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Mitigating Stigma Associated with Recycled Water: Aquifer Recharge and Trophic Levels

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ABSTRACT

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Stigmatization of water and food products can constrain markets and prevent the implementation of scientifically safe solutions to environmental problems, such as water scarcity. Recycled water can be a cost-effective, dependable, and safe solution to water shortages, however, consumers generally either require a large reduction in price to purchase and eat products made with recycled water or reject such products outright. If emerging agricultural technologies, such as recycled water are to be used to address growing water shortages worldwide, policymakers and industry stakeholders must identify effective strategies for mitigating stigma. Using a field experiment involving 314 adult participants, we test the effectiveness of two stigma-mitigating techniques that have not previously been explored. Our analysis suggests that passing recycled water through a natural barrier, such as an aquifer, removes the stigma consumers would otherwise attach to it. We also find that the trophic level an organism occupies in the food chain influences stigmatizing behavior. The greater the steps in the food chain between an organism and the use of recycled water, the less it is stigmatized. A plant crop used for food possesses the same qualities and contagions as the water with which it is irrigated but a food animal that eats that crop does not, or at least not to the same extent. These results have important implications for efforts to promote large-scale potable and non-potable recycled water projects and the use of recycled water in the agricultural industry.

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Abstract

Stigmatization of water and food products can constrain markets and prevent the implementation of scientifically safe solutions to environmental problems, such as water scarcity. Recycled water can be a cost-effective, dependable, and safe solution to water shortages, however, consumers generally either require a large reduction in price to purchase and eat products made with recycled water or reject such products outright. If emerging agricultural technologies, such as recycled water are to be used to address growing water shortages worldwide, policymakers and industry stakeholders must identify effective strategies for mitigating stigma. Using a field experiment involving 314 adult participants, we test the effectiveness of two stigma-mitigating techniques that have not previously been explored. Our analysis suggests that passing recycled water through a natural barrier, such as an aquifer, removes the stigma consumers would otherwise attach to it. We also find that the trophic level an organism occupies in the food chain influences stigmatizing behavior. The greater the steps in the food chain between an organism and the use of recycled water, the less it is stigmatized. A plant crop used for food possesses the same qualities and contagions as the water with which it is irrigated but a food animal that eats that crop does not, or at least not to the same extent. These results have important implications for efforts to promote large-scale potable and non-potable recycled water projects and the use of recycled water in the agricultural industry.

Keywords: Stigma, recycled water, aquifer recharge, trophic levels

JEL Classification: D12; Q15; Q18

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Stigmatization of water and food products by consumers can depress demand (Edelstein, 2004; Roth, 2007), lead to price shocks, and limit the tools available to policymakers, agricultural producers, and the food industry to respond to environmental challenges. Stigma arises when consumers perceive food products as risky to use or consume even in the face of overwhelming scientific evidence that they are safe (Gregory, Flynn and Slovic, 1995; Walker, 2001; Ellen and Bone, 2008; Potts and Nelson, 2008; Kanter, Messer, and Kaiser, 2009). For example, news reports that labeled lean finely textured beef (LFTB) as "pink slime" in March 2012 raised consumer concerns about its safety, resulting in a 42% drop in the price of LFTB by early April (Greene, 2012; Yadavalli and Jones, 2014). Similarly, consumers' perceptions of risks associated with consuming foods produced using genetically modified (GM) organisms has led to severe restrictions and, in some cases, bans of GM technologies, such as in Europe (Nelson, 2001; Rosendal, 2005; Tiberghien, 2009; Messer et al. 2017; McLoughlin, 2019), despite the important role drought-resistant GM food crops can play in addressing water shortages. Consumer concerns have likewise hampered other sustainable solutions to water scarcity, including the use of recycled water – wastewater treated to standards that make it safe for drinking and irrigation – for potable and non-potable uses. Potable uses are particularly stigmatized. Projects to provide potable water using treated wastewater were derailed in the United States and Australia because of the "yuck factor" people associated with the water, perceiving it as going directly from toilets to taps (Dolnicar and Hurlimann, 2009; Uhlmann and Head, 2011; Sedlak, 2014; Morgan and Grant-Smith, 2015; Rozin et al., 2015). Even the use of recycled water for irrigation has received little acceptance. Studies have shown that U.S. consumers either require a large reduction in price to purchase foods grown with recycled water or rejected the foods outright (Li, McCluskey and Messer, 2018; Savchenko et al., 2018; Ellis et al., 2019).

Alternative sources of drinking and irrigation water are desperately needed as 71% of the world's population, including 130 million people in the United States, currently suffer from moderate to severe water scarcity at least one month a year (Mekonnen and Hoekstra, 2016). Water shortages have an outsized effect on the agricultural industry, as it is responsible for 70% of freshwater consumption around the world (World Water Assessment Programme, 2016) and as much as 90% in parts of the western United States. Conditions are expected to worsen as climate change continues to unfold, causing shifts in global weather patterns that will exacerbate differences between wet and dry regions (Intergovernmental Panel on Climate Change, 2014). All the while, global demand for fresh water is increasing as the world's population grows, living standards rise, and the number of irrigated acres expands to compensate for a larger and wealthier global population (Mekonnen and Hoekstra, 2016). Cape Town, South Africa, in 2018 showcased the severity of water scarcity when its drinking water supplies nearly ran dry and affected farmers lost up to 25% of their crops (Mahr, 2018). The Cape Town water crisis also highlighted the sensitivity of water supplies to changing conditions and the risk inherent in complacency. In 2014, Cape Town's reservoirs were full, and water conservation measures had proven so successful that city officials and residents saw no need to diversify their water supplies (Onishi and Sengupta, 2018).

Recycled water can be a feasible and cost-effective means to satisfy the growing demand for water (Chen et al., 2013) because it can provide a dependable and safe alternative source. However, the stigma attached to recycled water is a significant and often the primary barrier to its widespread use for drinking and irrigation (Hartley, 2006; Lazarova et al., 2013; Ormerod and Scott, 2013). Therefore, it is critical from the perspective of policymakers and industry stakeholders to identify strategies that can effectively alleviate consumer concerns about various uses of recycled water.

In this paper, we analyze data from an economic field experiment involving 314 adult participants from the mid-Atlantic region of the United States. We test the effectiveness of two strategies to mitigate stigma associated with recycled water – passage through a natural barrier (an aquifer) and information about the trophic level of the food products. Our experimental design allows us to measure the effectiveness of the techniques in a non-hypothetical, demand-revealing setting and the results suggest that both methods are effective at mitigating stigma.

First, we evaluate whether passing recycled water through a natural barrier, such as an aquifer, alleviates the stigma associated with it. Such indirect potable reuses, which involve injecting recycled water into an underground aquifer, where it is stored for some time before being withdrawn and undergoing processing in a traditional water treatment plant, are not new. Recycled water has been used to recharge ground water supplies in California since the 1960s (California Association of Sanitation Agencies (CASA), 2019) as part of the state's efforts to address saltwater intrusions in local aquifers and combat the effects of drought. While several indirect potable reuse projects have been implemented in the United States, they have had mixed success. Some, such as the East Valley Water Recycled Project in Los Angeles, California, failed miserably due to public opposition (Lim and Safford, 2019) while others, such as the Groundwater Replenishment system in Orange County, California, are currently operating (Orange County Water District, 2019).

Despite some successful indirect potable reuse projects, it is not clear whether passing recycled water through a natural barrier reduces consumer concerns, information that is necessary for the success of future large-scale recycled water projects. We are not aware of any prior study that has explored the stigma-mitigating effects of passing recycled water through a physical environmental barrier in a non-hypothetical experimental setting in which the study participants' decisions have real outcomes.

Second, we examine whether the trophic level of a food product affects consumers' concerns about recycled water. Trophic level refers to an organism's place in the food chain. Plants are categorized as trophic level one because they generally do not consume other living organisms. Cattle, being herbivores, are categorized as trophic level two as they consume organisms from tropic level one. The sequence of plants being irrigated with recycled water and then consumed by cattle represents a type of processing that increases the degree of separation between recycled irrigation water and the beef and dairy products produced from the cattle. There is some evidence that a greater number of processing steps, between the food a consumer purchases and the recycled water used in its production, can have a destigmatizing effect. Savchenko et al. (2019b), for example, showed that simple processing, such as drying and liquefying, could alleviate some consumers' concerns about the use of recycled irrigation water for food products. Lease, MacDonald, and Cox (2014) likewise found that cooking meatballs prepared with recycled water removed the stigma. Thus, a product's trophic level could act as a stigma-mitigating barrier in consumers' minds against the negative effects they associate with recycled water. To our knowledge, this is the first study to test the effect of a product's trophic level on the stigma attached to it because of the use of recycled water in its production.

Prior studies have identified disgust, safety concerns, and a natural tendency to avoid unfamiliar products (neophobia) as significant factors contributing to the stigmatization of recycled water and consumer responses to its potable and non-potable uses (Savchenko et al., 2019a). Using functional magnetic resonance imaging, Ellis et al. (2019) provided neuroeconomic evidence that disgust is part of consumers' reactions to recycled water and that it is not readily dissipated by behavioral interventions such as videos on the benefits of recycled water. Instead, disgust tends to linger, and mitigation strategies appear to make other aspects of consumers' decision processes, such as how the choice affects society and their self-images, more important. Wester et al. (2016) similarly found that how recycled water was framed and presented to consumers determined how much they were consciously disgusted by it. There is also evidence that the stigma attached to the water and foods produced with it can be partially mitigated through branding and behavioral interventions, like exposure to information and messaging (Marette et al., 2010; McFadden and Huffman, 2017; Savchenko et al., 2018; Ellis, Savchenko, and Messer, 2019).

Several studies found that showing or simply telling people about the number of steps between the water they were drinking and a contaminant, such as municipal waste, lead, or a sterilized cockroach, that was once in contact with the water, reduced consumers' stigmatization (Rozin et al., 2015; Kecinski et al., 2016; Hui and Cain, 2017; Kecinski and Messer, 2018). Processes that have been effective are filtration, boiling, and dilution, and multiple redundant treatments were found to be more effective in reducing stigma than any singular treatment (Kecinski et al., 2016). In a hypothetical, stated-preference study, Rozin et al. (2015) found that allowing the recycled water to filter through a natural system, such as an aquifer, for ten years before treating it and introducing it as drinking water had a similar effect. Likewise, in a survey of California residents, Hui and Cain (2017) showed that informing residents that their local aquifer was recharged with recycled water partially abated their visceral reactions to it.

The results of our study contribute to the growing body of literature on ways to mitigate stigma associated with potable and non-potable uses of recycled water in several important ways.

First, using a revealed preference method instead of hypothetical surveys, we find that passing recycled water through an aquifer before using it for drinking and irrigation removes the stigma attached to it. This finding is particularly important for the success of large-scale recycled water projects and timely because policymakers in the United States are currently considering several large-scale projects that will produce and pass recycled water through aquifers for potable and non-potable uses (WaterWorld, 2018, 2019). Second, our analysis provides evidence that consumers view foods produced from trophic level two organisms that ate feed crops irrigated with recycled water as having significantly fewer negative qualities than recycled water. That is, in the minds of consumers, a food crop possesses the same qualities and contagions as the water with which it is irrigated, but the animals that eat those plants do not, or at least not to the same extent. A valuable finding for agricultural producers and the food industry as it implies that consumers will not stigmatize products such as meat and cheese because the animals' food was irrigated with recycled water. It also assists policymakers who are encouraging agricultural producers to expand their use of recycled water for irrigation by alleviating producers concerns about whether consumers will accept the resulting meat and dairy products. These findings introduce two additional strategies policymakers and industry stakeholders can use in their efforts to mitigate the stigma associated with recycled water.

1. Experiment Design

1.1 Method

To assess the effect of the two stigma-mitigation strategies on consumers' preferences for potable recycled water and food produced with it, we conducted a framed field experiment using a revealed-preference, single-bounded, dichotomous-choice design. We chose a dichotomous-choice design because it relies on a posted-price mechanism, which mimics consumers' usual purchasing decisions – when presented with a product, they choose either to purchase it at the listed price or not. Formally, participant *i* was offered purchase opportunity *j* at listed price P and chose either to purchase it (D = 1) or pass on the opportunity (D = 0):

$$D_{ij} = \begin{cases} 1 \; if \; P_{ij} \leq EU_{ij} \\ 0 \; if \; P_{ij} > EU_{ij} \end{cases}. \qquad (1)$$

When the price, P_{ij}, was less than or equal to participants' expected utility, EU_{ij}, they purchased the product. When P_{ij} was greater than participants' expected utility, they chose not to purchase the product. In line with Fehr and Rangel (2011), the decision value (expected utility), EU_{ij}, for participant *i*'s purchase opportunity *j* was generated by integrating attributes, such as product and water type, over various dimensions such as taste, healthfulness, sense of disgust, and self-image. The model assumes that

$$EU_{ij} = \sum W_{ij} C_{jk} \, (k), \qquad (2)$$

where C_j is a vector of attributes for dimension k of purchase opportunity *j*, and W_{ij} is a vector of weights participant *i* applies to each dimension of purchase opportunity j. Each stigma mitigation strategy, s, aimed to affect how a participant generated a value for a product's attribute (water type) and how the attribute was weighted. When computing expected utility each stigma mitigation strategy either minimized some dimension of the attribute, such as disgust, or emphasized a dimension, such as the product's separation from the perceived contagion. Taking this into account, Equation 2 becomes:

$$EU_{ij} = \sum W_{ij}(s) C_{jk} \, (k, s). \qquad (3)$$

1.2 Data and Mitigation Strategies

The experiment was conducted at a motor vehicle office, a large shopping mall, and a farmer's market located in the mid-Atlantic region of the United States. Participants were presented with products and entered their responses on tablet computers running Python-based software. We employed convenience sampling in multiple field locations to collect a sample that was more representative than is possible using the traditional and standard approach of recruiting undergraduate students for experiments conducted in a university laboratory.

Over the course of the experiment, as described in the experiment instructions (Appendix A), participants were presented with fifteen purchase opportunities consisting of five products produced with three different types of water. All products, with their branding labels removed, were displayed in a central location during the experiment so participants could view and compare them. In the instructions, participants were told they would earn $10 for their time and that they should think of this money as a bank from which they could withdraw money to purchase products. To make the decisions incentive-compatible and to encourage participants to carefully consider each purchase opportunity independently, administrators informed participants that one of their purchase decisions would be randomly selected for implementation at the end of the experiment and that each decision was equally likely to be binding. The purchase opportunities were presented on a single page to prevent bias related to the discovered preference hypothesis (Plott, 1996) and the order of their presentation was randomized across participants to avoid ordering effects. This enabled participants to change any decision after contemplating all purchase opportunities.

The three types of water used in the experiment to explore the stigma-mitigating effect of passing recycled water through a physical barrier were (1) —groundwater (a conventional source for potable and irrigation water), (2) recycled water (a stigmatized solution to water scarcity), and (3) groundwater drawn from an aquifer recharged with recycled water (a stigmatized water source that has passed through a physical barrier). Below are the definitions presented to participants at the beginning of the experiment and at the top of the purchasing opportunities page:

> **Recycled water** is highly treated wastewater from various sources such as domestic sewage, industrial wastewater, and storm water runoff.
>
> **Groundwater** is a source of fresh water that lies in aquifers beneath the land surface.
>
> An **aquifer** is an underground body of rock that contains or can transmit groundwater.
>
> **Aquifer recharge** is a process that replenishes groundwater stored in aquifers.

The five products presented to participants – bottled water,[1] fresh spinach, lamb chops, cheddar cheese, and hot chocolate mix – tested the effect a product's trophic level (see figure 1), and therefore degree of separation from recycled water, had on consumers' stigmatization of the product. Trophic levels technically do not apply to bottled water since water is a chemical substance rather than an organism. Therefore, we refer to water here as belonging to trophic level zero. Spinach, as a primary producer in the food chain, belongs to trophic level one, while lamb chops, cheddar cheese (made with milk from cows), and hot chocolate mix (made with dehydrated milk from cows) belong to trophic level two as byproducts of herbivores. The purchase opportunities in the experiment were phrased to emphasize a product's trophic level and described the water used as either "recycled water," "groundwater," or "groundwater from an aquifer recharged with recycled water" in the following questions.

1. Do you want to purchase 16 ounces of bottled [**recycled water**] for $**_____**?

2. Do you want to purchase approximately 8 ounces of spinach irrigated with [**recycled water**] for $_____?

3. Do you want to purchase approximately half a pound of lamb chops from lamb that grazed on grass irrigated with [**recycled water**] for $_____?

4. Do you want to purchase an approximately one-pound block of cheddar cheese made with milk from a cow that grazed on grass irrigated with [**recycled water**] for $_____?

5. Do you want to purchase approximately 16 ounces of hot chocolate mix made with powdered milk from a cow that grazed on grass irrigated with [**recycled water**] for $_____?

The price in each purchase decision was randomly drawn by the Python-based program from a normal distribution[2] with a standard deviation of one-half of the mean price. Mean prices were obtained from the most recently available national mean prices and were adjusted to 2017 levels using the U.S. Bureau of Labor Statistics' Consumer Price Index for All Urban Consumers: Food and Beverages.

Once the purchase decisions were made, the software presented participants with a survey (see Appendix B) that collected their demographic information. After completing the survey, participants rolled a digital die displayed on the screen to randomly determine which of their purchase decisions would be implemented. If a participant chose yes for the randomly selected binding option, they were given the product and whatever remained of the $10 participation fee after deducting the product's cost. Thus, if the listed price was $4, the participant received the product and the remaining $6. Participants who chose not to buy the randomly selected product received the $10 participation fee and no product.[3]

2. Results

The experiment was successfully completed by 314 adult participants, producing 4,710 observations. Summary statistics for the demographic characteristics of the sample are presented in table 1. Figure 2 displays inverse demand curves for the percentage of participants who, when given the opportunity, purchased (vertical axis) products produced with each type of water within a given price range (horizontal axis). Note that the curves for groundwater and groundwater from an aquifer recharged with recycled water are nearly identical, suggesting that the participants did not distinguish between the two types of water. However, demand for products produced with recycled water is consistently lower throughout the range of prices at which the products were offered.

Since the data collected in the experiment is binary (yes/no purchase decisions), we used a logit model to analyze the effects of the stigma-mitigation strategies. To account for the within-subject design (fifteen observations per participant), the logit model was estimated with a random effects' specification and clustered standard errors:

$$log\frac{D_{ij}}{1-D_{ij}} = \alpha + \beta_1{}'P_{ij} + \beta_2{}'W_{ij} + \beta_3{}'T_{ij} + \beta_4{}'X_i + \mu_i + \varepsilon_{ij} \qquad (4)$$

where μ_i ~ N(0, σ_μ^2) and ε_{ij} ~ N(0, σ^2), W_{ij} is a matrix of dummy variables for irrigation water type, T_{ij} is a matrix of dummy variables for trophic levels, and X_i is a matrix of control variables, including how frequently participant *i* generally consumes each product.

The regression results and Wald tests for Equation 4 are presented in tables 2 and 3 respectively. They show that participants prefer ($\rho < 0.01$) groundwater and groundwater from an aquifer recharged with recycled water over recycled water for potable and irrigation purposes. However, these results, like the inverse demand curves suggested, show that there is no significant difference ($\rho = 0.74$) in participants' preferences for groundwater and groundwater from an aquifer recharged with recycled water. These findings indicate that passing recycled water through an aquifer before using it for drinking and irrigation can remove the stigma associated with recycled water.

To determine whether a product's trophic level can have a mitigating effect on the stigma associated with recycled water, we examined an iteration of Equation 4 that included an interaction term between trophic level and water type. Since this iteration involved multiple comparisons, we used a Bonferroni correction of the Wald test probability values to guard against Type I errors. The results of that regression and the Wald tests are presented in tables 2 and 4 respectively. They show that there is no significant difference ($\rho = 0.11$ for groundwater, $\rho = 0.33$ for groundwater from an aquifer recharged with recycled water, and $\rho = 0.15$ for recycled water) in consumers' preferences for the trophic level zero (bottled water) and trophic level one (spinach) products regardless of water type. This suggests participants did not view plant crops as a barrier between them and the water it was irrigated with. For all water types, we find that participants prefer ($\rho < 0.01$) the products from trophic level two (lamb chops, cheddar cheese, and hot chocolate mix) over the product from trophic level zero (bottled water). This indicates that the herbivores in trophic level two provide enough separation from the recycled irrigation water to mitigate consumers' stigma. While the plant crop possesses the same level of stigma as the water with which it was irrigated, the animal that eats that crop inherits significantly less stigma.

3. Conclusion

Stigmatization of water and food products can constrain markets, preventing implementation of scientifically safe solutions to environmental problems such as water scarcity. Though recycled wastewater can be a cost-effective, dependable, and safe solution to water shortages, consumers, on average, either require a large reduction in price to purchase foods produced with recycled water or reject them outright. This negative response arises from a psychological reaction of disgust induced by the perception that the water goes directly from toilets to taps. Previous studies have provided evidence that such stigmatization can be partially reduced by behavioral interventions such as labels that provide positive information about recycled water and messaging that explains the environmental benefits of using this water. However, those mitigation strategies do not typically eliminate consumers' feelings of disgust. Instead, how recycled water is framed and presented to consumers determines how *much* they are consciously disgusted. Therefore, we explore new mitigation strategies that stress the barriers between a consumer and the contagions associated with recycled water.

In a field experiment involving 314 adult participants, we tested several stigma-mitigation strategies using a revealed-preference, incentive-compatible mechanism. We find that consumers prefer products produced with groundwater and groundwater from an aquifer recharged with recycled water over ones produced with recycled water and that there is no statistical difference in consumers' preferences for the two water sources. This indicates that passing recycled water through a natural barrier, such as an aquifer, before using it for drinking and irrigation significantly mitigates the stigma consumers attach to the resulting food products. These results are in line with the hypothetical, stated preference findings of Rozin et al. (2015) and Hui and Cain (2017).

We also find that the trophic level of an organism affects the degree of stigma consumers attach to products derived from it in much the same way as more-direct interventions such as filtering, boiling, and diluting recycled water. Our results indicate that consumers do not view the consumption of recycled water by plants (trophic level one) as an adequate barrier against their negative associations with the water. Food crops appear to be associated with the same level of stigma as the water with which they are irrigated. Consumption of those plants by herbivores, on the other hand, appears to provide adequate separation and significantly reduces their concerns about the effects of recycled water.

These findings provide valuable and, more importantly, actionable information for policymakers, water utilities, and the agricultural and food industries. The results show that consumers are much more likely to accept recycled water for potable and irrigation purposes if it first passes through a natural barrier, such as an aquifer. Recharging aquifers with recycled wastewater would not only remove the stigma attached to recycled water, but also contribute to solving the growing environmental problem of saltwater intrusions into aquifers. Such artificial groundwater recharging is used by some water districts in California (CASA, 2019; Orange County Water District, 2019), but the success of the projects has been mixed because of some public opposition to recycled water. Our findings provide valuable information for policymakers and planners who are promoting these types of large-scale water recycling projects. However, additional research is needed to see if consumers' responses to potable drinking water from an aquifer recharged with recycled water depends on whether they obtain their water from a municipal system, that further treats the water before it reaches taps, or from individual wells, that only provide further treatment when an in-home filtration system is installed.

Our finding that the use of recycled water in agriculture is most accepted by consumers as irrigation for crops fed to herbivores, such as cattle, rather than applied directly to plants intended for human consumption, is crucial for agricultural producers and the food industry in determining how to incorporate recycled water into their operations. This finding aligns with conclusions by Whiting et al. (2019) that little or no stigma attaches to inedible crops such as cotton while significant stigma attaches to fresh produce such as strawberries. Statistically, fresh produce irrigated with recycled water is as stigmatized as the water. If widespread adoption of recycled irrigation water is to succeed, producers should use it primarily for feed and for non-edible crops rather than for produce when possible.

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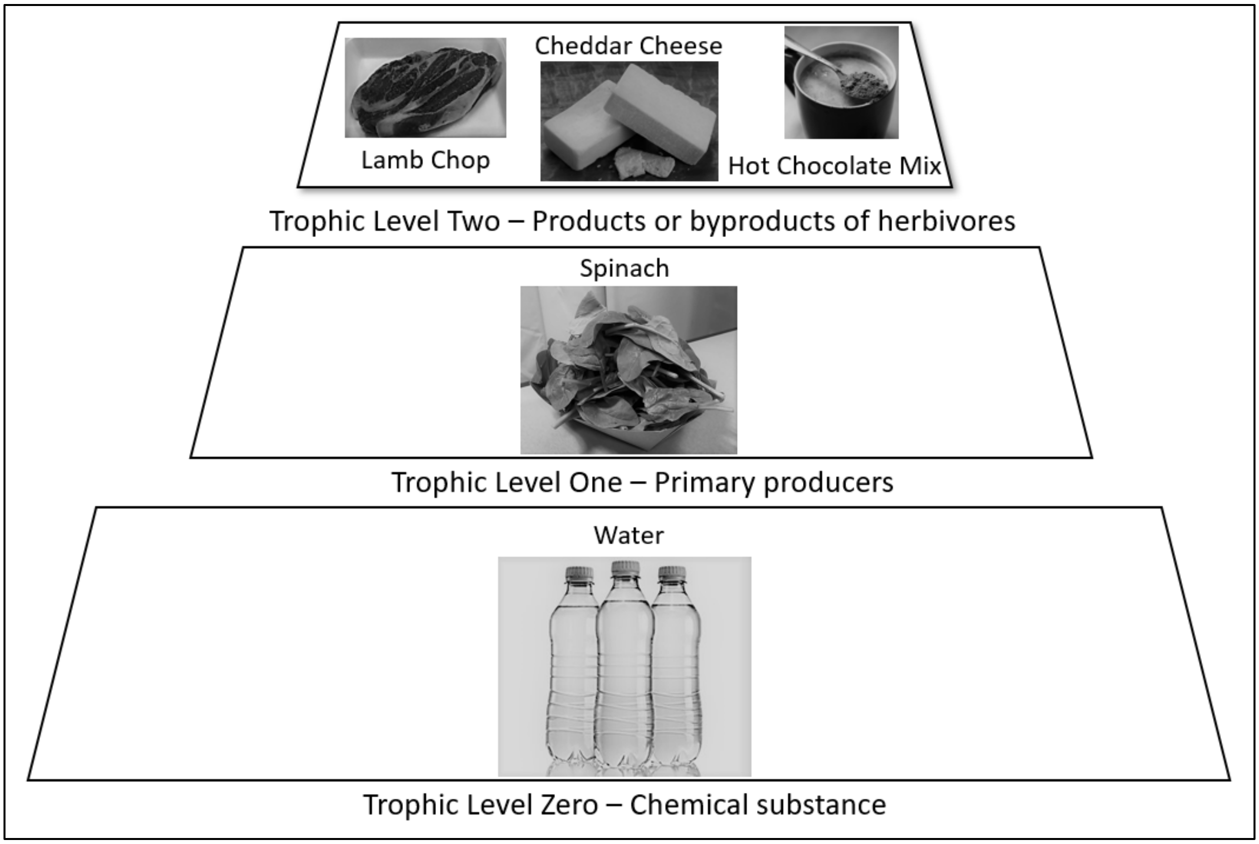

Figure 1. Products and their trophic levels

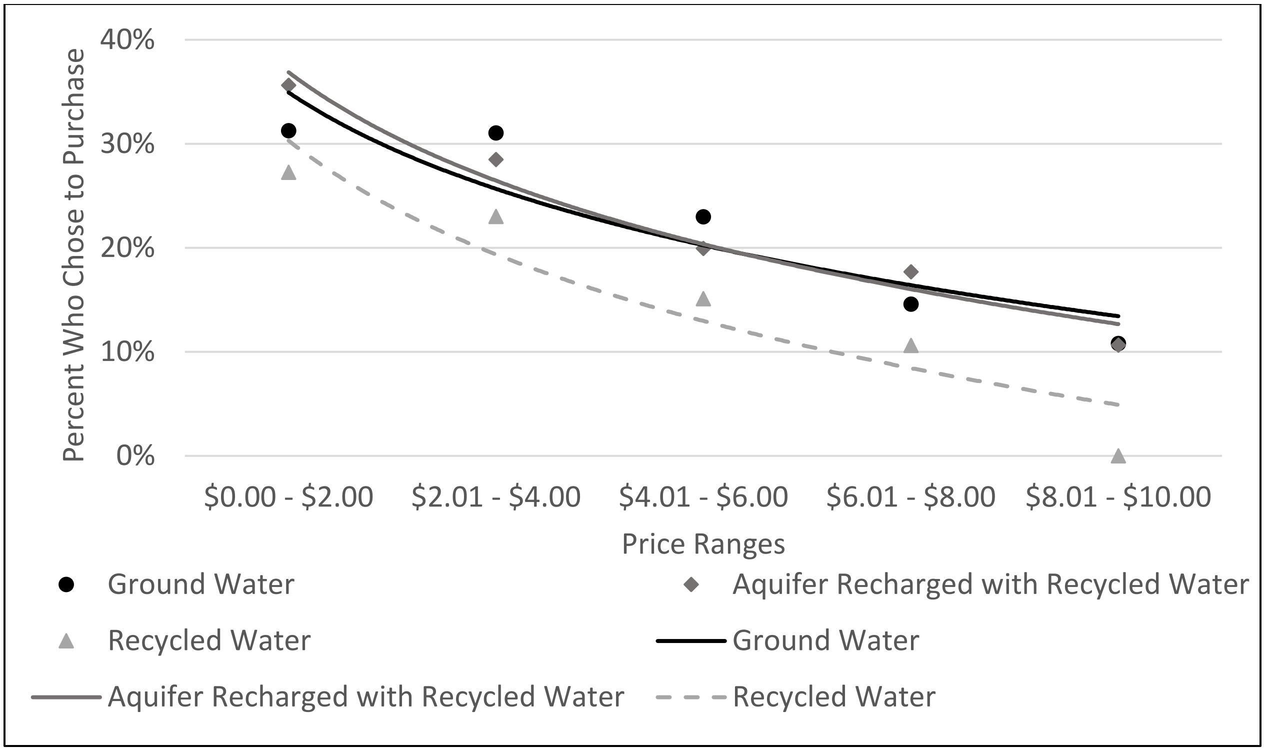

Figure 2. Inverse demand curve by water type

Table 1. Summary Statistics

Total Participants: 314			
Demographic Characteristics		Sample	Delaware
Gender	*Female*	51%	52%
Education	*High School or Less*	30%	46%
	Some College or Associate Degree	42%	27%
	Bachelor's Degree or higher	27%	27%
Annual Household Income	*Minimum*	< $14,999	
	Maximum	≥ $250,000	
	Median	$35,000–$49,999	$54, 895
	Mean	$35,000–$49,999	$75,235
Age	*Minimum*	18	
	Maximum	82	
	Median	36	40
	Mean	38	

Note: All Delaware data is from the 2016 American Community Survey.

Table 2. Results from Logit Models

	Equation 4		Equation 4 with Trophic Level Interactions	
	Coef.	S.E.	Coef.	S.E.
Price	-0.398***	(0.041)	-0.400***	(0.041)
Trophic Level				
One	0.449***	(0.175)	0.484**	(0.232)
Two	0.858***	(0.180)	1.093***	(0.212)
Water Type				
Aquifer Recharged with Recycled	-0.057	(0.175)	0.175	(0.228)
Recycled	-0.613***	(0.178)	-0.427*	(0.260)
Interactions				
*Aquifer Recharged with Recycled * Trophic Level One*			-0.114	(0.266)
*Recycled * Trophic Level One*			-0.361*	(0.206)
*Aquifer Recharged with Recycled * Trophic Level Two*			0.037	(0.308)
*Recycled * Trophic Level Two*			-0.335	(0.235)
Frequency of Consumption				
Trophic Level Zero	0.273***	(0.108)	0.273***	(0.108)
Trophic Level One	0.385***	(0.110)	0.386***	(0.110)
Trophic Level Two	-1.110***	(0.252)	-1.112***	(0.252)
Total N	4,710		4,710	
Groups	314		314	
AIC	3916.893		3921.426	
BIC	3981.467		4011.830	

*** Significant at the 1% level ** Significant at the 5% level * Significant at the 10% level

Note: An iteration of each model that includes dummy variables for the social-marketing treatments can be found in Appendix C. Including the dummy variables for the social-marketing treatments does not change the coefficients of interest in either model and the Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC) both indicate that the iteration not including them is the better fit. A discussion of the null results of the social-marketing treatments can be found in Ellis (2019).

Table 3. Wald Tests from Equation 4

Wald Test	χ^2	Prob.
Ground = Aquifer Recharged with Recycled	0.11	0.744
Ground = Recycled	11.81	0.001
Aquifer Recharged with Recycled = Recycled	14.53	0.000

Table 4. Wald Tests from Equation 4 with Trophic Level Interactions

	Ground			Aquifer Recharged with Recycled			Recycled		
Wald Test	χ^2	Prob.	BCP	χ^2	Prob.	BCP	χ^2	Prob.	BCP
Level Zero = Level One	4.37	0.037	0.110	2.54	0.111	0.332	3.90	0.048	0.145
Level Zero = Level Two	26.49	0.000	0.000	11.48	0.001	0.002	9.88	0.002	0.005
Level One = Level Two	12.06	0.001	0.002	5.61	0.018	0.054	1.62	0.203	0.608

BCP: Bonferroni Corrected Probability Value

Appendix A. Experiment Instructions

Printed Instructions

Please read these instructions carefully and do not communicate with anyone while you are making your decisions.

- **You will earn $10 by participating in this research that you may keep and/or use to purchase food or drink products.** You may think of this money as a bank account from which you can withdraw money.
- Depending on the decisions you make, you may receive a combination of cash and food or drink products.
- Your decisions are just like the ones you make in a store: you either buy the product at the listed price or you do not.
- There are no greater physical risks from participating in this study than those you would face in a store. **Please remember that all decisions are real purchasing decisions, but only one of your purchasing decisions will be randomly selected and implemented.**

Steps:

1. You will face a series of "options" to purchase a product. For each option, decide if you want to buy the product at the listed price by selecting "Yes" or "No."
2. Complete a short survey.
3. Roll a digital die to determine which purchasing option will be implemented (only one will be implemented).
4. Receive cash and/or product.

- **Example 1:** If you selected Yes for an option that cost $3 and this option is randomly implemented, you will receive the product and $7 cash ($10 – $3 = $7).
- **Example 2:** If you selected No for an option and this option is randomly implemented, you will receive $10 cash and will not receive any product.

Appendix B. Survey

Please answer the following questions:

1. What is your age?

2. What is your gender?
   - Male
   - Female

3. Do you live in the U.S.?
   - Yes
   - No

4. What is your ZIP code?

5. Which best describes your employment status?
   - Not employed, **not** looking for work
   - Not employed, looking for work
   - Employed, working 1-20 hours per week
   - Employed, working 21-39 hours per week
   - Employed, working 40 or more hours per week
   - Retired
   - Student
   - Disabled, not able to work

6. Are you politically:
   - Liberal
   - Moderate
   - Conservative
   - Other (please specify)

7. How would you identify your ethnicity?
- Non-Hispanic White
- Hispanic or Latino
- Middle Eastern or Arab
- Black
- East Asian
- South Asian
- Pacific Islander
- Native American
- Other (please specify)

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8. Which category best describes your household income (before taxes) in 2017?
- Less than $10,000
- $10,000-$14,999
- $15,000-$24,999
- $25,000-$34,999
- $35,000-$49,999
- $50,000-$74,999
- $75,000-$99,999
- $100,000-$149,999
- $150,000-$199,999
- $200,000-$249,999
- $250,000 and above

---

9. What is the highest level of education that you have completed?
- Less than high school
- High school graduate or equivalent (i.e.GED)
- Some college, but no degree
- Associate degree
- Bachelor's degree
- Graduate degree

---

10. How often do you consume the following types of foods and drinks?

Bottled Water:

Never	Rarely	Sometimes	Often	Always
○	○	○	○	○

Spinach:

Never	Rarely	Sometimes	Often	Always
○	○	○	○	○

Hot chocolate mix:

Never	Rarely	Sometimes	Often	Always
○	○	○	○	○

Lamb:

Never	Rarely	Sometimes	Often	Always
○	○	○	○	○

Cheddar Cheese:

Never	Rarely	Sometimes	Often	Always
○	○	○	○	○

11. Being able to drink treated wastewater is a possibility available to consumers. This drinking water has been referred to by several different names. On a scale of 1 (least favorable) to 5 (most favorable), please indicate how favorable you consider each of the following names for this water:

Nontraditional Water:

Least Favorable	○ 1	○ 2	○ 3	○ 4	○ 5	Most Favorable

EnviroWater:

Least Favorable	○ 1	○ 2	○ 3	○ 4	○ 5	Most Favorable

Reclaimed Water :

Least Favorable	○ 1	○ 2	○ 3	○ 4	○ 5	Most Favorable

ReNew Water :

Least Favorable	○ 1	○ 2	○ 3	○ 4	○ 5	Most Favorable

Reused Water :

Least Favorable	○ 1	○ 2	○ 3	○ 4	○ 5	Most Favorable

Low Footprint Water :

Least Favorable	○ 1	○ 2	○ 3	○ 4	○ 5	Most Favorable

12. Do you have a child/children under 18 years old in your household?
   - ○ Yes
   - ○ No

13. Do you grow your own food?
   - ○ Yes
   - ○ No

14. What type of water do you most often drink?
   - Bottled Water
   - Tap Water
   - Filtered Water
   - Other (Please specify)

15. Before this survey had you ever heard of:

   Groundwater
   - Yes
   - No

   Recycled water
   - Yes
   - No

   Groundwater from an aquifer that was recharged with recycled water
   - Yes
   - No

16. What percentage of **the U.S. food supply** do you think is irrigated with the following types of water? Please give your best estimate:

   Groundwater: %

   Recycled water: %

   Groundwater from an aquifer that was recharged with recycled water: %

17. What percentage of **food you buy** do you think is irrigated with the following types of water? Please give your best estimate:

   Groundwater: %

   Recycled water: %

   Groundwater from an aquifer that was recharged with recycled water: %

Appendix C. Logit Models with Social Marketing Dummy Variables

	Equation 4		Equation 4 with Trophic Level Interactions	
	Coef.	S.E.	Coef.	S.E.
Price	–0.398***	0.041	–0.400***	0.041
Trophic Level				
One	0.449***	0.175	0.484**	0.232
Two	0.858***	0.180	1.093***	0.212
Water Type				
Aquifer Recharged with Recycled	–0.057	0.175	0.175	0.228
Recycled	–0.613***	0.178	–0.427*	0.260
Interactions				
Aquifer Recharged with Recycled Trophic Level One*			–0.114	0.266
*Recycled*Trophic Level One*			–0.360*	0.206
Aquifer Recharged with Recycled Trophic Level Two*			0.037	0.308
*Recycled*Trophic Level Two*			–0.334	0.235
Social Marketing				
Celebrity Endorsements & Social Comparison	0.048	0.346	0.048	0.346
Celebrity Endorsement	0.164	0.344	0.163	0.344
Social Comparison	0.004	0.342	0.004	0.342
Frequency of Consumption				
Trophic Level Zero	0.276***	0.109	0.276***	0.109
Trophic Level One	0.386***	0.110	0.386***	0.110
Trophic Level Two	–1.103***	0.254	–1.105***	0.255
Total N	4,710		4,710	
Groups	314		314	
AIC	3922.630			
BIC	4006.577			

***Significant at the 1% level **Significant at the 5% level *Significant at the 10% level

[1] Bottled recycled water that was safe for potable use was sourced from Pima County Regional Wastewater Reclamation Department in Tucson, Arizona, through collaborators with the CONSERVE project.

[2] Participants were not made aware of the price distributions or of the mean prices for the products.

[3] Each participant was also randomly assigned to either a control group or one of three social marketing treatment groups. Additional information about the between-subject portion of the experiment, including the null results, is provided in Appendix C of this paper and in Ellis (2019).

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