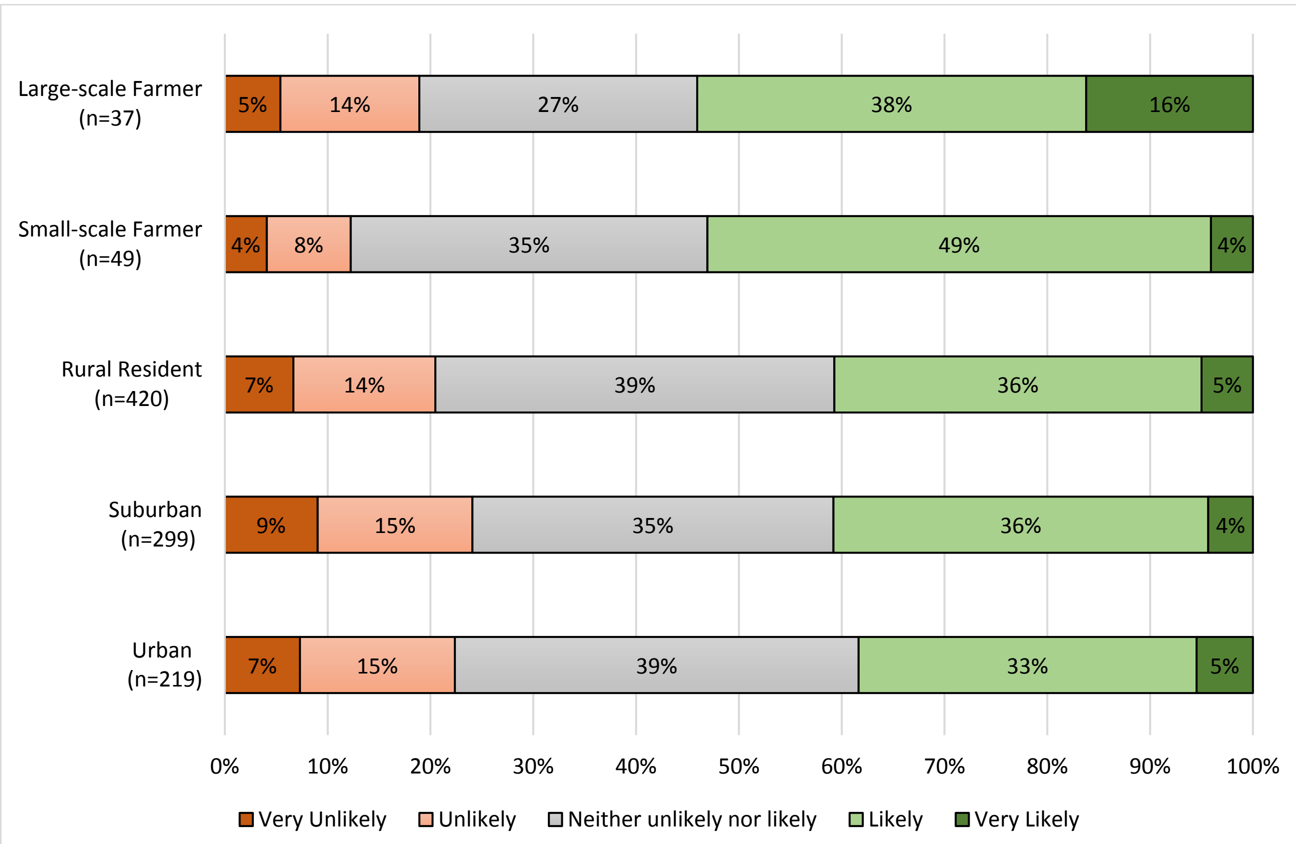


Figure 18. Respondents' self-reported likelihood of adopting any conservation practices to improve water quality in the next year by resident group prior to information page.

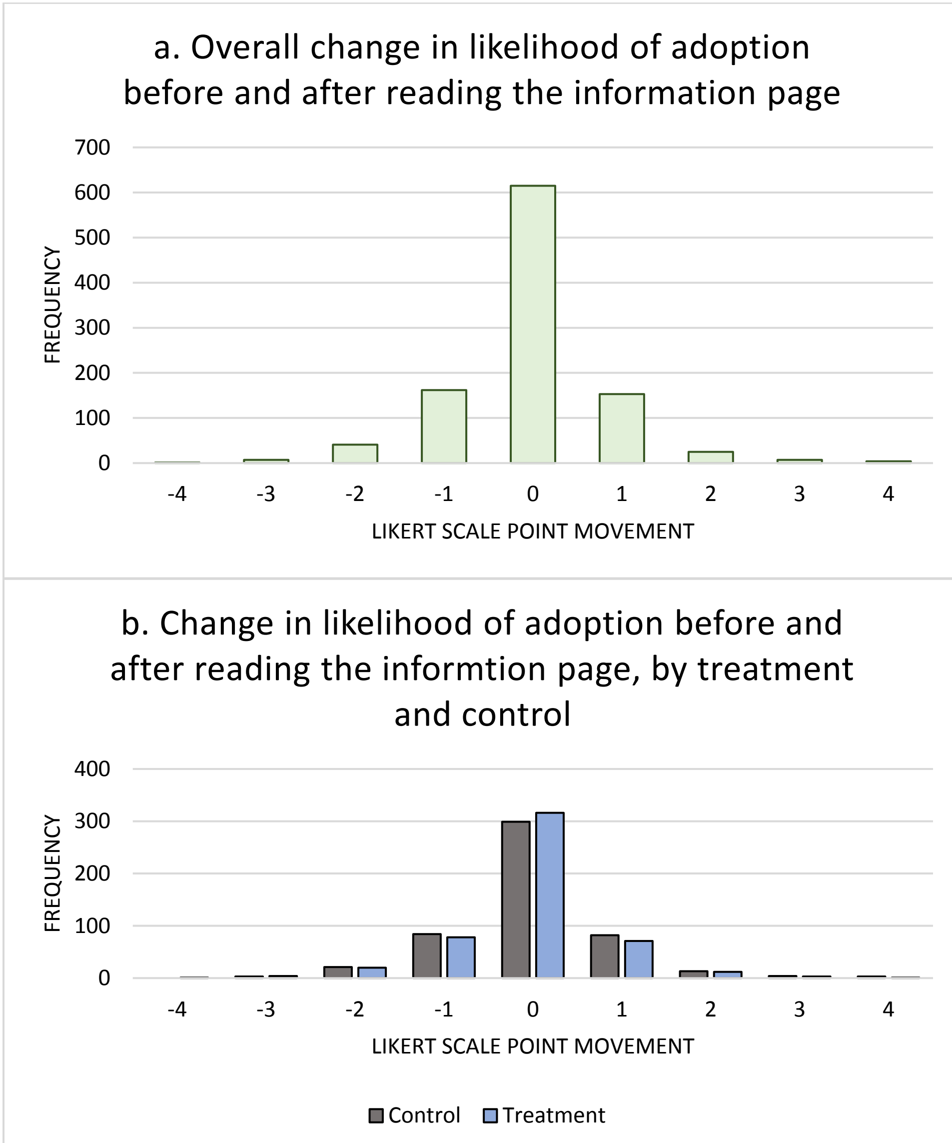


Figure 19. Change in respondents' self-reported likelihood of adopting conservation practices to improve water quality measured as the difference between likelihood rating after reading information page and likelihood rating before reading information. Negative values reflect a decreased self-reported likelihood of adoption after reading the information page, zero represents no change, and positive values reflect an increased likelihood of adoption after reading the information page. (a) Overall change in likelihood of adoption before and after reading the information page (ADOPTCHG); (b) Change in likelihood of adoption before and after reading the information page (ADOPTCHG), by treatment and control

References

Ahiablame, L. M., Engel, B. A., & Chaubey, I. (2012). Effectiveness of low impact development practices: Literature review and suggestions for future research. *Water, Air, and Soil Pollution*, *223*(7), 4253–4273. https://doi.org/10.1007/s11270-012-1189-2

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

Ajzen, I. (2005). Attitudes, Personality, and Behavior (2nd ed.). Milton-Keynes, England: Open University Press (McGraw-Hill).

Ajzen, I., & Fishbein, M. (1980). *Understanding Attitudes and Predicting Social Behavior*. Englewood Cliffs, NJ: Prentice-Hall.

Armitage, C. J., & Conner, M. (2001). Efficacy of the Theory of Planned Behaviour : A meta-analytic review. *British Journal of Social Psychology*, *40*, 471–499.

Armstrong, J. S., & Overton, T. S. (1977). Estimating nonresponse bias in mail surveys. *Journal of Marketing Research*, *14*(3), 396–402.

Arnold, C. L., & Gibbons, C. J. (1996). Impervious surface coverage: The emergence of a key environmental indicator. *Journal of the American Planning Association*, *62*(2), 243–258.

Baillie, S., Kaye-Blake, W., Smale, P., & Dennis, S. (2016). Agricultural Water Management Simulation modelling to investigate nutrient loss mitigation practices. *Agricultural Water Management*, *177*, 221–228. https://doi.org/10.1016/j.agwat.2016.07.018

Bamberg, S., Hunecke, M., & Bloaum, A. (2007). Social context, personal norms and the use of public transportation: Two field studies. *Journal of Environmental Psychology*, *27*, 190–203. https://doi.org/10.1016/j.jenvp.2007.04.001

Bieling, C. (2004). Non-industrial private-forest owners: possibilities for increasing adoption of close-to-nature forest management. *European Journal of Forest Research*, *123*(4), 293–303. https://doi.org/10.1007/s10342-004-0042-6

Bigelow, D.P. & Borchers, A. (2012) *Major land uses in the United States, 2012*. Economic Information Bulletin 178. U.S. U.S. Department of Agriculture, Economic Research Service.

Blackstock, K. L., Ingram, J., Burton, R., Brown, K. M., & Slee, B. (2010). Understanding and influencing behaviour change by farmers to improve water quality. *Science of the Total Environment*, *408*, 5631–5638. https://doi.org/10.1016/j.scitotenv.2009.04.029

Brehm, J. M., Pasko, D. K., & Eisenhauer, B. W. (2013). Identifying Key Factors in Homeowner’s Adoption of Water Quality Best Management Practices. *Environmental Management*, *52*, 113–122. https://doi.org/10.1007/s00267-013-0056-2

Burgess, J., & Harrison, C. M. (1998). *Environmental communication and the cultural politics of environmental citizenship*. *Environment and Planning A* (Vol. 30). Retrieved from http://journals.sagepub.com/doi/pdf/10.1068/a301445

Carpenter, S. R., Caraco, N. F., Correll, D. L., Howarth, R. W., Sharpley, A. N., & Smith, V. H. (1998). Nonpoint pollution of surface waters with phosphorus and nitrogen. *Ecological Applications*, *8*(3), 559–568. https://doi.org/10.1890/1051-0761(1998)008[0559:NPOSWW]2.0.CO;2

Chaubey, I., Chiang, L., Gitau, M. W., & Mohamed, S. (2010). Effectiveness of best management practices in improving water quality in a pasture-dominated watershed. *Journal of Soil and Water Conservation*, *65*(6), 424–437. https://doi.org/10.2489/jswc.65.6.424

Chouinard, H. H., Paterson, T., Wandschneider, P. R., Ohler, A. M., Chouinard, H. H., Paterson, T., … Ohler, A. M. (2008). Will Farmers Trade Profits for Stewardship ? Heterogeneous Motivations for Farm Practice Selection. *Land Economics*, *84*(1), 66–82. https://doi.org/10.1353/lde.2008.0046

Cialdini, R. B., Kallgren, C. A., & Reno, R. R. (1991). A focus theory of normative conduct: a theoretical refinement and reevaluation of the role of norms in human behavior. *Advances in Experimental Social Psychology*, *24*, 201–234.

Clark, C. F., Kotchen, M. J., & Moore, M. R. (2003). Internal and external influences on pro-environmental behavior: Participation in a green electricity program. *Journal of Environmental Psychology*, *23*, 237–246. https://doi.org/10.1016/S0272-4944(02)00105-6

Cook, S., & Ma, Z. (2014). Carbon sequestration and private rangelands: Insights from Utah landowners and implications for policy development. *Land Use Policy*, *36*, 522–532.

Cooper, P., Poe, G. L., & Bateman, I. J. (2004). The structure of motivation for contingent values: A case study of lake water quality improvement. *Ecological Economics*, *50*(1–2), 69–82.

Corbett, J. B. (2002). Motivations to Participate in Riparian Improvement Programs. *Science Communication*, *23*(3), 243–263. Retrieved from http://journals.sagepub.com.ezproxy.lib.purdue.edu/doi/pdf/10.1177/107554700202300303

Davies, B. B., & Hodge, I. D. (2006). Farmers' preferences for new environmental policy instruments: Determining the acceptability of cross compliance for biodiversity benefits. *Journal of Agricultural Economics*, *57*(3), 393–414. https://doi.org/10.1111/j.1477-9552.2006.00057.x

De Groot, J., & Steg, L. (2009). Morality and prosocial behavior: The role of awareness, responsibility, and norms in the Norm Activation Model. *The Journal of Social Psychology*, *1494*, 425–449.

Dietz, M. E. (2007). Low Impact Development Practices: A Review of Current Research and Recommendations for Future Directions. *Water, Air, and Soil Pollution*, *186*, 351–363. https://doi.org/10.1007/s11270-007-9484-z

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, phone, mail, and mixed-mode surveys: The tailored design method*. Hoboken, NJ: John Wiley & Sons, Inc.

Dutcher, D. D., Finley, J. C., Luloff, A. E., & Johnson, J. (2004). Landowner perceptions of protecting and establishing riparian forests: A qualitative analysis. *Society and Natural Resources*, *17*(4), 319–332. https://doi.org/10.1080/08941920490278773

Eden, S. E. (1993). Individual environmental responsibility and its role in public environmentalism. *Environment and Planning A*, *25*, 1743–1758.

Fahlquist, J. N. (2009). Moral Responsibility for Environmental Problems—Individual or Institutional? *Journal of Agricultural and Environmental Ethics*, *22*(2), 109–124. https://doi.org/10.1007/s10806-008-9134-5

Farrow, K., Grolleau, G., & Ibanez, L. (2017). Social Norms and Pro-environmental Behavior: A Review of the Evidence. *Ecological Economics*, *140*, 1–13. https://doi.org/10.1016/j.ecolecon.2017.04.017

Festinger, L. (1957). *A theory of cognitive dissonance*. *A theory of cognitive dissonance*. Stanford University Press.

Fishbein, M., & Ajzen, I. (2010). *Predicting and Changing Behavior: The Reasoned Action Approach*. New York, NY: Psychology Press.

Floress, K., Huff, E. S., Snyder, S. A., Koshollek, A., Butler, S., & Allred, S. B. (2018). Factors associated with family forest owner actions: A vote-count meta-analysis. *Landscape and Urban Planning*. https://doi.org/10.1016/j.landurbplan.2018.08.024

Gao, Y., Babin, N., Turner, A. J., Hoffa, C. R., Peel, S., & Prokopy, L. S. (2016). Understanding urban-suburban adoption and maintenance of rain barrels. *Landscape and Urban Planning*, *153*, 99–110. https://doi.org/10.1016/j.landurbplan.2016.04.005

Geller, E. S. (1989). Applied Behavior Analysis and Social Marketing: An Integration for Environmental Preservation. *Journal of Social Issues*, *45*(1), 17–36. Retrieved from http://research3.fit.edu/sealevelriselibrary/documents/doc_mgr/922/Geller._1989._Applied_Behavior_Analysis_&_Social_Marketing.pdf

Genskow, K., & Prokopy, L. S. (Eds.). (2011). *The Social Indicator Planning and Evaluation System (SIPES) for Nonpoint Source Management: A Handbook for Watershed Projects* (3rd ed.). Great Lakes Regional Water Program.

Gerber, G. L., & Cherneski, L. (2006). Sexual aggression toward women: Reducing the prevalence. *Annals of the New York Academy of Science*, *1087*, 35–46.

Gilroy, K. L., & McCuen, R. H. (2009). Spatio-temporal effects of low impact development practices. *Journal of Hydrology*, *367*, 228–236. https://doi.org/10.1016/j.jhydrol.2009.01.008

Guagnano, G. A., Stern, P. C., & Dietz, T. (1995). Influences on Attitude-Behavior Relationships A Natural Experiment with Curbside Recycling. *Environment and Behavior*, *27*(5), 699–718.

Hansen, A. J., Knight, R. L., Marzluff, J. M., Powell, S., Brown, K., Gude, P. H., & Jones, K. (2005). Effects Of Exurban Development on Biodiversity: Patterns, Mechanisms, and Research Needs. *Ecological Applications*, *15*(6), 1893–1905. https://doi.org/10.1890/05-5221

Hoppe, R. A., & Banker, D. E. (2010). *Structure and Finances of US Farms: Family Farm Report.* Economic Information Bulletin 66. U.S. Department of Agriculture, Economic Research Service.

Houle, J. N., & Berger, L. (2015). *Is Student Loan Debt Discouraging Homeownership among Young Adults? Social Service Review*. Chicago. Retrieved from http://www.journals.uchicago.edu/t-and-c

Houle, J. N., & College, D. (2014). A generation indebted: Young adult debt across three cohorts. *Social Problems*, *61*(3), 448–465. https://doi.org/10.1525/sp.2014.12110

Howarth, R., Sharpley, A., & Walker, D. (2002). Sources of Nutrient Pollution to Coastal Waters in the United States: Implications for Achieving Coastal Water Quality Goals. *Estuaries*, *24*(4b), 656–676. Retrieved from https://link.springer.com/content/pdf/10.1007%2FBF02804898.pdf

Indiana Lake Michigan Coastal Program. (2015a). *East Branch – Little Calumet River Watershed Fact Sheet*. Retrieved from http://www.in.gov/dnr/lakemich/files/lm-Little_Cal_Final.pdf

Indiana Lake Michigan Coastal Program. (2015b). *Trail Creek Watershed Fact Sheet*. Retrieved from http://www.in.gov/dnr/lakemich/files/lm-Trail_Creek2.pdf

Interis, M. (2011). On Norms: A Typology with Discussion. *The American Journal of Economics and Sociology*, *70*(2), 424–438. Retrieved from http://www.jstor.org/stable/41329193

Kahan, D. M., Jenkins-Smith, H., & Braman, D. (2011). Cultural cognition of scientific consensus. *Journal of Risk Research*, *14*(2), 147–174. https://doi.org/10.1080/13669877.2010.511246

Karppinen, H. (2005). Forest owners' choice of reforestation method: An application of the Theory of Planned Behavior. *Forest Policy and Economics*, *7*, 393–409. https://doi.org/10.1016/j.forpol.2003.06.001

Karppinen, H., & Berghäll, S. (2015). Forest owners' stand improvement decisions: Applying the Theory of Planned Behavior. *Forest Policy and Economics*, *50*, 275–284. https://doi.org/10.1016/j.forpol.2014.09.009

Kaushal, S. S., Groffman, P. M., Band, L. E., Elliott, E. M., Shields, C. A., & Kendall, C. (2011). Tracking Nonpoint Source Nitrogen Pollution in Human-Impacted Watersheds. *Environ. Sci. Technol*, *45*, 8225–8232. https://doi.org/10.1021/es200779e

Kinghorn, M. (2018). Indy-area suburbs dominate list of Indiana's fastest-growing communities (July-August 2018). *Indiana Business Research Center*, *19*(4).

Knowler, D., & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food Policy*, *32*, 25–48. https://doi.org/10.1016/j.foodpol.2006.01.003

Kollmuss, A., & Agyeman, J. (2002). Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, *8*(3), 239–260. https://doi.org/10.1080/13504620220145401

Läpple, D., & Kelley, H. (2013). Understanding the uptake of organic farming: Accounting for heterogeneities among Irish farmers. *Ecological Economics*, *88*, 11–19. https://doi.org/10.1016/j.ecolecon.2012.12.025

Liu, R., Zhang, P., Wang, X., Chen, Y., & Shen, Z. (2013). Assessment of effects of best management practices on agricultural non-point source pollution in Xiangxi River watershed. *Agricultural Water Management*, *117*, 9–18. https://doi.org/10.1016/j.agwat.2012.10.018

Liu, T., Bruins, R., & Heberling, M. (2018). Factors Influencing Farmers' Adoption of Best Management Practices: A Review and Synthesis. *Sustainability*, *10*(2), 432. https://doi.org/10.3390/su10020432

Liu, Y., Bralts, V. F., & Engel, B. A. (2015). Evaluating the effectiveness of management practices on hydrology and water quality at watershed scale with a rainfall-runoff model. *Science of the Total Environment*, *511*, 298–308. https://doi.org/10.1016/j.scitotenv.2014.12.077

Liu, Y., Theller, L. O., Pijanowski, B. C., & Engel, B. A. (2016). Optimal selection and placement of green infrastructure to reduce impacts of land use change and climate change on hydrology and water quality: An application to the Trail Creek Watershed, Indiana. *Science of the Total Environment*, *553*, 149–163. https://doi.org/10.1016/j.scitotenv.2016.02.116

Logan, T. J. (1990). Agricultural best management practices and groundwater protection. *Journal of Soil and Water Conservation*, *45*(2), 201–206.

Logan, T. J. (1993). Agricultural best management practices for water pollution control: current issues. *Ecosystems and Environment Elsevier Science Publishers B.V*, *46*, 223–231.

Mattia, C. M., Lovell, S. R., & Davis, A. (2018). Identifying barriers and motivators for adoption of multifunctional perennial cropping systems by landowners in the Upper Sangamon River Watershed, Illinois. *Agroforestry Systems*, *92*, 1155–1169. https://doi.org/10.1007/s10457-016-0053-6

McGuire, J., Morton, L. W., & Cast, A. D. (2013). Reconstructing the good farmer identity: Shifts in farmer identities and farm management practices to improve water quality. *Agriculture and Human Values*, *30*, 57–69. https://doi.org/10.1007/s10460-012-9381-y

McKenzie-Mohr, D. (2000). Promoting Sustainable Behavior: An Introduction to Community-Based Social Marketing. *Journal of Social Issues*, *56*(3), 543–554.

McKenzie-Mohr, D., & Smith, W. (1999). *Fostering sustainable behavior: An introduction to community-based social marketing* (2nd ed.). Gabriola Island, British Columbia, Canada: New Society.

Mehmood, S. R., & Zhang, D. (2005). Determinants of Forest Landowner Participation in the Endangered Species Act Safe Harbor Program Forest Landowners and Endangered Species. *Human Dimensions of Wildlife*, *10*, 249–257. https://doi.org/10.1080/10871200500292827

Milfont, T. L., Sibley, C. G., & Duckitt, J. (2010). Testing the Moderating Role of the Components of Norm Activation on the Relationship Between Values and Environmental Behavior. *Journal of Cross-Cultural Psychology*, *41*(1), 124–131. https://doi.org/10.1177/0022022109350506

Motallebi, M., O'Connell, C., Hoag, D., Osmond, D., Motallebi, M., O'Connell, C., Osmond, D. L. (2016). Role of Conservation Adoption Premiums on Participation in Water Quality Trading Programs. *Water*, *8*(6), 245. https://doi.org/10.3390/w8060245

Nejadhashemi, A.P., Woznicki, S.A., Douglas ‐ Mankin, K.R. (2011). Comparison of four models (STEPL, PLOAD, L-THIA, and SWAT) in simulating sediment, nitrogen, and phosphorus loads and pollutant source areas. Transactions of the ASABE (American Society of Agricultural and Biological Engineers), 54(3), 875-890.

Newburn, D., Alberini, A., Rockler, A., & Karp, A. (2014). *Adoption of household stormwater best management practices*. College Park. Retrieved from http://drum.lib.umd.edu/handle/1903/14974

Niemiec, R., Ardoin, N., Wharton, C., & Asner, G. (2016). Motivating residents to combat invasive species on private lands: Social norms and community reciprocity. *Ecology and Society*, *21*(2), 30.

Onwezen, M. C., Antonides, G., & Bartels, J. (2013). The Norm Activation Model: An exploration of the functions of anticipated pride and guilt in pro-environmental behaviour. *Journal of Economic Psychology*, *39*, 141–153. https://doi.org/10.1016/j.joep.2013.07.005

Park, J., & Ha, S. (2014). Understanding Consumer Recycling Behavior: Combining the Theory of Planned Behavior and the Norm Activation Model. *Family and Consumer Sciences Research Journal*, *42*(3), 278–291. https://doi.org/10.1111/fcsr.12061Perry-Hill, R., & Prokopy, L. S. (2014). Comparing different types of rural landowners: Implications for conservation practice adoption. *Journal of Soil and Water Conservation*, *69*(3), 266–278. https://doi.org/10.2489/jswc.69.3.266

Persaud, A., Alsharif, K., Monaghan, P., Akiwumi, F., Morera, M. C., & Ott, E. (2016). Landscaping practices, community perceptions, and social indicators for stormwater nonpoint source pollution management. *Sustainable Cities and Society*, *27*, 377–385. https://doi.org/10.1016/j.scs.2016.08.017

Peterson, M. N., Thurmond, B., Mchale, M., Rodriguez, S., Bondell, H. D., & Cook, M. (2012). Predicting native plant landscaping preferences in urban areas. *Sustainable Cities and Society*, *5*, 70–76. https://doi.org/10.1016/j.scs.2012.05.007

Pierce, F. J., & Frye, W. W. (Eds.). (1998). *Advances in Soil and Water Conservation*. Chelsea, MI: Sleeping Bear Press, Inc.

Pouta, E., & Rekola, M. (2001). The Theory of Planned Behavior in Predicting Willingness to Pay for Abatement of Forest Regeneration. *Society and Natural Resources*, *14*, 93–106. https://doi.org/10.1080/089419201300000517

Quimby, C. C., & Angelique, H. (2011). Identifying Barriers and Catalysts to Fostering Pro-Environmental Behavior: Opportunities and Challenges for Community Psychology. *American Journal of Community Psychology*, *47*, 388–396. https://doi.org/10.1007/s10464-010-9389-7

Raymond, L., & Schneider, L. (2014). Personal Moral Norms and Attitudes Toward Endangered Species Policies on Private Land. *Conservation and Society*, *12*(1), 1. https://doi.org/10.4103/0972-4923.132115

Reimer, A. P., Thompson, A. W., & Prokopy, L. S. (2012). The multi-dimensional nature of environmental attitudes among farmers in Indiana: Implications for conservation adoption. *Agriculture and Human Values*, *29*, 29–40. https://doi.org/10.1007/s10460-011-9308-z

Rezvanfar, A., Samiee, A., & Faham, E. (2009). Analysis of Factors Affecting Adoption of Sustainable Soil Conservation Practices among Wheat Growers. *World Applied Sciences Journal*, *6*(5), 644–651. Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Roseman, I. J., Antoniou, A. A., & Jose, P. E. (1996). Appraisal determinants of emotions: Constructing a more accurate and comprehensive theory. *Cognition and Emotion*, *10*(3), 241–277. https://doi.org/10.1080/026999396380240

Schwartz, S. H. (1977). Normative influences on altruism. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (pp. 221–279). New York: Academic Press.

Shaver, K. G. (1985). *The Attribution of Blame: Causality, Responsibility, and Blameworthiness*. New York, NY: Springer-Verlag.

Sheeder, R., & Lynne, G. D. (2011). Empathy-Conditioned Conservation: "Walking in the Shoes of Others" as a Conservation Farmer. *Land Economics*, *87*(3), 433–452. https://doi.org/10.1353/lde.2011.0027

Shin, D. W., & McCann, L. (2018). Analyzing differences among non-adopters of residential stormwater management practices. *Landscape and Urban Planning*, *178*, 238–247. https://doi.org/10.1016/J.LANDURBPLAN.2018.06.003

Steg, L., & Groot, J. (2010). Explaining prosocial intentions: Testing causal relationships in the norm activation model. *British Journal of Social Psychology*, *49*(4), 725–743. https://doi.org/10.1348/014466609X477745

Steg, L., & Vlek, C. (2008). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology*, *29*, 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004

Stern, P. C. (1999). Information, Incentives, and Proenvironmental Consumer Behavior. *Journal of Consumer Policy*, *22*, 461–478. Retrieved from https://link.springer.com/content/pdf/10.1023%2FA%3A1006211709570.pdf

Stern, P. C. (2000). Toward a Coherent Theory of Environmentally Significant Behavior. *Journal of Social Issues*, *56*(3), 407–424. https://doi.org/10.1111/0022-4537.00175

Stern, P. C., Dietz, T., Abel, T., Guagnano, G. A., & Kalof, L. (1999). A Value-Belief-Norm Theory of Support for Social Movements: The Case of Environmentalism. *Human Ecology Review*, *6*(2), 81–97.

Szumilas, M. (2010). Explaining Odds Ratios. *Journal of the Canadian Academy of Child and Adolescent Psychiatry*, *19*(3), 227–229. Retrieved from http://www.csm-oxford.org.uk/

Takahashi, B., Burnham, M., Terracina-Hartman, C., Sopchak, A. R., & Selfa, T. (2016). Climate Change Perceptions of NY State Farmers: The Role of Risk Perceptions and Adaptive Capacity. *Environmental Management*, *58*, 946–957. https://doi.org/10.1007/s00267-016-0742-y

U.S. Department of Commerce. (2012). *Statistical Abstract of the United States: 2012*. Washington DC. Retrieved from https://www2.census.gov/library/publications/2011/compendia/statab/131ed/2012-statab.pdf

United States Environmental Protection Agency. (2016). *National Nonpoint Source Program: A Catalyst for Water Quality Improvements*.

Urbonas, B. (1994). Assessment of stormwater BMPs and their technology. *Water Science and Technology*, *29*(12), 347–353.

Vogt, C. A., Winter, G., & Fried, J. S. (2005). Predicting Homeowners' Approval of Fuel Management at the Wildland-Urban Interface Using the Theory of Reasoned Action. *Society and Natural Resources*, *18*, 337–354. https://doi.org/10.1080/08941920590915242

Wall, G. (1995). Barriers to Individual Environmental Action: The Influence of Attitudes and Social Experiences. *Canadian Review of Sociology/Revue Canadienne de Sociologie*, *32*(4), 465–489. https://doi.org/10.1111/j.1755-618X.1995.tb00182.x

Wallace, B., & Clearfield, F. (1997). *Stewardship, Spirituality, and Natural Resources Conservation: A Short History*. Retrieved from https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1045622.pdf

Welch, E. W., & Marc-Aurele, F.J., J. (2001). Determinants of Farmer Behavior: Adoption of and Compliance with Best Management Practices for Nonpoint Source Pollution in the Skaneateles Lake Watershed. *Lake and Reservoir Management*, *17*(3), 233–245. https://doi.org/10.1080/07438140109354133

Wilson, R. S., Schlea, D. A., Boles, C. M. W., & Redder, T. M. (2018). Using models of farmer behavior to inform eutrophication policy in the Great Lakes. *Water Research*, *139*, 38–46. https://doi.org/10.1016/j.watres.2018.03.065

Wollni, M., & Andersson, C. (2014). Spatial patterns of organic agriculture adoption: Evidence from Honduras. *Ecological Economics*, *97*, 120–128. https://doi.org/10.1016/j.ecolecon.2013.11.010

Young, R. A., & Reichenbach, M. R. (1987). Factors influencing the timber harvest intentions of nonindustrial private owners. *Forest Science*, *33*(2), 381–393.

CHAPTER 4: SUMMARY AND CONCLUSIONS

The adoption of BMPs and LID strategies by watershed residents is important for reducing NPS pollution in the United States. Extensive research has explored factors influencing farmers' adoption of BMPs, while considerably less research has focused on urban and suburban residents. This research encompassed the urban-to-rural gradient of two counties in northwestern Indiana with mixed land uses. Through a household survey of residents in Porter and LaPorte counties, this research assessed watershed residents' awareness of, attitudes towards, and likelihood of adopting water quality improvement practices, as well as factors influencing their likelihood of adoption, particularly the role of norms and the role of information about responsibility. Based on the findings discussed in previous chapters, this research offers the following three considerations for water quality professionals and researchers.

First, sometimes watershed residents may exhibit a general awareness of and positive attitude towards water quality improvement practices; however, many may not have an immediate plan to adopt any practices, and not all those who express an interest in adoption would end up adopting any practices. Thus, it important for water quality programs to be aware of various external constraints that may ultimately deter watershed residents from transitioning from a favorable intention to actual adoption (e.g., Ajzen, 2005; Blackstock, Ingram, Burton, Brown, & Slee, 2010; Dutcher, Finley, Luloff, & Johnson, 2004; Quimby & Angelique, 2011; Rogers, 2003; Steg & Vlek, 2008; Wall, 1995). Several important barriers were identified in this research, including watershed residents' not knowing enough about specific practices they could adopt for their own home or property, concerns about difficulties in installing a practice, and concerns about maintaining the practice. Reducing these barriers to adoption will be essential for water quality programs. Generally speaking, education and outreach programs have demonstrated success when they are comprehensive, adaptive, representing key stakeholder inputs, and specific to stakeholder needs and concerns (Loomis, Bair, & Gonzalez-Caban, 2001; Marynowski & Jacobson, 1999). Similarly, water quality programs could benefit from highlighting benefits associated with water quality improvement, such as improved general environmental quality and reduced flash flood risk, at least in the context of this research.

Second, this research expanded understanding of personal and social (descriptive and subjective) norms in motivating watershed residents' adoption of water quality improvement practices. Specifically, this research suggests that urban, suburban, rural non-agricultural, and rural agricultural residents may differ in their perceived descriptive and subjective norms. Because descriptive and subjective norms are important for watershed residents in terms of their interest in water quality improvements, more research is needed to understand why such difference in social norms exists across resident group. So far, few studies have examined and compared personal and social norms across segments of population in the context of water quality management. However, this research generated some evidence to suggest that rather than focusing on increasing people's personal norms about water quality protection, water quality programs could benefit greatly from developing and implementing outreach and communication strategies that utilize social norms to catalyze behavioral change in the context of water quality improvement.

Finally, traditional outreach and education programs tend to assume that people do not adopt sustainable resource management and conservation practices because they lack information or have insufficient knowledge, and that if they were provided with information, they would adopt desired practices (e.g., Burgess & Harrison, 1998). While this research showed that residents may benefit from information about installation and maintenance of water quality improvement practices, it also provided evidence suggesting a limited role that information could play in shaping water quality improvement behaviors when holding other factors constant. Particularly, this research showed no difference in residents' self-reported likelihood of adopting water quality improvement practices whether they were provided with specific information about the responsibility of different resident groups for NPS pollution or generic information about NPS pollution—in fact, neither seemed to have motivated change in self-reported likelihood of adoption. Several reasons have been posited for why specific information about the responsibility of different resident groups for NPS pollution may be ineffective in changing willingness to engage in resource management and conservation behaviors, including but not limited to: the strength of contextual forces (Stern, 1999), barriers to action such as cost or inconvenience (Steg & Vlek, 2008; Stern, 1999), lack of emotional response (Kollmuss & Agyeman, 2002), and cognitive dissonance (Festinger, 1957; Kollmuss & Agyeman, 2002). More research is needed to investigate when and why information works (or not) in the context of water quality management. Moreover, this research found that watershed residents responded to information about NPS pollution differently based on their initial intention to adopt water quality improvement practices prior to receiving any information. As such, understanding how and why information may have different effects on different segments of population would be important. One practical consideration for water quality programs is to tailor their outreach to target favorable and less favorable watershed residents using different information content, types, formats, and/or sources as a way to maximize positive effects of information while minimizing potential negative effects. Given the complex role of information, it is important to keep in mind that not all water quality improvement information is equally effective or ineffective. However, this research provides important preliminary evidence suggesting that water quality programs may want to consider moving away from providing generic information about NPS pollution and water quality improvement practices to focusing on actionable behaviors that are specific to different resident types and how they manage and live on their properties.

References

Ajzen, I. (2005). Attitudes, Personality, and Behavior (2nd ed.). Milton-Keynes, England: Open University Press (McGraw-Hill).

Blackstock, K. L., Ingram, J., Burton, R., Brown, K. M., & Slee, B. (2010). Understanding and influencing behaviour change by farmers to improve water quality. *Science of the Total Environment, 408*, 5631–5638. https://doi.org/10.1016/j.scitotenv.2009.04.029

Burgess, J., & Harrison, C. M. (1998). *Environmental communication and the cultural politics of environmental citizenship*. *Environment and Planning A* (Vol. 30). Retrieved from http://journals.sagepub.com/doi/pdf/10.1068/a301445

Dutcher, D. D., Finley, J. C., Luloff, A. E., & Johnson, J. (2004). Landowner perceptions of protecting and establishing riparian forests: A qualitative analysis. *Society and Natural Resources*, *17*(4), 319–332. https://doi.org/10.1080/08941920490278773

Festinger, L. (1957). *A theory of cognitive dissonance*. *A theory of cognitive dissonance*. Stanford University Press.

Kollmuss, A., & Agyeman, J. (2002). Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, *8*(3), 239–260. https://doi.org/10.1080/13504620220145401

Loomis, J. B., Bair, L. S., & Gonzalez-Caban, A. (2001). Prescribed fire and public support: Knowledge gained, attitudes changed in Florida. *Journal of Forestry*, *99*(11), 18–22. https://doi.org/https://doi.org/10.1016/j.humimm.2010.05.008

Marynowski, S. B., & Jacobson, S. K. (1999). Ecosystem management education for public lands. *Wildlife Society Bulletin*, *27*(1), 134–145.

Quimby, C. C., & Angelique, H. (2011). Identifying Barriers and Catalysts to Fostering Pro-Environmental Behavior: Opportunities and Challenges for Community Psychology. *American Journal of Community Psychology*, *47*, 388–396. https://doi.org/10.1007/s10464-010-9389-7

Rogers, E. M. (2003). *Diffusion of Innovation* (5th ed.). New York, NY: The Free Press.

Steg, L., & Vlek, C. (2008). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology*, *29*, 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004

Stern, P. C. (1999). Information, Incentives, and Proenvironmental Consumer Behavior. *Journal of Consumer Policy*, *22*, 461–478. Retrieved from https://link.springer.com/content/pdf/10.1023%2FA%3A1006211709570.pdf

Wall, G. (1995). Barriers to Individual Environmental Action: The Influence of Attitudes and Social Experiences. *Canadian Review of Sociology/Revue Canadienne de Sociologie*, *32*(4), 465–489. https://doi.org/10.1111/j.1755-618X.1995.tb00182.x

APPENDIX A. INTERVIEW PROTOCOL

Water Quality Professional Interview Protocol for the Project "Combining Societal Acceptance and Biophysical Drivers of Conservation Practices to Improve Water Quality in Multi-use Landscapes"

Interviewer:
Interviewee (first name only):
Date and time of Interview:
Location of Interview:

Thank you for taking the time to do an interview with me. As I mentioned, my name is Jennifer Domenech and I am a Masters student at Purdue University working with Dr. Zhao Ma in the Department of Forestry and Natural Resources and Dr. Sarah McMillan in the Department of Agricultural and Biological Engineering. Our research aims to incorporate societal acceptance of best management practices into water quality modeling in order to more accurately estimate the true potential of these best management practices for improving water quality. In particular, my research tries to identify factors that influence rural to urban residents' willingness to adopt various water quality-related best management practices. During this interview, I'd like to ask you a few questions covering four topics: your involvement in water quality work, your concerns about water quality in northern Indiana, particularly in the East Branch–Little Calumet River and Trail Creek watersheds, your opinions about challenges to improving water quality, and public participation in water quality improvement effort. This interview is entirely voluntary and should take about 60 minutes. Everything you tell me during the interview will be kept strictly confidential and your response will not be revealed to anyone beyond the research team. For the purpose of our research, it would be really helpful for me to record this conversation. Are you comfortable with this?

Again, thank you for your willingness to participate in this interview. Unless you have any questions, let's go ahead and get started.

Section 1: General Involvement in Water Quality Work
To begin, I would like to ask you a couple questions about what you do with respect to water quality.

When did you first start working on water quality issues?

- *Prompt: What first motivated you to start working on water quality issues?*

What is the nature of your work with respect to water quality? How do you spend time addressing water quality concerns? What is the main focus of your water quality work?

- *Prompt*: *Do you work with local residents through field days or other outreach events?*
- *Prompt: Do you coordinate with other agencies/organizations to improve or develop programs or projects?*
- *Prompt: Do you physically visit and inspect sites to test water quality?*

Section 2: Concerns About Water Quality
Now, I would like to ask you generally about water quality impairments in the East Branch–Little Calumet River and Trail Creek watersheds.

Think about the East Branch–Little Calumet River and Trail Creek watersheds generally, what do you see as the most concerning water quality issues in <u>urban areas, if any</u>?

- *Prompt: What water quality issues in particular? Stormwater management? Chemical discharge? Excess nutrients? Soil erosion, etc.?*

Again in these two watersheds, what do you see as the most concerning water quality issue in <u>rural areas, if any</u>?

- *Prompt: What water quality issues in particular? Excess nutrients from agricultural production? Soil erosion, etc.?*

In your opinion, do you think different residents (whether rural or urban) in the watersheds know about these water quality issues? Do you think they know what are causing these water quality issues?

- *Prompt: Do you think residents are concerned with any particular pollutant? (nitrogen, phosphorus, E. coli, etc.)*

Think broadly about water quality issues in the East Branch–Little Calumet River and Trail Creek watersheds, do you see any resident group (urban or rural) as a bigger contributor to water quality problems than other groups? If so, which resident group and why?

- *Prompt: Do you think this particular resident group know about their own doing that cause these water quality issues?*

Section 3: Challenges to Addressing Water Quality Impairment
In this section, I would like to learn about your experiences working on water quality issues.

In your opinion, what is or are the most significant challenge(s) to improving water quality in the East Branch–Little Calumet River and Trail Creek watersheds?

- *Prompt: Is involvement of residents a major challenge? Is involvement of non-governmental organizations a major challenge? Lack of community leaders in organizing community-level water quality improvement projects? How about existing capacity of outreach or extension specialists? Is the level of commitment of the government a challenge?*

- *Prompt: To what extent do you think finding sufficient funding for projects has been a challenge to improving water quality?*

Do you see or experience different challenges when working with different resident groups (particularly urban vs. rural groups)? If so, what kinds of challenges?

- *Prompt: In your experience, do residents seem open to changing their behaviors or practices to address water quality problems?*

Section 4: Public Awareness and Participation in Water Quality Improvement Effort
We've talked about residents' awareness of water quality problems previously, I would now like to learn from you about public awareness of and participation in conservation efforts.

How much awareness do you think residents in the East Branch–Little Calumet River and Trail Creek watersheds have about conservation practices or best management practices to improve water quality? Do you think the awareness is different between rural and urban residents?

- *Prompt: What specific conservation practices to improve water quality do you think the public is aware of?*

- *Prompt: Where do you think residents get information about conservation practices to address water quality impairment?*

- *Prompt: What, if any, kinds of conservation practices to improve water quality do you most observe?*

What do you think are the general attitudes of residents towards adopting best management practices to improve water quality? Do you think the attitude is different between rural and urban residents?

- *Prompt: If the attitude is different between rural and urban residents, why?*

- *Prompt: From your perspective, does any particular resident group seem more willing to participate in conservation programs or adopt best management practices to improve water quality than others? Why?*

Generally speaking, how extensive is public participation in water quality improvement programs or adoption of best management practices among urban residents and rural residents (including farmers)?

Do you discuss water quality issues differently based on who the residents are or where they live (urban or rural)? If so, how?

Those are all the questions we have. Before we end, is there anything else that you would like to share?

Thank you very much for your time.

APPENDIX B. SURVEY INSTRUMENT: CONTROL

Background and Instruction

This survey is part of a research project conducted by the Department of Forestry and Natural Resources and the Department of Agricultural and Biological Engineering at Purdue University. The objective of this survey is to learn about residential awareness of and attitudes toward conservation practices to improve water quality. Your responses will help inform the development of future water quality programs.

For the purpose of this survey, please use the following definitions:

- ***Conservation practices to improve water quality, best management practice (BMP), stormwater management strategies,*** *and* ***low impact development (LID) strategies*** *are interchangeable.*
- ***Runoff*** *is water flow that occurs when excess stormwater or snowmelt flows across the land.*

Section 1: Your Residence

1. Do you live in an urban, suburban, or rural area? *Check only one*

- ☐ Urban (20,000 people or more)
- ☐ Suburban area (at least 2,500 and less than 20,000 people)
- ☐ Rural (all population, housing, and territory not within an urban or suburban area)

2. Do you personally operate a farm or have farm animals (e.g., cows, chickens, goats)? *Check only one*

- ☐ **No. I DO NOT own farmland, and I DO NOT operate a farm or have farm animals.**
- ☐ **No. I DO own farmland but I lease it out. I DO NOT operate a farm or have farm animals.**
  If you own farmland but do not operate it personally,
  please answer the survey based on your current residence.
- ☐ **Yes - IF YES, please answer a, b, and c below.**
  a. How many acres are planted crops? ____________________
  b. How many acres are pasture? ____________________
  c. Which farm animals do you raise? ____________________

Section 2: Surface Water Resources

3. Prior to this survey, which of the following best describes your overall awareness of conservation practices to improve water quality? *Check only one*

- ☐ Never heard of them
- ☐ Slightly aware
- ☐ Somewhat aware
- ☐ Very aware

4. Please indicate your level of agreement or disagreement with the statements below about the quality of *waterbodies (e.g., rivers, lakes, ditches, creeks)* in your area. *Check one box for each statement.*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. I think water quality in local waterbodies is excellent	☐	☐	☐	☐	☐
b. I am concerned about water quality in local waterbodies	☐	☐	☐	☐	☐
c. I have sufficient knowledge about water quality problems in local waterbodies in my area	☐	☐	☐	☐	☐
d. I have looked for information about water quality problems in local waterbodies in the past	☐	☐	☐	☐	☐
e. I think water quality in local waterbodies is affected by all residents living in my area	☐	☐	☐	☐	☐
f. I think water quality in local waterbodies is affected by residents living outside of my area, for example, upstream of where we live	☐	☐	☐	☐	☐

5. In your opinion, how much do you think each of the following groups have affected water pollution problems in your area? *Please write a percentage for each group.*

	Percentage
a. Urban Residents	_______ %
b. Suburban Residents	_______ %
c. Rural Residents (non-agricultural)	_______ %
d. Small-scale Agricultural Operations (fewer than 50 acres)	_______ %
e. Medium- or Large-scale Agricultural Operations	_______ %
Total:	**100** %

6. When thinking about sources of water pollution, based on what you know currently, how much of a problem are the following in your area? *Check one box for each item.*

	Not a Problem	Minor Problem	Moderate Problem	Severe Problem
a. Soil erosion from farm fields	☐	☐	☐	☐
b. Excessive use of lawn fertilizer and/or pesticides	☐	☐	☐	☐
c. Improperly maintained septic systems	☐	☐	☐	☐
d. Stormwater runoff from rooftops, parking lots, and roads	☐	☐	☐	☐
e. Use of salt and sand on paved areas	☐	☐	☐	☐
f. Waste materials from pets	☐	☐	☐	☐
g. Use of fertilizers, manure and/or pesticides for crop production	☐	☐	☐	☐
h. Removal of trees and vegetation along streams	☐	☐	☐	☐
i. Manure from animal feeding operations	☐	☐	☐	☐

7. Please indicate your level of agreement or disagreement with the following statements.
Check one box for each statement.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. Rivers and lakes provide many opportunities for my family and me to engage in outdoor activities	☐	☐	☐	☐	☐
b. Improving water quality in our waterbodies is not as important as what some people say	☐	☐	☐	☐	☐
c. I do not care what experts say about water quality	☐	☐	☐	☐	☐
d. I do not care what my family and friends say about water quality	☐	☐	☐	☐	☐
e. I do not care what others in my area say about water quality	☐	☐	☐	☐	☐
f. I do not care what the news say about water quality	☐	☐	☐	☐	☐
g. I do not know a whole lot about why water quality might be important to me or my community	☐	☐	☐	☐	☐
h. Protecting water quality is important to me	☐	☐	☐	☐	☐
i. From my point of view, there are consequences from polluting surface water in my area	☐	☐	☐	☐	☐

8. Please indicate your level of agreement or disagreement with the following statements.
Check one box for each statement.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. I feel personally responsible for protecting water quality in my area	☐	☐	☐	☐	☐
b. Everybody should do their part to reduce water pollution	☐	☐	☐	☐	☐
c. We should keep our local waterbodies clean because it is the right thing to do	☐	☐	☐	☐	☐
d. We should keep our surface water clean for the benefit of future generations	☐	☐	☐	☐	☐
e. If I am not careful, what I do on my property or in my home could harm water quality in my area	☐	☐	☐	☐	☐
f. I believe what I do on my property or in my home could help improve water quality in my area	☐	☐	☐	☐	☐

Section 3: Conservation Practices to Improve Water Quality

PRACTICES FOR YOUR HOME AND NEIGHBORHOOD	
Rain Garden, *a planted depression that captures runoff and allows water to soak into the ground slowly*	
a. What do you know about rain gardens? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to install a rain garden in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ____________________________
Vegetated or Green Roof, *a plant layer on roofs that reduces runoff and cooling costs*	
a. What do you know about green roofs? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to install a green roof in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ____________________________
Permeable Pavement, *pavement that allows runoff to soak into the ground and filter naturally through soil*	
a. What do you know about permeable pavement? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to install permeable pavement in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ____________________________
Swale System (Grassed Swale), *an open channel with grass or shrubs along the base and side to slow rain water*	
a. What do you know about swale systems? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to install a swale system in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ___________________________
Rain Barrel, *a barrel to collect rain water to reuse for watering plants and reduce stormwater runoff*	
a. What do you know about rain barrels? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently using it	**b. What is your likelihood to install a rain barrel in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ___________________________
Wet pond, *a pond designed to store and filter water from an entire neighborhood*	
a. What do you know about wet ponds? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to support the installation of a local wet pond in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ___________________________

If your property is **SMALLER** than one acre, skip to **Section 4** on page 8

If your property is **LARGER** than one acre, please **CONTINUE**

PRACTICES FOR YOUR LAND

Open wooded area, *a woodlot for small-scale production of forests as well as recreation uses*

a. What do you know about preserving wooded areas?	b. What is your likelihood to preserve an open wooded area in the next year?
☐ Never heard of it	☐ Unlikely
☐ Somewhat familiar with it	☐ Neither unlikely nor likely
☐ Know how to do it but have not done it	☐ Likely
☐ Currently doing it	☐ Not applicable ______________________________

Porous Pavement, ***pavement that allows runoff to soak into the ground and filter naturally through soil***

a. What do you know about porous pavement?	b. What is your likelihood to install porous pavement for your driveway, sidewalk, or parking lot in the next year?
☐ Never heard of it	☐ Unlikely
☐ Somewhat familiar with it	☐ Neither unlikely nor likely
☐ Know how to do it but have not done it	☐ Likely
☐ Currently doing it	☐ Not applicable ______________________________

Riparian Buffer/Vegetated Filter Strip, ***a strip of planted vegetation located along waterways and waterbodies***

a. What do you know about riparian buffers?	b. What is your likelihood to install a riparian buffer in the next year?
☐ Never heard of it	☐ Unlikely
☐ Somewhat familiar with it	☐ Neither unlikely nor likely
☐ Know how to do it but have not done it	☐ Likely
☐ Currently doing it	☐ Not applicable ______________________________

Wetland Basin, ***a shallow depression planted with vegetation designed to treat runoff***

a. What do you know about wetland basins?	b. What is your likelihood to install a wetland basin in the next year?
☐ Never heard of it	☐ Unlikely
☐ Somewhat familiar with it	☐ Neither unlikely nor likely
☐ Know how to do it but have not done it	☐ Likely
☐ Currently doing it	☐ Not applicable ______________________________

Windbreak, ***trees or shrubs planted in a line to reduce wind speed over bare soil, preventing soil erosion***

a. What do you know about windbreaks?	b. What is your likelihood to install a windbreak in the next year?
☐ Never heard of it	☐ Unlikely
☐ Somewhat familiar with it	☐ Neither unlikely nor likely
☐ Know how to do it but have not done it	☐ Likely
☐ Currently doing it	☐ Not applicable ______________________________

If you **DO NOT** operate farmland or have farm animals, skip to **Section 4** on page 8

GO If you **DO** operate farmland or have farm animals, please **CONTINUE**

PRACTICES FOR YOUR FARM

Cover Crops, *a crop grown during the winter to protect and enrich the soil*

a. What do you know about cover crops?
- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to use cover crops in the next year?
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ______________________________

Conservation Tillage, *soil cultivation that leaves crop residue on fields to reduce soil erosion and runoff*

a. What do you know about conservation tillage?
- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to use conservation tillage in the next year?
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ______________________________

Grass Strip or Filter Strip, *a strip of planted vegetation located along roads, ditches, or between crop fields*

a. What do you know about grass strips?
- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to install grass strips in the next year?
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ______________________________

Critical Area Planting, *permanent vegetation grown on sites expected to have high erosion*

a. What do you know about critical area planting?
- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to use critical area planting in the next year?
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ______________________________

No-till Farming, *growing crops year to year without disturbing the soil through tillage*

a. What do you know about no-till farming?
- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to use no-till farming in the next year?
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ______________________________

If you **DO NOT** have farm animals, skip to **Section 4** on page 8

If you **DO** have farm animals, please **CONTINUE**

PRACTICES FOR FARM ANIMALS

Animal Exclusion, *exclusion of farm animals from streams and critical areas not intended for grazing by fencing*

a. What do you know about animal exclusion?	b. What is your likelihood to install animal exclusions in the next year?
☐ Never heard of it	☐ Unlikely
☐ Somewhat familiar with it	☐ Neither unlikely nor likely
☐ Know how to do it but have not done it	☐ Likely
☐ Currently doing it	☐ Not applicable ___________________________

Rotational Grazing, *farm animals are regularly rotated to fresh paddocks to prevent overgrazing and optimize grass growth*

a. What do you know about rotational grazing?	b. What is your likelihood to implement rotational grazing in the next year?
☐ Never heard of it	☐ Unlikely
☐ Somewhat familiar with it	☐ Neither unlikely nor likely
☐ Know how to do it but have not done it	☐ Likely
☐ Currently doing it	☐ Not applicable ___________________________

Compost manure, *manure management to reduce volume and density and kill pathogen*

a. What do you know about composting manure?	b. What is your likelihood to compost manure in the next year?
☐ Never heard of it	☐ Unlikely
☐ Somewhat familiar with it	☐ Neither unlikely nor likely
☐ Know how to do it but have not done it	☐ Likely
☐ Currently doing it	☐ Not applicable ___________________________

Avoid application of manure on frozen ground, *frozen manure is not absorbed into the soil when the ground is frozen and is often carried off the land with snowmelt*

a. What do you know about avoiding the application of manure on frozen ground?	b. What is your likelihood to avoid applying manure on frozen ground in the next year?
☐ Never heard of it	☐ Unlikely
☐ Somewhat familiar with it	☐ Neither unlikely nor likely
☐ Know how to do it but have not done it	☐ Likely
☐ Currently doing it	☐ Not applicable ___________________________

Please **CONTINUE** to **Section 4** on the next page

Section 4: Attitudes toward Conservation Practices to Improve Water Quality

9. Given your current understanding, what is your general attitude towards conservation practices to improve water quality?
Check only one
- ☐ Very negative
- ☐ Somewhat negative
- ☐ Neither negative nor positive
- ☐ Somewhat positive
- ☐ Very positive

10. Would you be interested in learning more about conservation practices to improve water quality?
- ☐ Yes
- ☐ No

11. Given your current understanding of conservation practices to improve water quality, what is your likelihood to adopt any practices in the next year? *Check only one*
- ☐ Very unlikely
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Very likely

12. Please indicate your level of agreement or disagreement with the following statements about conservation practices that can be used to improve water quality. *Check one box for each statement.*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. Knowing what conservation practices I could use to improve water quality is important to me	☐	☐	☐	☐	☐
b. Even if I adopt conservation practices, it does not matter because somebody else will be polluting	☐	☐	☐	☐	☐
c. For me, conservation practices are too expensive to implement	☐	☐	☐	☐	☐
d. For me, conservation practices are too complicated to implement	☐	☐	☐	☐	☐
e. None of the conservation practices I am familiar with are relevant or applicable to my property or my home	☐	☐	☐	☐	☐
f. By adopting conservation practices, I could help improve water quality	☐	☐	☐	☐	☐
g. I have a responsibility to adopt conservation practices to improve water quality as much as I could	☐	☐	☐	☐	☐
h. It is important to protect water quality even if it slows economic development	☐	☐	☐	☐	☐
i. It is important to protect water quality even if it costs me more	☐	☐	☐	☐	☐

Section 5: Conservation Practices to Improve Water Quality in Your Area

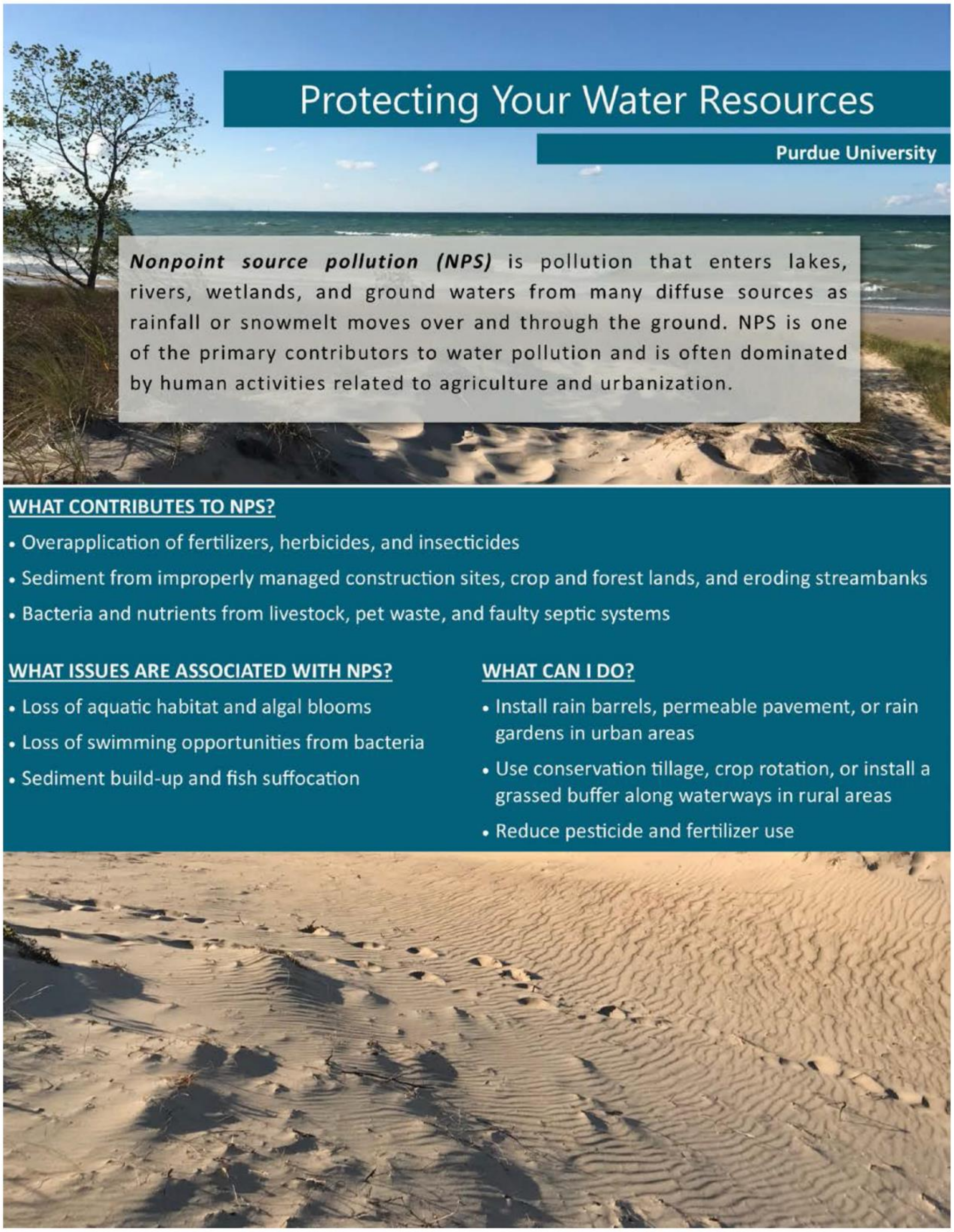
13. What have you noticed in terms of people around you adopting conservation practices to improve water quality in your area? *Check one box for each group of people.*

	Nobody has adopted conservation practices for water quality	**A few have adopted** conservation practices for water quality	**Most have adopted** conservation practices for water quality	**I do not know if anyone has adopted** conservation practices for water quality
a. Among my family…	☐	☐	☐	☐
b. Among my friends…	☐	☐	☐	☐
c. Among my neighbors…	☐	☐	☐	☐
d. Among people in my community…	☐	☐	☐	☐

14. Please indicate your level of agreement or disagreement with the following statements. *Check one box for each statement.*

	Strongly Disagree	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
a. Conservation practices do not fit how I want my property or land to look	☐	☐	☐	☐	☐
b. I believe implementing conservation practices on my property or in my home would bother my neighbors	☐	☐	☐	☐	☐
c. I would feel the need to adopt conservation practices to improve water quality if others in my family did so	☐	☐	☐	☐	☐
d. I would feel the need to adopt conservation practices to improve water quality if my friends did so	☐	☐	☐	☐	☐
e. I would feel the need to adopt conservation practices to improve water quality if my neighbors did so	☐	☐	☐	☐	☐
f. I would feel the need to adopt conservation practices to improve water quality if others in my community did so	☐	☐	☐	☐	☐
g. My family would like to see me adopting conservation practices to improve water quality	☐	☐	☐	☐	☐
h. My friends would like to see me adopting conservation practices to improve water quality	☐	☐	☐	☐	☐
i. My neighbors would like to see me adopting conservation practices to improve water quality	☐	☐	☐	☐	☐
j. Others in my community would like to see me adopting conservation practices	☐	☐	☐	☐	☐
k. Among the people I know, many would agree adopting conservation practices to improve water quality is a good thing to do	☐	☐	☐	☐	☐

Please read the following information before completing Sections 6 and 7



Protecting Your Water Resources

Purdue University

Nonpoint source pollution (NPS) is pollution that enters lakes, rivers, wetlands, and ground waters from many diffuse sources as rainfall or snowmelt moves over and through the ground. NPS is one of the primary contributors to water pollution and is often dominated by human activities related to agriculture and urbanization.

WHAT CONTRIBUTES TO NPS?

- Overapplication of fertilizers, herbicides, and insecticides
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks
- Bacteria and nutrients from livestock, pet waste, and faulty septic systems

WHAT ISSUES ARE ASSOCIATED WITH NPS?

- Loss of aquatic habitat and algal blooms
- Loss of swimming opportunities from bacteria
- Sediment build-up and fish suffocation

WHAT CAN I DO?

- Install rain barrels, permeable pavement, or rain gardens in urban areas
- Use conservation tillage, crop rotation, or install a grassed buffer along waterways in rural areas
- Reduce pesticide and fertilizer use

Section 6: Water Quality Improvement Programs

15. Given your current understanding of conservation practices to improve water quality, what is your likelihood of adopting any practices in the next year? *Check only one*

- ☐ Very unlikely
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Very likely

16. Please indicate the level of importance you place on the following potential benefits associated with adopting conservation practices that help improve surface water quality. *Check one box for each item.*

	Not Important	Slightly Important	Moderately Important	Somewhat Important	Very Important
a. Income or monetary benefits	☐	☐	☐	☐	☐
b. Be a good example to my family	☐	☐	☐	☐	☐
c. Be a good example to my friends	☐	☐	☐	☐	☐
d. Be a good example to my neighbors	☐	☐	☐	☐	☐
e. Be a good example to people in my community	☐	☐	☐	☐	☐
f. Improved surface water quality	☐	☐	☐	☐	☐
g. Increased water storage and filtration	☐	☐	☐	☐	☐
h. Improved aquatic habitat	☐	☐	☐	☐	☐
i. Improved outdoor recreation	☐	☐	☐	☐	☐
j. Reduced likelihood of flash floods	☐	☐	☐	☐	☐
k. Improved environmental quality in general	☐	☐	☐	☐	☐

17. Which of the following would make you <u>less interested</u> in adopting conservation practices to improve water quality? *Check all that apply.*

a. Not knowing enough about it	☐
b. Hearing that the conservation practice went wrong or did not work well	☐
c. Being one of the first few from my community to participate in a conservation program	☐
d. Being one of the first few from my community to adopt a conservation practice	☐
e. Difficulty installing the conservation practice	☐
f. Difficulty maintaining the conservation practice over time	☐
g. Making my property look different from other properties in my neighborhood	☐
h. Concern about my neighbors not liking it	☐
i. Concern about how my property or home would look like after installing a conservation practice	☐
j. Concern about the practice adversely affecting other management strategies (e.g., cover crops or crop residue blocking tile drains or ditches)	☐

Section 7: About You

19. What is your age? ___________ years

20. What is your sex? *Check only one.*
- ☐ Male
- ☐ Female

21. What is your race? *Check only one*
- ☐ White
- ☐ Black or African American
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Native Hawaiian or Other Pacific Islander

22. Are you of Hispanic, Latino, or Spanish origin?
- ☐ Yes
- ☐ No

23. Who is responsible for making decisions about your property or home such as installing conservation practices to improve water quality? *Check only one.*
- ☐ I am solely responsible for making decisions about my property / home
- ☐ I share responsibility for making decisions about my property / home
- ☐ Someone else is responsible for making decisions about my property / home

24. Do you rent or own your home where you live? *Check only one*
- ☐ Rent
- ☐ Own

25. What is the highest level of school you have completed? *Check only one.*
- ☐ Less than high school/GED
- ☐ High School/GED
- ☐ Some college
- ☐ Associate's degree
- ☐ Bachelor's degree
- ☐ Graduate Degree

26. What is your household's annual income before tax? *Check only one.*
- ☐ Less than $25,000
- ☐ $25,000 to $49,999
- ☐ $50,000 to $99,999
- ☐ $100,000 to $149,999
- ☐ $150,000 to $199,999
- ☐ $200,000 or more

Thank you for your time and assistance.

Please return your completed questionnaire in the business reply envelope provided.

Please use the space below for any additional comments.

APPENDIX C. SURVEY I NSTRUMENT: TREATMENT

Background and Instruction

This survey is part of a research project conducted by the Department of Forestry and Natural Resources and the Department of Agricultural and Biological Engineering at Purdue University. The objective of this survey is to learn about residential awareness of and attitudes toward conservation practices to improve water quality. Your responses will help inform the development of future water quality programs.

For the purpose of this survey, please use the following definitions:

- ***Conservation practices to improve water quality, best management practice (BMP), stormwater management strategies,*** *and* ***low impact development (LID) strategies*** *are interchangeable.*
- ***Runoff*** *is water flow that occurs when excess stormwater or snowmelt flows across the land.*

Section 1: Your Residence

1. Do you live in an urban, suburban, or rural area? *Check only one*

- ☐ Urban (20,000 people or more)
- ☐ Suburban area (at least 2,500 and less than 20,000 people)
- ☐ Rural (all population, housing, and territory not within an urban or suburban area)

2. Do you personally operate a farm or have farm animals (e.g., cows, chickens, goats)? *Check only one*

- ☐ **No. I DO NOT own farmland, and I DO NOT operate a farm or have farm animals.**
- ☐ **No. I DO own farmland but I lease it out. I DO NOT operate a farm or have farm animals.**
  If you own farmland but do not operate it personally,
  please answer the survey based on your current residence.
- ☐ **Yes - IF YES, please answer a, b, and c below.**
  a. How many acres are planted crops? ______________________________
  b. How many acres are pasture? ______________________________
  c. Which farm animals do you raise? ______________________________

Section 2: Surface Water Resources

3. Prior to this survey, which of the following best describes your overall awareness of conservation practices to improve water quality? *Check only one*

- ☐ Never heard of them
- ☐ Slightly aware
- ☐ Somewhat aware
- ☐ Very aware

4. Please indicate your level of agreement or disagreement with the statements below about the quality of *waterbodies (e.g., rivers, lakes, ditches, creeks)* in your area. *Check one box for each statement.*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. I think water quality in local waterbodies is excellent	☐	☐	☐	☐	☐
b. I am concerned about water quality in local waterbodies	☐	☐	☐	☐	☐
c. I have sufficient knowledge about water quality problems in local waterbodies in my area	☐	☐	☐	☐	☐
d. I have looked for information about water quality problems in local waterbodies in the past	☐	☐	☐	☐	☐
e. I think water quality in local waterbodies is affected by all residents living in my area	☐	☐	☐	☐	☐
f. I think water quality in local waterbodies is affected by residents living outside of my area, for example, upstream of where we live	☐	☐	☐	☐	☐

5. In your opinion, how much do you think each of the following groups have affected water pollution problems in your area? *Please write a percentage for each group.*

	Percentage
a. Urban Residents	_______ %
b. Suburban Residents	_______ %
c. Rural Residents (non-agricultural)	_______ %
d. Small-scale Agricultural Operations (fewer than 50 acres)	_______ %
e. Medium- or Large-scale Agricultural Operations	_______ %
Total:	**100** %

6. When thinking about sources of water pollution, based on what you know currently, how much of a problem are the following in your area? *Check one box for each item.*

	Not a Problem	Minor Problem	Moderate Problem	Severe Problem
a. Soil erosion from farm fields	☐	☐	☐	☐
b. Excessive use of lawn fertilizer and/or pesticides	☐	☐	☐	☐
c. Improperly maintained septic systems	☐	☐	☐	☐
d. Stormwater runoff from rooftops, parking lots, and roads	☐	☐	☐	☐
e. Use of salt and sand on paved areas	☐	☐	☐	☐
f. Waste materials from pets	☐	☐	☐	☐
g. Use of fertilizers, manure and/or pesticides for crop production	☐	☐	☐	☐
h. Removal of trees and vegetation along streams	☐	☐	☐	☐
i. Manure from animal feeding operations	☐	☐	☐	☐

7. Please indicate your level of agreement or disagreement with the following statements.
Check one box for each statement.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. Rivers and lakes provide many opportunities for my family and me to engage in outdoor activities	☐	☐	☐	☐	☐
b. Improving water quality in our waterbodies is not as important as what some people say	☐	☐	☐	☐	☐
c. I do not care what experts say about water quality	☐	☐	☐	☐	☐
d. I do not care what my family and friends say about water quality	☐	☐	☐	☐	☐
e. I do not care what others in my area say about water quality	☐	☐	☐	☐	☐
f. I do not care what the news say about water quality	☐	☐	☐	☐	☐
g. I do not know a whole lot about why water quality might be important to me or my community	☐	☐	☐	☐	☐
h. Protecting water quality is important to me	☐	☐	☐	☐	☐
i. From my point of view, there are consequences from polluting surface water in my area	☐	☐	☐	☐	☐

8. Please indicate your level of agreement or disagreement with the following statements.
Check one box for each statement.

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. I feel personally responsible for protecting water quality in my area	☐	☐	☐	☐	☐
b. Everybody should do their part to reduce water pollution	☐	☐	☐	☐	☐
c. We should keep our local waterbodies clean because it is the right thing to do	☐	☐	☐	☐	☐
d. We should keep our surface water clean for the benefit of future generations	☐	☐	☐	☐	☐
e. If I am not careful, what I do on my property or in my home could harm water quality in my area	☐	☐	☐	☐	☐
f. I believe what I do on my property or in my home could help improve water quality in my area	☐	☐	☐	☐	☐

Section 3: Conservation Practices to Improve Water Quality

PRACTICES FOR YOUR HOME AND NEIGHBORHOOD	
Rain Garden, *a planted depression that captures runoff and allows water to soak into the ground slowly*	
a. What do you know about rain gardens? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to install a rain garden in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ______________________
Vegetated or Green Roof, *a plant layer on roofs that reduces runoff and cooling costs*	
a. What do you know about green roofs? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to install a green roof in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ______________________
Permeable Pavement, *pavement that allows runoff to soak into the ground and filter naturally through soil*	
a. What do you know about permeable pavement? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to install permeable pavement in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ______________________
Swale System (Grassed Swale), *an open channel with grass or shrubs along the base and side to slow rain water*	
a. What do you know about swale systems? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to install a swale system in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ______________________
Rain Barrel, *a barrel to collect rain water to reuse for watering plants and reduce stormwater runoff*	
a. What do you know about rain barrels? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently using it	**b. What is your likelihood to install a rain barrel in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ______________________
Wet pond, *a pond designed to store and filter water from an entire neighborhood*	
a. What do you know about wet ponds? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to support the installation of a local wet pond in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ______________________

If your property is **SMALLER** than one acre, skip to **Section 4** on page 8

If your property is **LARGER** than one acre, please **CONTINUE**

PRACTICES FOR YOUR LAND	
Open wooded area, *a woodlot for small-scale production of forests as well as recreation uses*	
a. What do you know about preserving wooded areas? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to preserve an open wooded area in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ___________________________
Porous Pavement, ***pavement that allows runoff to soak into the ground and filter naturally through soil***	
a. What do you know about porous pavement? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to install porous pavement for your driveway, sidewalk, or parking lot in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ___________________________
Riparian Buffer/Vegetated Filter Strip, ***a strip of planted vegetation located along waterways and waterbodies***	
a. What do you know about riparian buffers? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to install a riparian buffer in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ___________________________
Wetland Basin, ***a shallow depression planted with vegetation designed to treat runoff***	
a. What do you know about wetland basins? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to install a wetland basin in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ___________________________
Windbreak, ***trees or shrubs planted in a line to reduce wind speed over bare soil, preventing soil erosion***	
a. What do you know about windbreaks? ☐ Never heard of it ☐ Somewhat familiar with it ☐ Know how to do it but have not done it ☐ Currently doing it	**b. What is your likelihood to install a windbreak in the next year?** ☐ Unlikely ☐ Neither unlikely nor likely ☐ Likely ☐ Not applicable ___________________________

If you **DO NOT** operate farmland or have farm animals, skip to **Section 4** on page 8

GO If you **DO** operate farmland or have farm animals, please **CONTINUE**

PRACTICES FOR YOUR FARM

Cover Crops, *a crop grown during the winter to protect and enrich the soil*

a. What do you know about cover crops?
- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to use cover crops in the next year?
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ______________________________

Conservation Tillage, *soil cultivation that leaves crop residue on fields to reduce soil erosion and runoff*

a. What do you know about conservation tillage?
- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to use conservation tillage in the next year?
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ______________________________

Grass Strip or Filter Strip, *a strip of planted vegetation located along roads, ditches, or between crop fields*

a. What do you know about grass strips?
- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to install grass strips in the next year?
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ______________________________

Critical Area Planting, *permanent vegetation grown on sites expected to have high erosion*

a. What do you know about critical area planting?
- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to use critical area planting in the next year?
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ______________________________

No-till Farming, *growing crops year to year without disturbing the soil through tillage*

a. What do you know about no-till farming?
- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to use no-till farming in the next year?
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ______________________________

If you **DO NOT** have farm animals, skip to **Section 4** on page 8

If you **DO** have farm animals, please **CONTINUE**

PRACTICES FOR FARM ANIMALS

Animal Exclusion, *exclusion of farm animals from streams and critical areas not intended for grazing by fencing*

a. What do you know about animal exclusion?

- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to install animal exclusions in the next year?

- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ____________________________

Rotational Grazing, *farm animals are regularly rotated to fresh paddocks to prevent overgrazing and optimize grass growth*

a. What do you know about rotational grazing?

- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to implement rotational grazing in the next year?

- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ____________________________

Compost manure, *manure management to reduce volume and density and kill pathogen*

a. What do you know about composting manure?

- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to compost manure in the next year?

- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ____________________________

Avoid application of manure on frozen ground, *frozen manure is not absorbed into the soil when the ground is frozen and is often carried off the land with snowmelt*

a. What do you know about avoiding the application of manure on frozen ground?

- ☐ Never heard of it
- ☐ Somewhat familiar with it
- ☐ Know how to do it but have not done it
- ☐ Currently doing it

b. What is your likelihood to avoid applying manure on frozen ground in the next year?

- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Not applicable ____________________________

Please **CONTINUE** to **Section 4** on the next page

Section 4: Attitudes toward Conservation Practices to Improve Water Quality

9. Given your current understanding, what is your general attitude towards conservation practices to improve water quality?
Check only one
- ☐ Very negative
- ☐ Somewhat negative
- ☐ Neither negative nor positive
- ☐ Somewhat positive
- ☐ Very positive

10. Would you be interested in learning more about conservation practices to improve water quality?
- ☐ Yes
- ☐ No

11. Given your current understanding of conservation practices to improve water quality, what is your likelihood to adopt any practices in the next year? *Check only one*
- ☐ Very unlikely
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Very likely

12. Please indicate your level of agreement or disagreement with the following statements about conservation practices that can be used to improve water quality. *Check one box for each statement.*

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
a. Knowing what conservation practices I could use to improve water quality is important to me	☐	☐	☐	☐	☐
b. Even if I adopt conservation practices, it does not matter because somebody else will be polluting	☐	☐	☐	☐	☐
c. For me, conservation practices are too expensive to implement	☐	☐	☐	☐	☐
d. For me, conservation practices are too complicated to implement	☐	☐	☐	☐	☐
e. None of the conservation practices I am familiar with are relevant or applicable to my property or my home	☐	☐	☐	☐	☐
f. By adopting conservation practices, I could help improve water quality	☐	☐	☐	☐	☐
g. I have a responsibility to adopt conservation practices to improve water quality as much as I could	☐	☐	☐	☐	☐
h. It is important to protect water quality even if it slows economic development	☐	☐	☐	☐	☐
i. It is important to protect water quality even if it costs me more	☐	☐	☐	☐	☐

Section 5: Conservation Practices to Improve Water Quality in Your Area

13. What have you noticed in terms of people around you adopting conservation practices to improve water quality in your area? *Check one box for each group of people.*

	Nobody has adopted conservation practices for water quality	**A few have adopted** conservation practices for water quality	**Most have adopted** conservation practices for water quality	**I do not know if anyone has adopted** conservation practices for water quality
a. Among my family…	☐	☐	☐	☐
b. Among my friends…	☐	☐	☐	☐
c. Among my neighbors…	☐	☐	☐	☐
d. Among people in my community…	☐	☐	☐	☐

14. Please indicate your level of agreement or disagreement with the following statements.
Check one box for each statement.

	Strongly Disagree	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
a. Conservation practices do not fit how I want my property or land to look	☐	☐	☐	☐	☐
b. I believe implementing conservation practices on my property or in my home would bother my neighbors	☐	☐	☐	☐	☐
c. I would feel the need to adopt conservation practices to improve water quality if others in my family did so	☐	☐	☐	☐	☐
d. I would feel the need to adopt conservation practices to improve water quality if my friends did so	☐	☐	☐	☐	☐
e. I would feel the need to adopt conservation practices to improve water quality if my neighbors did so	☐	☐	☐	☐	☐
f. I would feel the need to adopt conservation practices to improve water quality if others in my community did so	☐	☐	☐	☐	☐
g. My family would like to see me adopting conservation practices to improve water quality	☐	☐	☐	☐	☐
h. My friends would like to see me adopting conservation practices to improve water quality	☐	☐	☐	☐	☐
i. My neighbors would like to see me adopting conservation practices to improve water quality	☐	☐	☐	☐	☐
j. Others in my community would like to see me adopting conservation practices	☐	☐	☐	☐	☐
k. Among the people I know, many would agree adopting conservation practices to improve water quality is a good thing to do	☐	☐	☐	☐	☐

Please read the following information before completing Sections 6 and 7

Protecting Your Water Resources

Purdue University

Nonpoint source pollution (NPS) is pollution that enters lakes, rivers, wetlands, and ground waters from many diffuse sources as rainfall or snowmelt moves over and through the ground. NPS is one of the primary contributors to water pollution and is often dominated by human activities related to agriculture and urbanization.

WHAT CONTRIBUTES TO NPS?

- Overapplication of fertilizers, herbicides, and insecticides
- Sediment from improperly managed construction sites, crop and forest lands, and eroding streambanks
- Bacteria and nutrients from livestock, pet waste, and faulty septic systems

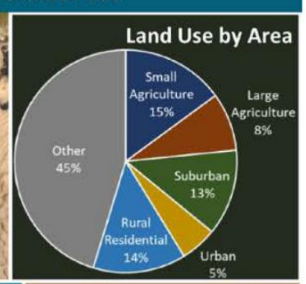
WHAT ISSUES ARE ASSOCIATED WITH NPS?

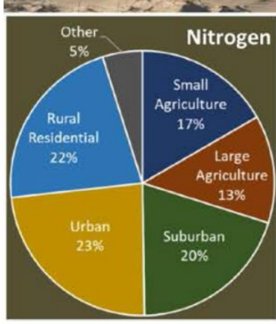
- Loss of aquatic habitat and algal blooms
- Loss of swimming opportunities from bacteria
- Sediment build-up and fish suffocation

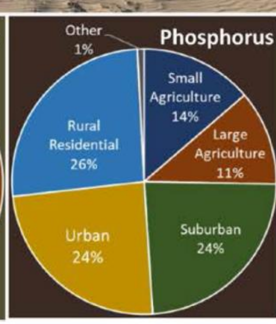
WHAT CAN I DO?

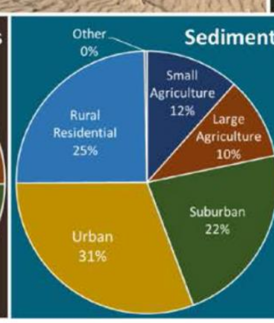
- Install rain barrels, permeable pavement, or rain gardens in urban areas
- Use conservation tillage, crop rotation, or install a grassed buffer along waterways in rural areas
- Reduce pesticide and fertilizer use

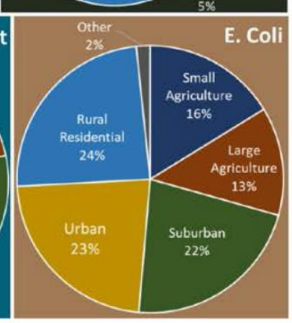
In a study recently conducted by Purdue University, researchers found the following pollutants produced by each resident group's land use practices in the East Branch-Little Calumet and Trail Creek Watersheds. The pie chart to the right shows percentage of land use by each group.











Section 6: Water Quality Improvement Programs

15. Given your current understanding of conservation practices to improve water quality, what is your likelihood of adopting any practices in the next year? *Check only one*

- ☐ Very unlikely
- ☐ Unlikely
- ☐ Neither unlikely nor likely
- ☐ Likely
- ☐ Very likely

16. Please indicate the level of importance you place on the following potential benefits associated with adopting conservation practices that help improve surface water quality. *Check one box for each item.*

	Not Important	Slightly Important	Moderately Important	Somewhat Important	Very Important
a. Income or monetary benefits	☐	☐	☐	☐	☐
b. Be a good example to my family	☐	☐	☐	☐	☐
c. Be a good example to my friends	☐	☐	☐	☐	☐
d. Be a good example to my neighbors	☐	☐	☐	☐	☐
e. Be a good example to people in my community	☐	☐	☐	☐	☐
f. Improved surface water quality	☐	☐	☐	☐	☐
g. Increased water storage and filtration	☐	☐	☐	☐	☐
h. Improved aquatic habitat	☐	☐	☐	☐	☐
i. Improved outdoor recreation	☐	☐	☐	☐	☐
j. Reduced likelihood of flash floods	☐	☐	☐	☐	☐
k. Improved environmental quality in general	☐	☐	☐	☐	☐

17. Which of the following would make you <u>less interested</u> in adopting conservation practices to improve water quality? *Check all that apply.*

a. Not knowing enough about it	☐
b. Hearing that the conservation practice went wrong or did not work well	☐
c. Being one of the first few from my community to participate in a conservation program	☐
d. Being one of the first few from my community to adopt a conservation practice	☐
e. Difficulty installing the conservation practice	☐
f. Difficulty maintaining the conservation practice over time	☐
g. Making my property look different from other properties in my neighborhood	☐
h. Concern about my neighbors not liking it	☐
i. Concern about how my property or home would look like after installing a conservation practice	☐
j. Concern about the practice adversely affecting other management strategies (e.g., cover crops or crop residue blocking tile drains or ditches)	☐

Section 7: About You

19. What is your age? ___________ years

20. What is your sex? *Check only one.*
- ☐ Male
- ☐ Female

21. What is your race? *Check only one*
- ☐ White
- ☐ Black or African American
- ☐ American Indian or Alaska Native
- ☐ Asian
- ☐ Native Hawaiian or Other Pacific Islander

22. Are you of Hispanic, Latino, or Spanish origin?
- ☐ Yes
- ☐ No

23. Who is responsible for making decisions about your property or home such as installing conservation practices to improve water quality? *Check only one.*
- ☐ I am solely responsible for making decisions about my property / home
- ☐ I share responsibility for making decisions about my property / home
- ☐ Someone else is responsible for making decisions about my property / home

24. Do you rent or own your home where you live? *Check only one*
- ☐ Rent
- ☐ Own

25. What is the highest level of school you have completed? *Check only one.*
- ☐ Less than high school/GED
- ☐ High School/GED
- ☐ Some college
- ☐ Associate's degree
- ☐ Bachelor's degree
- ☐ Graduate Degree

26. What is your household's annual income before tax? *Check only one.*
- ☐ Less than $25,000
- ☐ $25,000 to $49,999
- ☐ $50,000 to $99,999
- ☐ $100,000 to $149,999
- ☐ $150,000 to $199,999
- ☐ $200,000 or more

Thank you for your time and assistance.

Please return your completed questionnaire in the business reply envelope provided.

Please use the space below for any additional comments.