



# Gauging Residential Knowledge and Behavior to Inform Stormwater Outreach Efforts across South Carolina

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**Abstract.** Public outreach and education are important components of local stormwater management efforts aimed at protecting water quality and reducing pollutants of concern. Increasingly, educators recognize that creating effective outreach material depends on an understanding of the target audience, their current behavior, and their barriers and motivations to adopting pro-environmental behaviors. Clemson Extension's Carolina Clear program partners with 39 communities across South Carolina to provide compliance-based stormwater education and outreach. On behalf of these community partners, Carolina Clear conducted the third iteration of a telephone survey to gauge local knowledge, perceptions, and behaviors of residents related to stormwater and watershed health. Results presented here will highlight key knowledge gaps (e.g., the misconception that stormwater runoff is treated) and behaviors (e.g., dumping down storm drains) that could potentially be targeted through education and removal of barriers (e.g., storm drain markings). Survey results showed ongoing misperceptions about the major sources of stormwater pollution, whether stormwater is treated, and what behaviors generate pollution. However, results also show a high level of concern about water quality, as well as a desire to practice pro-environmental behavior. Highlighting the connection between potential sources of pollution, such as pet waste and septic systems, and impacts, such as shellfish bed closures and swimming restrictions, could provide stronger awareness and motivation, particularly among the large number of residents who enjoy visiting beaches and who swim, fish, and boat in local waterways. Ultimately, the survey results can be used by a variety of educators and practitioners statewide to better understand and identify target audiences and to guide the development of stormwater programming that addresses these knowledge gaps. Conducting focus groups with subpopulations of residents is recommended as a next step to further identify specific motivations within subpopulations of residents. Combining the survey results with focus-group data can help educators remove barriers to taking action and further motivate behavior change.

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## INTRODUCTION

Stormwater runoff is a major contributor to water quality pollution and flooding across South Carolina. Because nonpoint sources of pollution can be difficult to attribute back to the primary source, regulatory actions have often been ineffective at curbing polluted stormwater runoff. Communities that own Municipal Separate Storm Sewer Systems (MS4s), a network of stormwater conveyance systems that discharge into waters of the state, are required to obtain National Pollutant Discharge Elimination System (NPDES) permit coverage to authorize discharge of pollutants into state waters. Despite the fact that NPDES permits are

intended to reduce pollutant loading to state waterbodies, as of 2018, approximately 1,040 waterbodies were listed as impaired on the South Carolina Department of Health and Environmental Control (SC DHEC) 2018 303(d) list, with over 1,200 total impairments (SC DHEC, 2018) (Figure 1). In order to combat the adverse effects of stormwater runoff on receiving waters, regulated MS4 communities are required to develop a program to address 6 minimum control measures (MCMs): (1) public education and outreach, (2) public participation/involvement, (3) illicit discharge detection and elimination, (4) construction site runoff control, (5) post-construction site runoff control, and (6) pollution prevention/good housekeeping (SCDHEC 2013).

Individual actions and behaviors of residents contribute to water quality and quantity issues; therefore, providing public outreach, education, and involvement opportunities is one strategy to target polluters directly and reduce pollution-causing actions across the landscape. This follows from an assumption that people are often unaware that their behavior on land can impact water quality and water quantity downstream, but if they know better (e.g., knowledge gained through stormwater outreach efforts), they will do better (e.g., limit pollution-generating activities, resulting in fewer impaired water bodies). However, 15 years after the first MS4 permit was issued in South Carolina, the number of waterbodies on SCDHEC’s 303(d) list (2018) increased by 7% (Figure 2). While the pollution driving these impairments comes from a variety of sources and sectors (e.g., land use change, development, agriculture), pollution generated by individuals and individual behavior is the source most easily targeted through education.

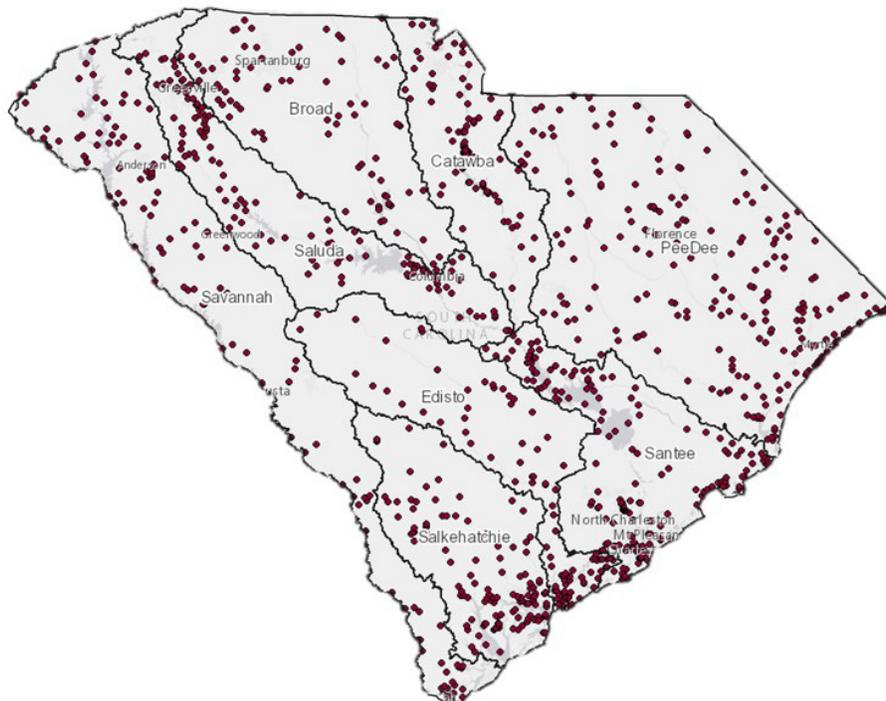
South Carolina has over 70 regulated MS4 communities, 39 of which contract with Clemson Extension’s Carolina Clear program to provide their compliance-based stormwater education, outreach, and involvement. The Carolina Clear model works through a regional consortium-based approach, where multiple MS4 communities partner on a stormwater education strategy, led by local Clemson Extension agents. A key deliverable from this partnership, and a requirement of the MS4 permit, is a periodic evaluation of the effective-

ness of educational efforts (SCDHEC 2013). Carolina Clear uses a telephone survey of residents in participating consortium areas (across 6 counties of South Carolina and spanning all 3 regions: the coast, the midlands, and upstate) to gauge effectiveness of programming over time and to better understand the informational needs of its education program’s target audiences. Previous surveys were conducted in 2009 and 2013. The third iteration of the survey was conducted in 2019.

Stormwater departments are increasingly focused on education as part of their mission, whether the education is provided by staff of the department or contracted out to a group such as Clemson Extension. Educational efforts are often reactive by necessity; if an illicit discharge is discovered, or if improper disposal of fats, oils, and grease leads to a sanitary sewer overflow, timely distribution of outreach materials may be necessary to curb these pollution sources. However, being able to anticipate behaviors and observe trends allows educators to proactively address problems and develop more robust informational campaigns aimed at reducing barriers and changing behavior over the longer term.

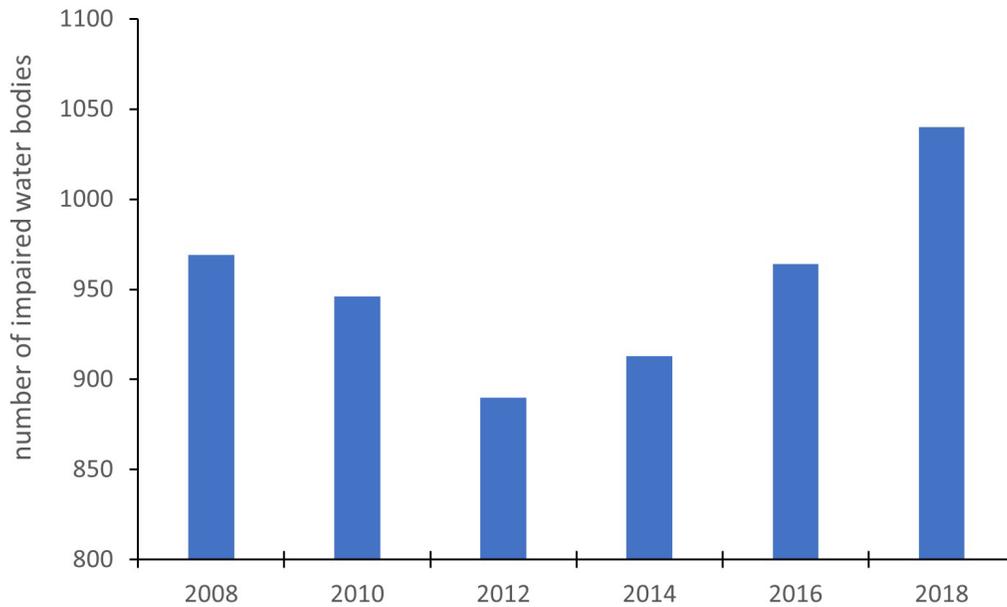
### BACKGROUND AND RELATED WORK

Notably, research indicates that education alone does not always lead to behavior change (McKenzie-Mohr et al. 2012); instead, motivation is the primary driver (Schultz



**Figure 1.** South Carolina waterbodies on SCDHEC’s 303(d) list (data from SCDHEC Watershed Atlas).

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**Figure 2.** Number of waterbodies across South Carolina included on SC DHEC’s 303(d) list of impaired waters, assessed biennially (SCDHEC 2019).

2011). Even people who want to do the right thing are often limited by barriers other than lack of knowledge (Ajzen et al. 2011). This doesn’t mean that education and outreach are not effective, but it does mean that a clear understanding of target audiences, and their attitudes and motivations, is necessary to tailor education and outreach to meet audience needs and motivate action. It is not enough to develop general education materials and hope they connect with an audience; motivating pro-environmental behavior that protects water quality requires deploying targeted materials directly to those who need them (Shepherd 1999).

Generally, the goal of a behavior change effort will be to motivate the target audience to either *accept* a new behavior, *reject* a potentially undesirable behavior, *modify* a current behavior, *abandon* an old undesirable behavior, or *continue* a desired behavior (Lee and Kotler 2011). Messages aimed at promoting actionable behaviors are more likely to resonate with an audience if they identify single, achievable, specific actions the audience can take (Costanzo et al. 1986).

MCM 1 (public education and outreach) of South Carolina’s MS4 permit includes a requirement to identify the target audience (SC DHEC 2013). This will depend on which pollutant of concern is being targeted, and the source of the pollution. But it is also essential to identify the current audience behaviors, and the target behaviors that you want the audience to take. MCM 1 also requires that “program goals and objectives must include short-term goals geared to increase awareness of the issue as well as longer-term goals

geared to affect behavior change to the maximum extent practicable” (SC DHEC 2013). However, it is important to keep in mind that raising awareness in the short term will not be enough to affect behavior change in the long term.

Regularly surveying residents is one way to identify audience knowledge and behaviors, and to gauge whether behaviors are changing over time. The results of previous Carolina Clear surveys conducted in 2009 and 2013 have been used to identify target audiences, identify new and emerging topics, inform creation of messages, and identify appropriate channels for message delivery. For example, storm drain markings indicating “drains to waterway” were installed in locations where residents were unclear on the final destination of stormwater runoff. However, this scale of data collection can be a challenge for a small stormwater department that may not have a full-time stormwater educator on staff. The 2019 Carolina Clear telephone survey includes a diverse set of communities spanning the coast, midlands, and upstate of South Carolina, and results presented here may be useful to other stormwater departments and educators seeking to identify and better understand their target audiences.

### PROJECT OBJECTIVES / GOAL

As defined by the initial survey effort in 2009, the primary goal of the Carolina Clear telephone survey is to better understand the knowledge, perceptions, and behaviors of residents related to stormwater and watershed health

(Giacalone et al. 2010). Additional goals include identifying barriers to pro-environmental behavior and segmenting out audience characteristics to more effectively target subpopulations. Ultimately, the survey results can be used by a variety of educators and practitioners to guide stormwater programming across the state and to provide evaluation data that can be used to indicate the effectiveness of education and behavior change efforts over time.

### MATERIALS AND METHODS

The telephone survey instrument was developed by adapting the questions used in the previous two iterations of the survey in 2009 and 2013. It was important to provide consistency in order to highlight where perceptions are changing and knowledge has been gained, although additional questions were added to address new issues or gaps in understanding. The survey consisted of 53 questions, including a mix of open-ended, closed-ended, single- or multiple-response, scaled, and series questions. The survey instrument was approved by Clemson’s Institutional Review Board (IRB2019-178).

Implementation of the telephone survey instrument was contracted out to Responsive Management, a survey research firm specializing in natural resource and outdoor recreation issues. Responsive Management conducted pretests of the questionnaire to ensure proper wording, flow, and logic in the survey. The survey was conducted by telephone, using Responsive Management’s own in-house telephone inter-

viewing facilities, and targeted both landlines and cell phones. The sample of adult South Carolina residents was obtained from Marketing Systems Group and used a probability-based selection process to ensure that each eligible resident within each region had an equal chance of being selected for the survey. This process ensured that the sample was valid because every resident had a known chance of participating in the survey. The sample consisted of residents within 5 regions across the state that contract with the Carolina Clear program to provide compliance-based stormwater outreach and education. These regions include 11 counties and all 39 partner MS4 communities (Figure 3). The five regions are:

- Region 1 (Pickens Area): Pickens and Anderson Counties
- Region 2 (Pee Dee Area): Florence, Darlington, and Sumter Counties
- Region 3 (Beaufort Area): Beaufort County
- Region 4 (Charleston Area): Charleston, Berkeley, and Dorchester Counties
- Region 5 (Myrtle Beach Area): Horry and Georgetown Counties

The survey was conducted in August and September 2019 using Questionnaire Programming Language (QPL) for data collection. A total of 2,003 surveys were completed (Table 1).

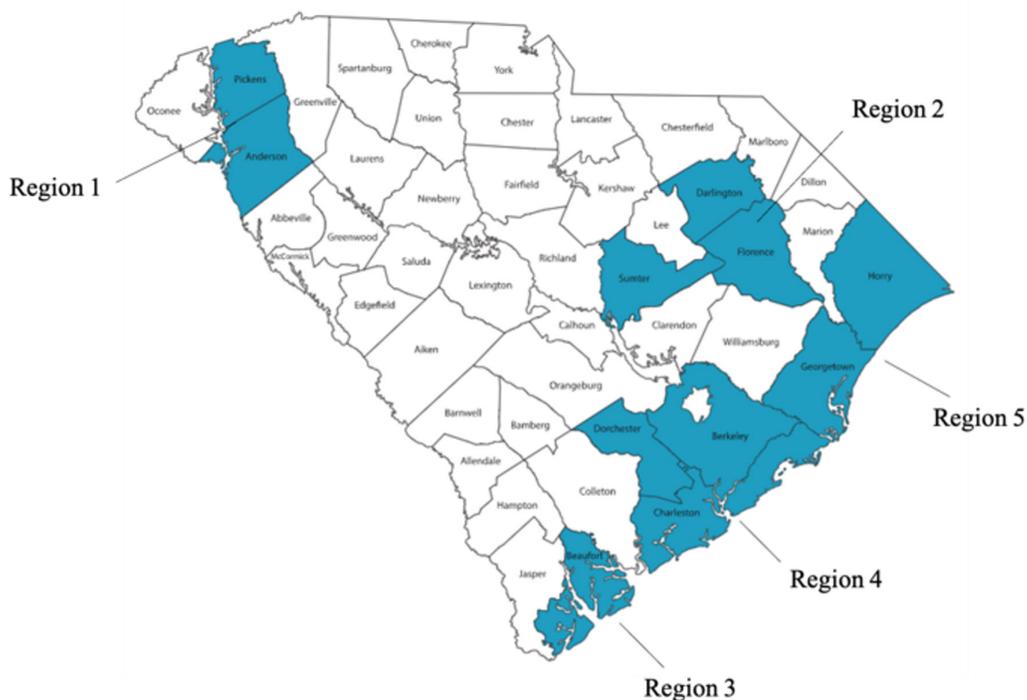


Figure 3. Survey targeted residents in eleven counties across South Carolina.

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**Table 1.** Sample Size, Total Population, and Sampling Error by Region (Responsive Management, 2019)

Region	Sample	Population	Sampling Error
Region 1 (Pickens)	402	246,894	4.88
Region 2 (Pee Dee)	401	238,375	4.89
Region 3 (Beaufort)	400	144,108	4.89
Region 4 (Charleston)	400	578,579	4.90
Region 5 (Myrtle Beach)	400	300,324	4.90
Study Area Total	2,003	1,508,280	2.19

Data analysis was performed using IBM SPSS Statistics as well as proprietary software developed by Responsive Management. The results were weighted by age and gender within each region so that the data were representative of these demographic characteristics for the total population of that region. The regions were then weighted to represent their proper proportions within the 5 regions as a whole. Results are reported at a 95% confidence interval.

## RESULTS

Similar to the previous iterations of the survey, results were divided into four general categories to best interpret their role in water quality protection and to determine how they can be used to inform outreach strategies. These categories were: level of concern, watershed knowledge, assessment of impacts, and behavior.

### LEVEL OF CONCERN

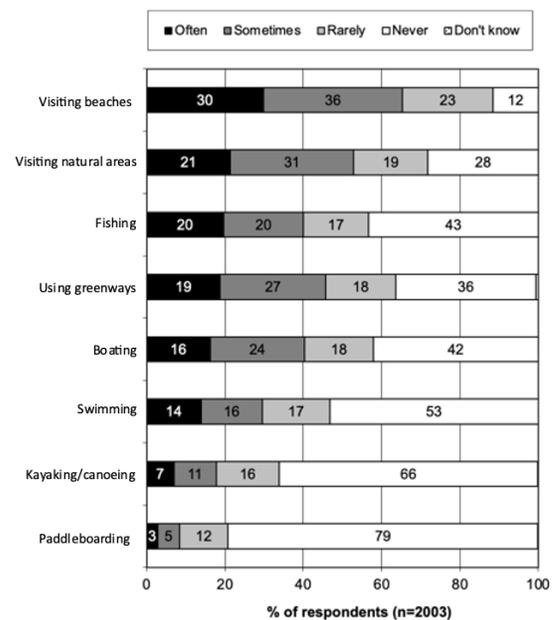
Virtually all residents (99%) consider clean water to be important to South Carolina’s economy and tourism, with 94% saying they feel it is *very* important.

The majority of residents often or sometimes visit beaches (65%) and other natural areas (53%) for recreation, and 40% of residents often or sometimes fish or boat (Figure 4). Most residents (87%) are concerned with pollution in their local waterways, and 57% are *very* concerned. Notably, the degree of concern is markedly lower in Region 1 (Anderson and Pickens Counties), compared to the other regions. Also, Region 1 is the only region where the degree of concern decreased since the last time the survey was conducted in 2013 (from 92% in 2013 to 82% in 2019). Region 1 also has the highest concentration of approved watershed-based plans, so it could follow that awareness of ongoing local efforts to improve water quality is reducing overall levels of concern. Those residents most associated with being *very* concerned are African American residents, female residents, and those who live in a large city or urban area, compared to

other groups. Most residents (93%) think litter is a problem in their county, with 52% saying it is a *major* problem.

### WATERSHED KNOWLEDGE

Residents were asked, in an open-ended question, how they think pollution from land enters local waterways. The majority (73%) of residents described stormwater as the primary pathway, although some residents were able to give more detail about transport mechanisms (e.g., via overland flow or storm drains) than others. The primary “other” way that was commonly mentioned alluded to point sources of pollution (e.g., factories). This understanding of the connection between land-based pollution and water pollution didn’t necessarily carry over when similar questions were asked, particularly when questions were posed in a yes/no format. Residents were asked, in an open-ended question, where water flows after entering a storm drain. Residents



**Figure 4.** Participation by residents (%) in various outdoor activities.

most often said they do not know (37%); otherwise, the top responses were that water flows directly into local waterways (35%), water is collected and sent to a wastewater treatment plant (11%), and water is diverted to a neighborhood stormwater pond, structure, or system (10%).

About a quarter of residents (26%) think water that flows into storm drains is treated at a wastewater treatment plant (WWTP) before it reaches waterways, while over a third (34%) did not know what happens to the water. Region 1 (Anderson and Pickens Counties) residents are more likely than those in other regions to think stormwater is treated at a WWTP, Region 4 residents (Charleston, Berkeley, and Dorchester Counties) were more likely to recognize that stormwater is not treated at a WWTP, and Region 2 (Sumter, Darlington, and Florence Counties) residents had the highest rate of unsure responses (47%). All of the South Carolina counties surveyed are MS4 communities, which means stormwater is not treated at a WWTP. However, South Carolina was the sixth-fastest-growing state in 2019 (US Census Bureau 2019), and if new residents are moving from areas that had combined sewer, they may be unaware that they have moved to an MS4 community. Ensuring all residents understand that their stormwater is not treated is an important step in making the connection between land-based sources of pollution and impacts on local water quality.

**ASSESSMENT OF IMPACTS**

Residents were read a list of possible sources of water pollution and were asked to state how much impact (great impact, some impact, very little impact, no impact, don't know) each has on waterways in their area. Pollution sources

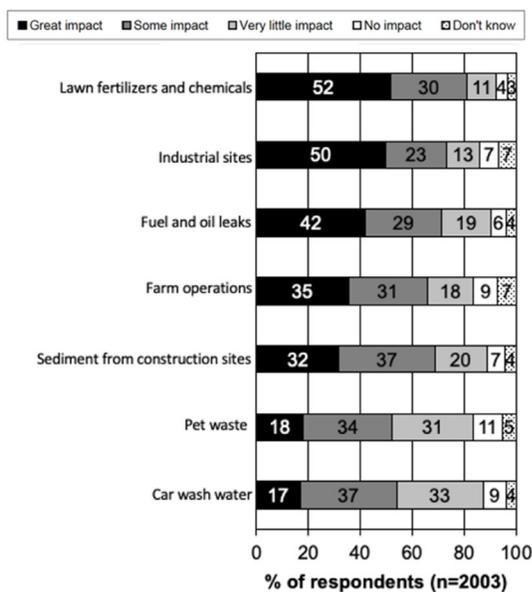
included fertilizers and lawn chemicals, industrial sites, vehicle leaks, farm operations, sediment from construction sites, pet waste, and runoff from home car-washing (Figure 5). Fertilizers and chemicals that people use on their lawns or gardens was at the top of the list, with 81% of residents saying it has a *great* impact or *some* impact on waterways. This is followed by a grouping of responses that had 66% to 73% of residents saying each had a *great* impact or *some* impact on waterways in their area: industrial sites, fuel and oil leaks from vehicles, sediment or dirt from construction sites, and farming operations. Pet waste and runoff from people washing their cars were considered to be the least impactful to local waterways, among the options stated. Bacteria is the biggest threat to water quality in South Carolina (based on total number of bacteria impairments compared to other impairments); thus, while each of the listed pollutants can impact water quality, residents continue to view point sources of pollution (like industrial sites) as having a disproportionate impact on overall watershed health. These results are consistent with responses from previous surveys (Giacalone et al. 2010) and suggest that educational materials should better highlight the predominant pollutants of concern in local waterbodies and their primary sources.

**BEHAVIOR**

**Personal Activities**

Residents were asked about several personal actions taken over the past 2 years that could either positively or negatively impact water quality. Their responses indicated that most dog owners (81%) always or sometimes picked up after their dog, 67% always did so (particularly those in urban/suburban areas), and 15% never did (particularly those in rural areas). Among residents who typically pick up their dog's waste, 77% dispose of it in the trash. Among those who do not typically pick up their dog's waste, the top reason is that the waste is on their own property. Other common reasons given were a belief that dog poop is biodegradable or acts as fertilizer, and that it is inconvenient to pick it up. This indicates that lack of knowledge of dog poop as a potential source of pathogens to waterways could be a barrier to adopting a new pro-environmental behavior (picking up and disposing of dog poop in the trash), but also that a lack of convenient access to pet-waste bags and/or trash cans could be a barrier to those who already know that pet waste is a threat to water quality but aren't motivated to go out of their way to pick it up and dispose it.

A majority (61%) of residents who do their own lawn-care always or sometimes considered the likelihood of rain before applying pesticide or fertilizer, 44% always did so, and 29% never did so. Over a third of residents (41%) had dumped something down a storm drain (particularly males, those living in urban/suburban areas, and those between 18



**Figure 5.** Perception of impact on water quality attributed to various pollution sources.

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and 34 years old), and soapy water from car-washing was the most common pollutant dumped (88%), followed by trash/litter (4%). This is not entirely surprising considering that soapy water from car-washing was seen as the least impactful pollutant on water quality, and that many residents are still unsure of where stormwater goes after it enters the storm drain. Only 3% of these same residents dumped leaves or grass clippings down the storm drain or into a ditch.

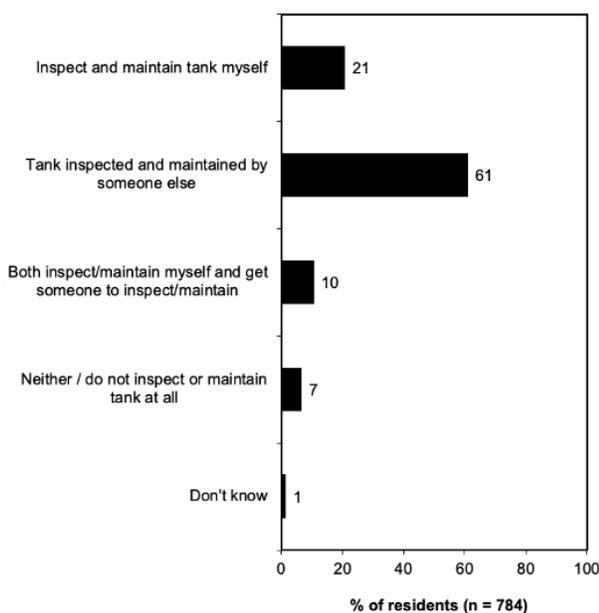
## Home Maintenance

About a third of residents surveyed (34%) own a septic tank. Septic tank ownership was much more common in Region 1 (Pickens and Anderson Counties) and Region 2 (Florence, Darlington, and Sumter Counties) than the other regions. Of those who own a septic tank, a majority (61%) have the tank inspected and maintained by someone else, 21% personally inspect and maintain the tank, 10% do both, and 7% do not inspect or maintain the tank at all and do not have it done for them (Figure 6). Those who have their septic tank serviced or maintained most often said they have their tank maintained through pumping (47%), a general inspection or visual check (27%), or by using additives (20%). While 38% of residents with septic tanks had them inspected once in the last 2 years, 36% of residents had not had their tank inspected during that time frame (Figure 7). Those who had not had their septic tank inspected were more likely to be 55 years old or older, live in Region 1 (Pickens and Anderson Counties), have an annual household income over \$60,000, and often or sometimes boat or swim in local waterways. SCDHEC recommends that septic tanks be inspected every 1 to 2 years and pumped out

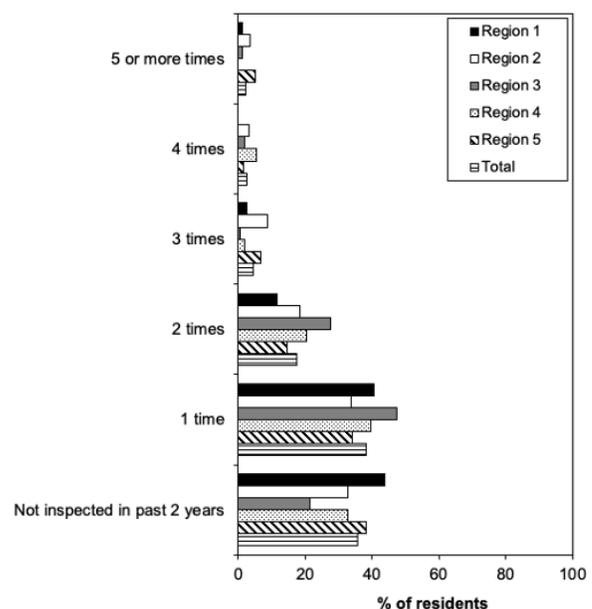
every 3 to 5 years, and generally recommends against using additives, which are often ineffective and can be harmful to the proper functioning of a system (SCDHEC 2021). Because bacteria are the main pollutant of concern in South Carolina waterways, and poorly functioning septic systems can act as a source of fecal bacteria, outreach efforts should focus on modifying existing behaviors and providing timely prompts, reminders, and incentives for septic inspections.

## Lawns and Landscaping

A majority of residents (56%) do their own landscaping, compared to 21% who hire someone to do landscape maintenance for them. The groups most likely to do their own landscaping include those in rural areas, those who often or sometimes fish, those who often or sometimes swim or boat in local waterways, and those between 35 and 54 years old. Among those with a lawn or garden, a slight majority (52%) typically look for plants that are native to South Carolina for use in their landscape. The primary reasons residents gave for not considering native plants were they “just didn’t think about it,” they already had a mature landscape, or attractiveness of plants was a more important consideration. Native plants require less irrigation, fertilizers, and pesticides, and they provide food and habitat for pollinators; as such, they are often a focus of outreach efforts to reduce nutrient loading to waterways. Expanding outreach programs focused on promoting the use of native plants will need to target key audiences separately; those who are unaware of the benefit of native plants will need to accept a new behavior, while those who prefer nonnative plants for aesthetic reasons will



**Figure 6.** Responsibility for inspection and maintenance among residents with septic tanks.



**Figure 7.** Number of times residents with septic tanks had them inspected or maintained in the past 2 years.

need to modify a current behavior. Recognizing the different motivations of these audiences will be essential to bringing about the desired change in landscaping norms.

A majority of those with a lawn or garden (56%) have experienced flooding on their property, compared to 42% who never have; 21% are flooded multiple times a year, 14% are flooded about once a year, and the remainder are flooded less than once a year. Region 1 (Pickens and Anderson Counties) residents are the least likely to be flooded, compared to those in other regions. Actions residents can take to manage stormwater on their property to help alleviate minor flooding include the installation of stormwater control measures, such as rain gardens or rain barrels.

Among those who have a lawn or garden, only 6% have a rain garden in their yard. Those with rain gardens are more likely to live in Region 2 (Florence, Darlington, and Sumter Counties), Region 5 (Horry and Georgetown Counties), or Region 3 (Beaufort County); often or sometimes go swimming, fishing, and boating; and have an annual household income over \$60,000.

A small percentage of residents (7%) currently own a rain barrel. Those with rain barrels are more likely to live in Region 1 (Pickens and Anderson Counties) or Region 2 (Florence, Darlington, and Sumter Counties), often or sometimes go boating or fishing, have a bachelor's degree or higher, live in a rural or suburban area, and have an annual income of less than \$60,000 a year. Rain barrels take up very little space and don't require a large yard, making them ideal BMPs for residents in urbanized areas. Targeting outreach to urban residents about the benefits of rainwater harvesting and providing convenient opportunities to make or purchase rain barrels could help to increase BMP adoption and reduce runoff in urban areas with high impervious cover. Of those who own a rain barrel, most (79%) currently have it installed and working on their property, which means 21% have one they aren't using. This suggests that providing additional resources and information to teach people how to set up their rain barrel, or connecting them with someone who can install it for them, could be an important step to ensuring that a purchased rain barrel is put to use. While most residents with a rain barrel use the harvested rainwater to water their plants, garden, and/or lawn, 16% did say they use it to manage stormwater on their property.

## DISCUSSION

The results of this study suggest that a lack of knowledge about how pollutants move from land to water, what impact pollutants have on water quality, and how individual behaviors can contribute to water quality degradation may be contributing sources to polluted stormwater runoff and associated waterbody impairments. Previous Carolina Clear surveys have indicated that even when residents recognized

the harm from a particular pollutant (e.g., pet waste), they didn't always take the appropriate behavior to prevent that harm (e.g., picking up and disposing of it in the trash). This third iteration of the survey attempted to further delve into the reasons people gave for taking or not taking a desired behavior, in order to clearly identify the behaviors that could be successfully targeted through education.

A number of key knowledge gaps were identified that highlight areas where educational efforts could address misconceptions. The basic concept of where stormwater goes is still something that hasn't reached the level of common knowledge among the population in the survey regions. Lack of clarity on what happens to stormwater after it enters a storm drain, and misconceptions on whether the water is treated at a WWTP before discharging to local waterways, appears to affect willingness to dump pollutants directly down storm drains. Targeted education, particularly for residents who wash their car at home, can help to prevent improper dumping.

The relative perceived impact of various pollutants on local water quality does not align with the major impairments of South Carolina waterways. Excess nutrients were seen as having the greatest impact on water quality, despite the fact that bacteria are the most widespread impairment in South Carolina. This could be due to the fact that excess nutrients can lead to highly visible impacts such as algal blooms. Highlighting the connection between potential sources of bacteria, such as pet waste and septic systems, and impacts, such as shellfish bed closures and swimming restrictions, could provide stronger awareness and motivation, particularly among the large number of residents who enjoy visiting beaches and who swim, fish, and boat in local waterways. Further gauging audience motivations will also be important to reach those who won't be motivated by an increase in knowledge. Activities where people participate in water-based activities, such as boat landings and beaches, could also be important locations to disseminate messages and interview target audiences.

While pet waste is only one of a number of potential bacteria sources, ranking its impact as lower than other pollutants could indicate a lack of awareness of the effects of bacterial pollution, or a lack of understanding of the mechanism of transport of fecal bacteria to local waterways. Education and outreach campaigns targeting pet owners should highlight the connection between pet waste and water quality, particularly emphasizing pet waste not just as a source of litter, but as a source of bacterial contamination.

Several key behaviors were also identified that, if implemented, would help to protect water quality. The use of stormwater BMPs in residential landscapes can serve two purposes: reducing runoff and reducing pollution loading. Residents who have experienced flooding in the past may be easier to motivate to adopt BMPs such as rain barrels and

rain gardens if the water storage capacity is emphasized. In fact, a recent study in Vermont indicated that adoption of green stormwater infrastructure rises after floods (Coleman et al. 2018). For audiences in areas that have been subjected to recent floods, emphasizing the flood control ability of BMPs as opposed to the water quality benefits may serve as a stronger motivator for adoption.

Regular septic maintenance is an important behavior that can reduce bacterial loading to waterways, groundwater, and private wells, yet many residents are not properly maintaining their septic tanks. Research from Washington state indicates that septic education efforts, based on the belief that homeowners are unaware of the need to maintain their septic tanks, will often fail because regular maintenance is not in the rational self-interest of the homeowner (Mohamed 2009). Mohamed (2009) suggested that septic education programs need to be complemented by regulations established and enforced at the state level. Adding information about existing septic regulations and SCDHEC recommendations to current education strategies could be a good first step to increasing motivation among septic owners. Pairing this information with contact information for contractors, sending prompts to remind septic owners of their inspection schedule, and, if possible, offering financial incentives or rewards for regular inspections could make septic maintenance an easier behavior to adopt. Follow-up focus groups or interviews with septic owners from the groups identified as least likely to have their tank regularly inspected may be needed to better identify the barriers to inspection.

Best practices for landscape maintenance, including proper fertilizer use and incorporation of native plants, could resonate with those audiences already aware of and concerned about nutrient pollution. Promoting the use of native plants in the landscape directly targets a behavior that can reduce nutrient loading to waterways. For the residents who just don't think about native plants, information on the benefits paired with increased availability at nurseries and gardening stores may be enough to motivate a behavior change. Brzuszek et al. (2009) found an increasing trend of using native plants by landscape architects in the southeast US, even when their clients weren't specifically requesting them. Collaborating with landscape architects on educational strategies, and partnering with them to share messages, could be a first step to motivating residents who deliberately chose not to use native plants in their landscapes. Among audiences who don't consider native plants to be as aesthetically pleasing as non-native plants, an approach could focus on increasing use and identification of showy native plants in public spaces and demonstration gardens (involving volunteers in the design and installation), as well as increased recognition of yards that incorporate native plants (e.g., yard of the month designation) to motivate through changing the social norm of what an attractive landscape looks like.

While the survey results were limited to only 11 counties (comprising 39 MS4s) around the state, the uplands, the midlands, and the coast were all represented to some degree in the survey regions. There may be limitations in extrapolating the data to represent other regions or counties not included in the survey, but for MS4 communities that don't already have this information collected, it could provide helpful insights into general audience characteristics. In communities outside of the survey regions, the survey results could serve as a useful starting point to guide the development of their own surveys or focus groups.

Despite requirements in the MS4 permit mandating public outreach, education, and involvement, the number of impairments across South Carolina waterways have increased over the last 9 years. While pollutants come from a variety of sources, urban areas in particular are affected by polluted stormwater running off impervious surfaces impacted by human activities. In order to reduce these land-based pollution sources from urban and suburban areas, it is essential to understand what residents know about stormwater pollution and which behaviors are contributing to water quality impairments. The results of this survey can help stormwater educators better determine who their target audiences are and what specific behaviors need to be targeted to protect water quality from polluted stormwater runoff. As a next step, conducting focus groups of target audiences could further disentangle the barriers to pro-environmental behaviors and better identify specific motivators to encourage behavior change within subpopulations of residents. With that knowledge, stormwater educators will be able to craft outreach messages and campaigns more effectively tailored to key audiences with a greater chance of motivating sustainable behavior change.

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