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Adoption of Household Stormwater Best Management Practices

2013 REPORT

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Contents

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Key Points

- Existing adoption levels are low for all household stormwater best management practices (BMPs), particularly rain gardens (2.5%) and rain barrels (7.6%).
- The ratio on awareness-to-adoption is much greater than one for all practices (e.g., for every 17 households that have heard of rain gardens only one household has an existing rain garden).
- Households with flower or vegetable gardeners have much higher awareness and adoption levels for most BMPs than those who are not gardeners.
- Households with higher environmental concern for protecting the Chesapeake Bay and reducing urban runoff have significantly higher adoption levels for lawn-care practices and rain barrels than those with lower environmental concern.
- The main barriers for rain garden adoption are that the costs are too high and that households do not feel informed enough.
- Survey responses to a hypothetical rebate program for rain gardens indicate that the adoption rate more than tripled when comparing no rebate to offering a 50% rebate.
- When providing options on payment method, the majority of households would prefer to receive a cost-share payment or cash/check prior installing a rain garden, as compared to a tax credit or rebate where the payment is made only after installation.

Recommendations

- Take the time to engage with early adopters and community leaders to enhance social diffusion of BMP adoption into the larger community.
- The survey results identify gardeners and concerned environmentalists as early adopters and therefore outreach professionals should work with groups such as Master Gardeners, garden clubs, watershed groups, and other concerned citizens when planning outreach activities.

Introduction

Urban stormwater runoff is the source for 22% of phosphorus, 18% of nitrogen and 51% of sediment load for Maryland's annual load contributions into the Chesapeake Bay (MDE 2012).[1] Urban stormwater is the one sector of the total maximum daily load (TMDL) that continues to see increasing loads as more forest and agricultural lands are converted to residential and other developed uses. The Bay TMDL requires all counties to quantify and reduce those pollutant loads from urban stormwater in their watershed implementation plans (WIPs). To comply with the 2025 Bay TMDL, the estimated costs are $7.3 billion for urban stormwater restoration strategies in Maryland's Phase II WIP, with local governments being responsible for the majority of these costs (MDE 2012).[2]

To address this issue, it is critical that residents adopt stormwater best management practices (BMPs) on their properties. A significant portion of the existing nonpoint source pollution in Maryland comes directly from residential stormwater runoff, and it will be challenging to meet urban nonpoint pollution reductions solely on non-residential lands. Voluntary adoption of stormwater BMPs is essential because it is unlikely that existing homeowners will be highly regulated and mandated to implement BMPs on their private property. Local governments will need a considerable amount of community partnership to design innovative programs for awareness and incentives that motivate citizens to change behavior and practices. In particular, incentive programs from local government hold promise to increase the voluntary implementation of stormwater BMPs on existing residential properties.

This report summarizes the findings of a household survey conducted by the University of Maryland (UMD) in 2012 regarding the adoption of stormwater BMPs on residential properties. The first goal of this study is to understand the current levels of adoption and awareness for four stormwater BMPs, including rain barrels, rain gardens, low fertilizer lawn care, and conservation landscaping. We also determine which types of households have

[1] Maryland Department of Environment (MDE). 2012. "Maryland's Phase II Watershed Implementation Plan for the Chesapeake Bay TMDL" Table 2 page 9.

[2] Maryland Department of Environment (MDE). 2012. "Maryland's Phase II Watershed Implementation Plan for the Chesapeake Bay TMDL" Table 14 page 56.

higher or lower levels of adoption and awareness for each BMP according to demographics, gardening activities, environmental attitudes, and other household factors. This information should help local governments and outreach professionals target specific groups to increase adoption or awareness levels. The second goal is to develop and analyze a hypothetical rebate program for rain gardens. We analyzed the household-level response to whether they would adopt a rain garden at their own expense or when offered a rebate ranging from 10 to 50 percent. We also asked households about potential barriers to the adoption of rain gardens. This information should assist local governments in designing effective rebate programs to induce rain garden adoption. The survey focused on single-family homeowners because they represent an important group on the landscape who are decision makers on private residential lots to voluntarily adopt stormwater BMPs.

Data

In the summer of 2012, UMD conducted a survey of household stormwater BMPs in Howard County, Maryland. The survey focused on single-family homeowners with lot size less than one acre. Parcel data from the Maryland Department of Assessments and Taxation (MD Property View) was used to create a random sample of households. Letters were mailed to 10,000 households in June 2012. Each letter included an invitation to participate in an online self-administered survey questionnaire. This resulted in 1,716 respondents with completed questionnaires.

The first part of the survey asked respondents about their awareness and actual adoption of four stormwater BMPs—rain gardens, rain barrels, low fertilizer lawn care, and conservation landscaping. Awareness for each practice type was assessed based on whether the respondent had heard of the practice. Adoption was based on whether the respondent actually utilizes the practice. The survey also collected information on demographics (e.g., age, gender, education, household income, etc.), gardening activities, environmental attitudes, and other household factors. This information was used to assess which household factors may affect the likelihood of adoption and awareness for each practice.

PHOTO CREDIT: RAIN DOG DESIGNS

A rain garden is a garden with a shallow depression that collects and drains stormwater. Rain gardens slow down and soak in rain water into the ground, helping to improve water quality and reduce urban stormwater runoff.

The second part of the survey design created a hypothetical rebate program for rain gardens. Survey respondents who did not have an existing rain garden were asked about their housing size to compute the expected rain garden size and costs. Then, each respondent was asked hypothetical questions about their willingness to install a rain garden at their own cost (i.e., without rebate) and willingness to install a rain garden with a rebate. These survey responses were analyzed to assess factors that potentially affect the willingness to install a rain garden, focusing on how the level of rebate incentives would increase the rain garden adoption rate.

Table 1

Adoption and Awareness Levels for Stormwater Best Management Practices

Practice Type (n = 1,716 Households)	PERCENTAGE OF HOUSEHOLDS			Ratio on Aware : Adopt
	Adopted	Aware But Not Adopted	Not Aware	
Low Fertilizer Lawn Care	23.4	56.0	20.6	3 : 1
Conservation Landscape	10.2	50.0	39.8	6 : 1
Rain Barrel	7.6	83.5	8.9	12 : 1
Rain Garden	2.5	42.4	55.0	17 : 1

Adoption and Awareness for Stormwater Best Management Practices

Adoption Rates and Awareness Levels

Table 1 summarizes the percentage of households in our sample according to three outcomes—have adopted, aware but not adopted, and not aware—for each practice type. Adoption rates are low for all four practices, particularly rainscape practices. Only 2.5% of households have rain gardens and 7.6% have rain barrels. Meanwhile, lawn-care practices have higher adoption rates with 23.4% of households using low fertilizer lawn care and 10.2% using conservation landscaping. However, Table 1 still indicates that the majority of households have not yet adopted these stormwater BMPs, suggesting significant room for expanded use of all practices.

Awareness levels are relatively high for most practices. Table 1 shows that 91.1% of respondents have heard of rain barrels (only 8.9% not aware). Rain gardens have the lowest level of awareness, with only 45% of respondents being aware and the other 55% not aware. The majority of households have heard of the lawn-care practices, including 79.4% aware of low fertilizer lawn care and 60.2% aware of conservation landscaping.

The ratio of awareness-to-adoption is much greater than one for all practice types. Table 1 shows that rain gardens have a 17:1 ratio, meaning that for every 17 households that have heard of rain gardens only one household has an existing rain garden. A high ratio is an indication that there are substantial barriers to adoption. These barriers may be informational (e.g., lack of knowledge on types of plants in rain gardens, location of inexpensive materials or contractors, etc.) or financial (e.g. lack of rebates on installation costs). The ratio of awareness-to-adoption for lawn-care practices is lower than rainscape practices, though even low fertilizer lawn care has a ratio of 3:1.

Factors Affecting Likelihood of Adoption and Awareness

We analyzed the household-level factors that explain variation in the likelihood of both adoption and awareness for each practice type. Statistical analysis was performed using a probit

regression model. Probit models are commonly used when there is a discrete outcome. That is, the household has either adopted or not adopted the practice. Hence, the probit model is used to estimate the likelihood of adoption as a function of household-level characteristics (e.g., age, education, etc.). Table 2 shows the household factors that are positively or negatively associated with adoption by practice type. This statistical analysis is similarly used to assess which factors affect the likelihood of awareness. (See Appendix for more detailed statistical analysis results on probit model coefficient estimates on adoption in Table A1 and awareness in Table A2).

Surprisingly, few demographic and neighborhood characteristics in Table 2 are significantly associated with explaining variation in the adoption rates. High income households (> $150,000 in annual income) have relatively higher rates of adoption for both low fertilizer lawn care and conservation landscaping. Additionally, long-term residents with 10 or more years living in the neighborhood had higher rates of adoption for low fertilizer lawn care and conservation landscaping. Respondents with a college degree had significantly higher levels of awareness of rain gardens compared to those respondents without college a degree. However, a college degree did not significantly affect the rate of adoption for all practices. Households with children had similar levels of awareness and adoption compared to households without children for all practice types.

Gardening activities are among the most important factors explaining adoption rates, particularly flower gardeners. Flower gardeners are associated with higher rates of adoption for rain barrels, low fertilizer lawn care, and conservation landscaping. Households with flower gardeners also have higher levels of awareness for most practices (rain gardens, rain barrels, and conservation landscaping) compared to those households that are not flower gardeners. Vegetable gardeners similarly have higher rates of adoption and awareness for most practices relative to those who are not vegetable gardeners.

Environmental attitudes are also highly related to the awareness and adoption rates. Environmental attitudes were measured based on household responses to provide ratings to two

PHOTO CREDIT: AMANDA ROCKLER

Rain barrels conserve water by collecting rain water from roofs. Rain barrels can then be used for watering gardens and washing cars.

Table 2

Factors Affecting the Likelihood of Awareness and Adoption for Stormwater Best Management Practices

VARIABLE	AWARENESS				ADOPTION			
	Low Fertilizer	Conservation Landscape	Rain Barrel	Rain Garden	Low Fertilizer	Conservation Landscape	Rain Barrel	Rain Garden
Demographic Characteristics								
Age (65+ Years Old)	0	0	0	0	0	0	0	0
Male	0	0	0	0	0	0	0	0
College Degree	0	0	0	+	0	0	0	0
Household Income								
Income ($100K-150K)	0	0	0	0	0	0	0	0
Income (> $150K)	0	0	0	0	+	+	0	0
Children In Household	0	0	0	0	0	0	0	0
Household Size	0	0	- -	0	0	0	0	0
Neighborhood Characteristics								
Columbia Resident	0	0	0	++	0	0	0	0
Long-Term Resident (> 10 Yrs)	++	0	+	0	++	+	0	0
Large Lot (> 0.5 Acres)	0	0	0	+	0	0	0	0
Gardening Characteristics								
Vegetable Garden	0	0	+	++	0	++	++	0
Flower Garden	0	++	+	++	++	++	++	0
Environmental Attitudes								
Chesapeake Bay [a]	++	++	++	++	++	++	0	0
Urban Runoff [b]	++	++	++	+	+	++	++	0

[a] "Chesapeake Bay" indicates response to "The Chesapeake Bay and local streams are very important to me personally" (1= strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

[b] "Urban runoff" indicates response to "Protecting local streams and the Chesapeake Bay in your area from runoff from homes is the…" (1 = sole responsibility of government, 2 = mainly responsibility of government, 3 = equal responsibility for individuals and government, 4 = mainly responsibility of individuals, 5 = sole responsibility of individuals)

++ = Positive Relationship at 1% Level
+ = Positive Relationship at 5% Level
0 = No Significant Relationship
- - = Negative Relationship at 1% Level
- = Negative Relationship at 5% Level

main statements. First, households were asked: "The Chesapeake Bay and local streams are very important to me personally" (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree). Second, they were asked: "Protecting local streams and the Chesapeake Bay in your area from runoff from homes is the…" (1 = sole responsibility of government, 2 = mainly responsibility of government, 3 = equal responsibility for individuals and government, 4 = mainly responsibility of individuals, 5 = sole responsibility of individuals). Table 2 shows that environmental attitudes were strongly associated with higher levels of awareness for all four practices. Furthermore, households with a higher rating on whether the Chesapeake Bay is important also had significantly higher rates of adoption for low fertilizer lawn care and conservation landscaping. Similarly, households that think individuals are responsible for protecting the Chesapeake Bay and local streams from urban runoff had higher rates of adoption for low fertilizer lawn care, conservation landscaping, and rain barrels.

The adoption rate for rain gardens is the only practice that is not significantly associated with environmental attitudes and flower gardeners. In fact, none of the household factors are significant for the adoption of rain gardens. However, the likely reason is that there are a small number of households with rain gardens (only 43 existing rain gardens versus 1,673 without rain gardens). When there are a small number of adopters, then there is limited available data to determine which household characteristics are statistically related to adoption. The next section discusses analysis on household responses to a hypothetical rebate program for rain gardens. This provides a richer data set to analyze factors affecting the adoption of rain gardens.

Incentives and Barriers for Rain Garden Adoption

Hypothetical Rebate Program for Rain Gardens

This section provides the results of survey responses to a hypothetical rebate program for rain garden adoption. A hypothetical approach was needed to analyze the willingness to adopt because there was no significant rebate program already established in the study region when the survey was conducted in June 2012. However, the local government is interested in understanding how the rain garden adoption rate would increase in response to implementing a rebate program. Only the 1,673 households without existing rain gardens were asked about their hypothetical responses to rebate incentives to install a rain garden (not the 43 households with existing rain gardens).

These households without an existing rain garden were shown a brochure in the online survey with background information on the purpose and maintenance of rain gardens. Then, the expected rain garden size and costs were estimated based on each respondent's housing size information. Specifically, the housing footprint was computed from the house size in square feet and number of stories. The expected rain garden size was calculated based on a one-inch rainfall event, house footprint, and assumed rain garden depth of 5 inches.[3] The expected rain garden cost was determined according to the rain garden size in square feet and an assumed installation cost of $9 per square foot.[4]

[3] Dietz, M. and K. Filchak. 2004. "Rain Gardens in Connecticut: A Design Guide for Homeowners". University of Connecticut Cooperative Extension System. http://nemo.uconn.edu/publications/rain_garden_broch.pdf

[4] Clark. M. and G. Acomb. 2008. "Bioretention Basins/Rain Gardens". University of Florida Extension. http://buildgreen.ufl.edu/Fact_sheet_Bioretention_Basins_Rain_Gardens.pdf

Consider, for example, a respondent that says their house size is 2,000 square feet with two stories, meaning that the house footprint is 1,000 square feet. The expected rain garden size is 200 square feet, using the 5:1 ratio on rain garden depth to house foot print to accommodate the typical one-inch rainfall event. The expected rain garden cost is $1,800 for this household if they install the rain garden without a rebate. In the survey, the overall range in the expected rain garden size was 70 to 500 square feet (cost of $630 to $4,500), with an average size of 200 square feet (cost of $1,800).

The respondent was then asked two hypothetical questions regarding their willingness to adopt a rain garden, according to their specific expected size and costs. The first question asked was: "If installing a rain garden could help improve the quality of the [Chesapeake Bay/local streams], would you install a rain garden at your home in the next planting season?" Basically, this asks whether the respondent would adopt a rain garden at their own expense (i.e., without rebate). The phrase "helps the [Chesapeake Bay/ local streams]" was randomly assigned to survey respondents, where half the respondents saw "helps the Chesapeake Bay" and the other half saw "helps local streams". The rationale was to assess whether helping the Chesapeake Bay versus local streams had a different motivating effect on the willingness to adopt a rain garden. Then, for only those respondents who replied that they would not adopt a rain garden at their own expense, a second question was asked: "If you were offered an incentive equal to [10, 20, 30, 40, 50]% of the cost of the rain garden, would you install a rain garden at your home?" The rebate percentage offered from 10 to 50 percent was randomly assigned in this survey question.

Table 3 summarizes the results for the two survey questions about willingness to adopt for the overall sample of 1,673 respondents. There were 279 respondents (16.7%) who said they would be willing to install a rain garden at their own cost (without rebate). Another 674 respondents (40.3%) were willing to install a rain garden with the rebate offered. The remaining 720 respondents (43.0%) were not willing to install a rain garden even when offered a rebate.

Factors Affecting the Likelihood of Rain Garden Adoption

We analyzed the household-level factors that affect the willingness to adopt a rain garden, with an emphasis on the response to the rebate level offered. Table 4 shows the household factors

Table 3

Survey Responses to Hypothetical Rebate Program for Rain Gardens

SURVEY RESPONSE	NUMBER OF HOUSEHOLDS (%)
Willing to adopt rain garden at own cost (without rebate)	279 (16.7%)
Willing to adopt rain garden with rebate	674 (40.3%)
Not willing to adopt rain garden with rebate	720 (43.0%)
TOTAL	1,673 (100.0%)

Table 4

Factors Affecting the Willingness to Adopt for Hypothetical Rebate Program for Rain Gardens

VARIABLE	ADOPT AT OWN COST	ADOPT WITH REBATE
Rain Garden Characteristics		
Rain Garden Size	- -	- -
Rebate Amount ($)	na	++
Prior Awareness Of Rain Garden	+	0
Ches Bay/Local Streams Treatment	0	0
Demographic Characteristics		
Household Income ($1000)	++	0
Age (65+ Years Old)	0	-
Male	0	-
College Degree	0	0
Neighborhood Characteristics		
Long-Term Resident (10+ Years)	0	0
Gardening Characteristics		
Vegetable Garden	0	0
Flower Garden	++	++
Environmental Attitudes		
Chesapeake Bay [a]	++	++
Urban Runoff [b]	0	0

[a] "Chesapeake Bay" indicates response to "The Chesapeake Bay and local streams are very important to me personally" (1= strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

[b] "Urban runoff" indicates response to "Protecting local streams and the Chesapeake Bay in your area from runoff from homes is the…" (1 = sole responsibility of government, 2 = mainly responsibility of government, 3 = equal responsibility for individuals and government, 4 = mainly responsibility of individuals, 5 = sole responsibility of individuals)

++ = Positive Relationship at 1% Level **- - = Negative Relationship at 1% Level**

+ = Positive Relationship at 5% Level **- = Negative Relationship at 5% Level**

0 = No Significant Relationship

that are positively or negatively associated with the likelihood of rain garden adoption. Statistical analysis was performed based on a probit regression model, analogous to the probit model results on adoption in Table 2. However, Table 4 shows the results on household factors that affect the willingness to adopt at own cost (left side) and willingness to adopt with rebate (right side). (See Appendix Table A3 for more detailed statistical results on probit model coefficient estimates).

Table 4 shows that the rain garden size has a negative effect on both the willingness to adopt at own cost and willingness to adopt with a rebate. Note that rain garden size is essentially the rain garden installation cost because, in this survey, the expected cost is just the rain garden size multiplied by $9 per square foot. Hence, Table 4 indicates that an increase in the rain garden size would lower the likelihood that a household is willing to adopt the rain garden at their own cost (i.e., without rebate). The results also suggest that an increase in the rain garden size would lower likelihood that a household is willing to adopt with a rebate. This is logical because each additional square foot of rain

PHOTO CREDIT: AMANDA ROCKLER

Conservation landscaping is a type of landscaping that replaces lawn with native plants. It benefits the environment by improving water quality, reducing fertilizer needs, and providing wildlife habitat.

garden size increases the rain garden cost, such that the rebate level offered compensates some percentage of this expense (ranging from 10 to 50 percent) but the household still typically bears a significant portion of the cost.

That said, the rebate amount has a strong positive effect on the willingness to adopt with a rebate (Table 4). Hence, the rain garden adoption rate does increase significantly as the rebate amount offered rises. Prior awareness of rain gardens also has a positive relationship with the willingness to adopt at own cost. This suggests that promotional campaigns to increase awareness of rain gardens would increase the likelihood of rain garden adoption. The randomly assigned treatment variable was not significant for the phrase would you install a rain garden if it "helps the Chesapeake Bay" versus "helps local streams". This suggests that motivations to help the Bay versus local streams were similar.

Household income has a positive effect on the willingness to adopt at own cost, but it does not affect the willingness to adopt with a rebate. This result is expected that households with higher annual income would be more likely to adopt at their own expense. Other demographic factors in Table 4 have a significant effect on the willingness to adopt with a rebate, but not the willingness to adopt at own cost. Male respondents were less likely to be willing to adopt with a rebate compared to female respondents. Senior citizens (> 65 year old) were also less willing to adopt with a rebate relative to respondents aged 65 years or younger.

Flower gardeners were more likely to adopt a rain garden both at their own cost and with a rebate. Vegetable gardeners, however, were not significantly more likely to adopt a rain garden. Regarding environmental attitudes, households who said that the Chesapeake Bay and local streams were important to them personally were also more likely to adopt a rain garden at their own cost and with a rebate.

Table 5

Reasons for Choosing Not to Adopt a Rain Garden

IMPORTANT FACTORS	NO ADOPTION EVEN WITH REBATE (n=720)
Costs are still too high.	59%
I don't feel informed enough.	44%
There is no room to put a rain garden on my property.	20%
I do not enjoy gardening or landscaping.	19%
Building a rain garden seems difficult. I need some technical assistance or advice.	17%
Rain garden will reduce space for activities like barbeque or for children to play.	14%
I would like advice and assistance from county/ state extension office or other organizations.	13%
Rain gardens would not help restore local streams in my area very much.	11%
Rain gardens would not help restore the Chesapeake Bay very much.	8%
Homeowners association would not encourage or allow rain gardens.	8%
I do not like how rain gardens look.	5%
Rain gardens may decrease my property values.	4%
My neighbors and friends would not like it.	2%

The regression analysis of the survey responses allows us to estimate the adoption rate predicting the share of households willing to adopt a rain garden for any given rebate level offered. Figure 1 shows that share of households willing to install a rain garden as a function of the percentage of the rebate level offered. This graph shows that an estimated 17% of households would adopt a rain garden at their own cost (i.e., rebate = 0%). The adoption rate increased to an estimated 58% when a 50% rebate was offered. Hence, when comparing the adoption rate for no rebate versus the 50% rebate, it led to about three times the adoption rate of rain gardens.

Barriers for Installing Rain Gardens

In addition to the quantitative regression analysis above, it is important to understand the qualitative factors that are barriers for the adoption of rain gardens. Table 5 shows the responses to reasons for not installing a rain garden for the subgroup of respondents who replied that they would not adopt a rain garden even with a rebate. The respondents were provided a list of potential reasons for choosing not to install a rain garden and were asked to check all that apply. Table 5 shows that the most important reason was that the costs are still too high (59%). Hence, while the hypothetical rebate program randomly offered financial incentives ranging from a 10% to 50% rebate, many respondents still thought that larger rebates would be needed to encourage them to adopt a rain garden. Another important reason was that respondents did not feel informed enough (44%). This suggests that informational campaigns on rain gardens

The majority of households would prefer to receive the incentive payment upfront before installing a rain garden.

would be helpful, but further research is needed to understand what types of information are creating the barriers (i.e., lack of info on rain garden design, suitable contractors, types of plants, etc.). Table 5 also indicates which reasons are not important barriers. For example, the visual characteristics of rain gardens do not seem to pose a significant barrier since few respondents indicated that they do not like the look of rain gardens (5%) or that rain gardens would decrease their property value (4%).

We also investigated the qualitative reasons for choosing to install a rain garden. Table 6 summarizes the relative importance of the reasons for choosing to install a rain garden for three subgroups—those with existing rain gardens, those willing to adopt at own cost, and those willing to adopt with a rebate. Table 6 indicates that an important reason for a household being willing to adopt a rain garden is that they already enjoy gardening and landscaping activities. This is expected since the installation and maintenance costs would be lower if the household is willing to do the work rather than hiring landscaping contractors. Table 6 also indicates that an important reason for choosing to install a rain garden is that they think it will help restore the Chesapeake Bay and local streams. Hence, the qualitative factors in Table 6 appear to confirm the quantitative regression analysis results in Table 4, showing that gardening activities and environmental attitudes are important household factors that explain higher rates of rain garden adoption for these types of households.

We also asked about the preferred payment methods for those households who are willing to adopt with an incentive. Basically, these 674 respondents who said they would only adopt with an incentive were asked: "If you were given the option to choose, how would you prefer to receive the money?". The "cost-share" option was selected for 35% of households, in which the household would pay part of the cost out-of-pocket with the rest covered by the funding source. The "cash/check" option was chosen by 29% of households, where the household would pay part of the cost and receive a check or cash upon application. Meanwhile, a "tax credit" option was preferred by 20% of households, where the household pays all the cost out-of-pocket and then receives a one-time tax credit applied in the following tax year. The "rebate" option was selected by 15% of households, where the household pays all the cost out-of-pocket and then later receives a partial refund from the funding source. In sum, this suggests that the majority of households would prefer to receive the incentive payment upfront

before installing a rain garden. That is, approximately two-thirds of households preferred the "cost-share" or "cash/check" options with up-front payment prior to installation, as compared to one-third of households that preferred the "tax credit" or "rebate" options where the payment is made only after installation.

Table 6

Reasons for Choosing to Adopt a Rain Garden for Household Subgroups with Existing Rain Gardens, Willing to Adopt at Own Cost, and Willing to Adopt with Rebate

IMPORTANT FACTORS	EXISTING (n = 43)	ADOPT AT OWN COST (n = 279)	ADOPT WITH REBATE (n = 674)
I enjoy gardening or landscaping.	63%	54%	42%
Rain gardens can help restore the Chesapeake Bay.	54%	88%	82%
Rain gardens can help restore local streams in my area.	50%	84%	73%
Maintenance of a rain garden is minimal.	48%	66%	61%
Rain gardens look great.	44%	46%	38%
Building a rain garden is not too difficult.	33%	57%	43%
Rain gardens can improve or keep up my property value.	10%	51%	58%
My neighbors have rain gardens too.	10%	5%	5%
The homeowners association, city or other organization is encouraging rain gardens.	2%	20%	24%
My neighbors like rain gardens.	0%	6%	6%
Funding provision reduced cost of installing rain garden.	n/a	n/a	60%

Conclusions

Compliance with the TMDL and other water quality regulations is likely to increase the need for the promotion and adoption of household-level stormwater BMPs. Although many local governments do not have ordinances requiring stormwater BMPs on private property, providing incentive programs or promotional campaigns can increase the voluntary adoption for retrofit BMPs on existing residential properties. Achieving more widespread BMP adoption may require expansion of cost-share programs both in terms of funding levels and eligibility of BMP types. This survey provides baseline information on the current levels of adoption and awareness.

It was quite clear from the survey responses that incentives matter. Respondents were three times more likely to install a rain garden when offered a 50% rebate than without a rebate.

The main results of the survey indicate that the awareness level was much higher than the adoption level for each of the four BMPs surveyed (Table 1). Only 2.5% of households surveyed had installed a rain garden, even though 45% of household were aware of rain gardens. Low fertilizer lawn care, the most common of the four BMPs, was only adopted by 23% of the households surveyed. The most important factors affecting the likelihood of adoption were related to gardening activities and environmental attitudes toward the Chesapeake Bay and urban runoff (Table 2). Gardeners and concerned environmentalists had a significantly higher than average likelihood of adoption for lawn care practices and rain barrels. Surprisingly, adoption levels for BMPs did not vary significantly according to most demographic factors (e.g., age, gender, education) for the households surveyed.

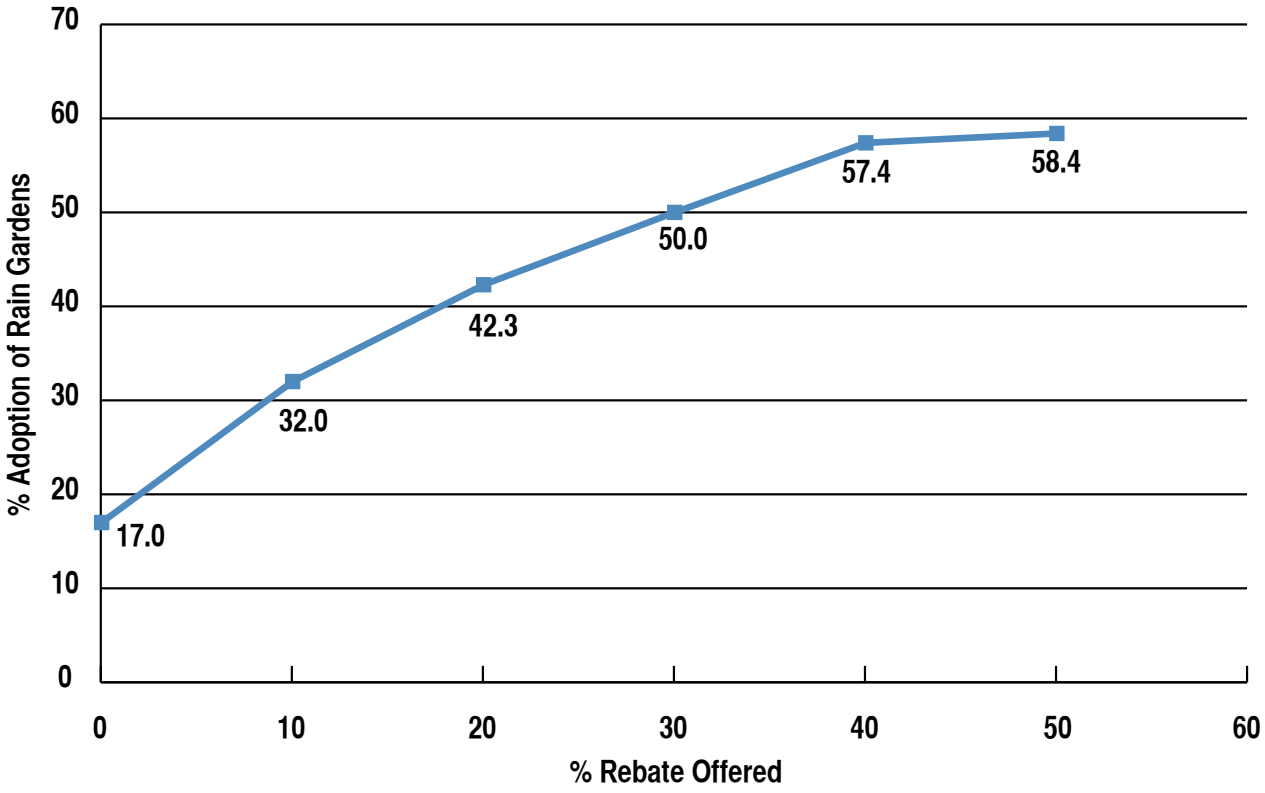
The hypothetical rain garden rebate program was developed because, at the time of the survey in 2012, there was not a significant existing incentive program in our study area (Howard County). It was quite clear from the survey responses that incentives matter. Respondents were three times more likely to install a rain garden when offered a 50% rebate than without a rebate (Figure 1). Higher income households were more likely to adopt rain garden at their own expense. Flower gardeners were also more likely to adopt a rain garden.

These results may be significant in how outreach professionals engage citizens about BMP adoption. To understand the complexity of social dynamics that lead to adoption, practitioners need to understand the barriers and benefits associated with the requested behavior change and a vast array of other defining household and community characteristics. One method for targeting an audience is to find the early adopters who are the community opinion leaders and well-connected socially and locally; have the resources and risk tolerance to try new things; and are the people who are watched by others. Outreach professionals may be able to tailor their programming and utilize the early adopters who can then build a more robust community network. The survey identifies gardeners and concerned environmentalists as early adopters and therefore it would behoove outreach professionals to work with groups such as Master Gardeners, garden clubs, watershed groups, and other concerned citizens when planning outreach activities.

In conclusion, this survey examines the current factors affecting adoption of BMPs and the response to hypothetical rebates for rain gardens. Further research is needed to improve our understanding of household behavior change and the role of incentive programs. First, this

Figure 1:

Share of Households Willing to Adopt Rain Garden by Percentage Rebate Offered



survey focused on quantitative analysis to assess household factors affecting the likelihood of adoption. It would also be helpful to conduct complimentary assessments on the specific barriers and social marketing aspects that are often more suitable to qualitative surveys with open-end questions. Second, our analysis was focused in central Maryland on households in Howard County. There are currently low adoption levels for all BMPs, despite this being a population with relatively high income and education levels. It would be helpful to conduct similar surveys in other regions in Maryland to understand the baseline adoption levels as a benchmark to evaluate our progress as we attempt to meet the future TMDL requirements. Lastly, although we needed to develop a hypothetical rebate program at the time of this survey, actual incentive programs are likely to become increasingly more common as local governments attempt to encourage voluntary BMP adoption. In the future, it will be helpful to analyze the actual response to these rebate programs, with an aim to improve program design.

Appendix

Table A1:

Probit Regression Model on Household Factors Affecting the Likelihood of Adoption of Stormwater Best Management Practices

Variable	LOW FERTILIZER		CONSERVATION LANDSCAPE		RAIN BARREL		RAIN GARDEN	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Demographic Characteristics								
Age (65+ Years Old)	-0.046	0.097	0.114	0.115	-0.139	0.139	0.242	0.166
Male	-0.076	0.075	-0.036	0.285	-0.062	0.104	0.060	0.144
College Degree	0.115	0.103	-0.015	0.129	-0.230	0.130	0.168	0.219
Household Income								
Income ($100K-150K)	-0.021	0.111	0.176	0.145	0.095	0.147	-0.045	0.226
Income (> $150K)	0.213*	0.108	0.323*	0.141	-0.050	0.150	0.271	0.216
Children In Household	-0.066	0.050	-0.027	0.067	-0.077	0.070	-0.175	0.112
Household Size	-0.013	0.040	-0.062	0.054	-0.006	0.052	0.065	0.069
Neighborhood Characteristics								
Columbia Resident	0.067	0.071	0.059	0.090	-0.032	0.100	0.234	0.140
Long-Term Resident (> 10 Yrs)	0.430**	0.087	0.257*	0.112	-0.002	0.116	-0.155	0.164
Large Lot (> 0.5 Acres)	0.114	0.082	0.035	0.102	0.002	0.113	0.166	0.154
Gardening Characteristics								
Vegetable Garden	0.118	0.074	0.376**	0.087	0.600**	0.096	0.156	0.142
Flower Garden	0.337**	0.095	0.544**	0.142	0.591**	0.167	0.400	0.222
Environmental Attitudes								
Chesapeake Bay [a]	0.178**	0.038	0.147**	0.048	0.052	0.050	0.066	0.068
Urban Runoff [b]	0.095*	0.040	0.160**	0.052	0.155**	0.535	0.043	0.087
Intercept	-2.487**	0.262	-3.266**	0.361	-2.613**	0.369	-3.248**	0.585

[a] "Chesapeake Bay" indicates response to "The Chesapeake Bay and local streams are very important to me personally" (1= strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

[b] "Urban runoff" indicates response to "Protecting local streams and the Chesapeake Bay in your area from runoff from homes is the…" (1 = sole responsibility of government, 2 = mainly responsibility of government, 3 = equal responsibility for individuals and government, 4 = mainly responsibility of individuals, 5 = sole responsibility of individuals)

Table A2:

Probit Regression Model on Household Factors Affecting the Likelihood of Awareness of Stormwater Best Management Practices

Variable	LOW FERTILIZER		CONSERVATION LANDSCAPE		RAIN BARREL		RAIN GARDEN	
	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error	Coefficient	Std. Error
Demographic Characteristics								
Age (65+ Years Old)	0.077	0.105	-0.066	0.090	0.195	0.148	-0.168	0.090
Male	0.012	0.076	-0.072	0.068	0.039	0.095	-0.011	0.068
College Degree	0.115	0.102	-0.071	0.093	0.091	0.130	0.191*	0.093
Household Income								
Income ($100K-150K)	0.011	0.110	0.082	0.100	-0.009	0.143	0.145	0.100
Income (> $150K)	0.156	0.111	0.007	0.098	0.068	0.143	0.018	0.098
Children In Household	-0.018	0.050	-0.026	0.046	0.030	0.060	-0.022	0.045
Household Size	-0.058	0.041	-0.001	0.037	-0.131**	0.049	-0.001	0.037
Neighborhood Characteristics								
Columbia Resident	0.099	0.074	0.041	0.065	0.071	0.093	0.284**	0.065
Long-Term Resident (> 10 Yrs)	0.233**	0.082	0.137	0.074	0.217*	0.101	0.043	0.074
Large Lot (> 0.5 Acres)	0.023	0.084	0.110	0.075	-0.124	0.105	0.167*	0.074
Gardening Characteristics								
Vegetable Garden	-0.084	0.076	0.103	0.068	0.213*	0.101	0.225**	0.067
Flower Garden	0.146	0.086	0.286**	0.078	0.238*	0.102	0.335**	0.080
Environmental Attitudes								
Chesapeake Bay [a]	0.116**	0.035	0.098**	0.032	0.150**	0.042	0.132**	0.032
Urban Runoff [b]	0.173**	0.042	0.097**	0.036	0.179**	0.055	0.077*	0.036
Intercept	-0.505*	0.256	-0.723**	0.231	0.019	0.309	-1.615**	0.234

[a] "Chesapeake Bay" indicates response to "The Chesapeake Bay and local streams are very important to me personally" (1= strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

[b] "Urban runoff" indicates response to "Protecting local streams and the Chesapeake Bay in your area from runoff from homes is the…" (1 = sole responsibility of government, 2 = mainly responsibility of government, 3 = equal responsibility for individuals and government, 4 = mainly responsibility of individuals, 5 = sole responsibility of individuals)

Table A3:

Probit Model on Factors Affecting the Willingness to Adopt Rain Garden at Own Cost and with Rebate

Variable	ADOPT AT OWN COST		ADOPT WITH REBATE	
	Coefficient	Std. Error	Coefficient	Std. Error
Rain Garden Characteristics				
Rain Garden Size	-0.0024**	0.0008	-0.0042**	0.0008
Rebate Amount ($)	na	na	0.0009**	0.0001
Prior Awareness Of Rain Garden	0.1941*	0.0781	-0.0148	0.0723
Ches Bay/Local Stream Treatment	0.0651	0.0756	0.0481	0.0695
Demographic Characteristics				
Household Income ($1000)	0.0024**	0.0009	0.0015	0.0008
Age (65+ Years Old)	-0.1371	0.1155	-0.2444*	0.0971
Male	-0.0539	0.0828	-0.1592*	0.0764
College Degree	-0.0044	0.1112	0.0346	0.1019
Neighborhood Characteristics				
Long-Term Resident (10+ Years)	-0.1467	0.0844	-0.0525	0.0807
Gardening Characteristics				
Vegetable Garden	-0.1388	0.0837	-0.0551	0.0775
Flower Garden	0.4088**	0.1061	0.2674**	0.0856
Environmental Attitudes				
Chesapeake Bay [a]	0.2635**	0.0437	0.1792**	0.0360
Urban Runoff [b]	0.0347	0.0434	-0.0019	0.0406
Intercept	-2.2154**	0.3223	-0.5551*	0.2798

Significance at the 1%, and 5% level are represented by ** and * respectively.

[a] "Chesapeake Bay" indicates response to "The Chesapeake Bay and local streams are very important to me personally" (1= strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

[b] "Urban runoff" indicates response to "Protecting local streams and the Chesapeake Bay in your area from runoff from homes is the…" (1 = sole responsibility of government, 2 = mainly responsibility of government, 3 = equal responsibility for individuals and government, 4 = mainly responsibility of individuals, 5 = sole responsibility of individuals)

This publication, Adoption of Household Stormwater Best Management Practices (EB-413), is a series of publications of the University of Maryland Extension and the Center for Agricultural and Natural Resource Policy. The information presented has met UME peer review standards, including internal and external technical review. For more information on related publications and programs, visit: http://agresearch.umd.edu/canrp. Please visit http://extension.umd.edu/ to find out more about Extension programs in Maryland.

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