DOI: 10.1111/ajae.12256

ARTICLE

Mitigating stigma associated with recycled water

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Funding information
USDA National Institute for Food and Agriculture, Grant/Award Number: 20166800725064; CONSERVE: A Center of Excellence at the Nexus of Sustainable Water Reuse, Food, and Health, USDA National Institute for Food and Agriculture, Grant/Award Number: 2019-67023-29854; National Science Foundation's EPSCoR, Grant/Award Number: 1757353; entitled "Water in the Changing Coastal Environmental of Delaware"

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 products made with recycled water or reject such products outright. If emerging sustainable agricultural technologies, such as recycled water, are to be used to address growing water shortages worldwide, policymakers, water managers, and industry stakeholders must identify effective strategies for mitigating the stigma associated with recycled water. Using field experiments involving 1420 adult participants, we test the effectiveness of two stigma-mitigating techniques. We also demonstrate a novel twist to the collection of representative samples in non-hypothetical field experimental settings and then compare the results to a more traditional field experiment that recruited participants at large public gatherings. The analysis of these two different samples suggests a common finding: 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 by consumers. These results have important implications for efforts to promote large-scale potable and non-potable water recycling projects and the use of recycled water in the agricultural industry.

KEYWORDS
aquifer recharge, drought, irrigation, recycled water, representative sampling, trophic levels, water management

JEL CLASSIFICATION
D12, Q15, Q18

Stigmatization of water and food products by consumers can limit the tools available to policymakers, water managers, agricultural producers, and the food industry to respond to environmental challenges (Edelstein, 2004; Roth, 2007). Stigma arises when consumers perceive food products as risky to use or consume despite the overwhelming scientific evidence that they are safe (Ellen & Bone, 2008; Kanter et al., 2009; Potts & Nelson, 2008; Walker, 2001). One of the primary barriers to widespread use of sustainable supply side solutions to water scarcity such as recycled water—wastewater treated to standards that make it safe for drinking and irrigation—is the stigma attached to it (Hartley, 2006; Lazarova et al., 2013; Ormerod & Scott, 2013). It is critical from the perspective of stakeholders to identify strategies that can effectively alleviate consumer concerns about various uses of recycled water so it can be a viable solution to water scarcity.

Using data from two framed field experiments, this paper tests the effectiveness of two strategies to mitigate the stigma associated with recycled water: passage through a natural barrier (an aquifer) and information about the trophic level of food products.[1] The first experiment (Study I) involves 314 adult participants from four U.S. mid-Atlantic states (Delaware, Maryland, New Jersey, and Pennsylvania). The second (Study II) involves a representative sample of 1106 adult participants from across the United States that intentionally oversampled participants from the mid-Atlantic region so that a direct comparison with Study I could be made. Our experimental design allows us to measure the effectiveness of these stigma-mitigating techniques in a non-hypothetical, demand-revealing setting using a representative sample of U.S. adult consumers. We also provide useful insights about recruiting representative samples online for incentive-compatible field experiments.

Although potable water recycling projects have been successfully implemented in places such as Big Spring and Wichita Falls, Texas, and Fountain Valley, California (Martin, 2014), consumer concerns have derailed similar efforts. Projects to provide potable recycled water were indefinitely delayed or canceled in other places, such as Tampa, Florida; Brownwood, Texas; and South Queensland, Australia (Hummer & Eden, 2016; Morgan & Grant-Smith, 2015; Wester et al., 2016). The use of recycled water for irrigation has also struggled to gain acceptance. Recent studies examining consumer preferences for produce irrigated with recycled water have shown that U.S. consumers either require a large reduction in price to purchase these foods relative to produce irrigated with water from conventional or unspecified sources, or reject these foods outright (Ellis et al., 2021; Savchenko et al., 2019a).[2] Although there currently is no mandatory irrigation water labeling for produce, an increase in marketers labeling food based on the "freshness" of irrigation water could contribute to the stigmatization of foods produced with recycled water similar to the negative effects of labeling other food processes perceived as risky by consumers (Messer et al., 2017; Savchenko et al., 2018). Results from Ellis et al. (2021) and Savchenko et al. (2018) indicate a consumer backlash could occur if the use of recycled irrigation water becomes more widely known by consumers. Both studies also found that messaging about the environmental benefits of recycled water did not alleviate consumer concerns. Thus, the strategy outlined by Zilberman et al. (2018) of "green" retailers voluntarily labeling a product to signal its sustainability to consumers will likely not be successful in the case of recycled irrigation water.

Several studies have found that informing people about the number of steps between the water they drink and a contaminant, such as municipal waste, lead, or a sterilized cockroach, reduced consumers' stigmatization of the water (Kecinski et al., 2016, 2018; Kecinski & Messer, 2018). Both of our stigma mitigation strategies leverage this effect. First, we evaluate whether passing recycled water through a natural barrier, such as an aquifer, alleviates the stigma associated with it. Such indirect potable water reuse projects inject recycled water into an aquifer, where it is stored for some time before withdrawal to undergo processing in a traditional water treatment plant. Hypothetical, stated-preference studies have found evidence that allowing recycled water to filter through an aquifer reduces the stigma attached to it (Hui & Cain, 2017; Rozin et al., 2015). Although 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 & Safford, 2019), whereas 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 unclear whether passing recycled water through a natural barrier reduces consumer concerns, information that is necessary for the success of future large-scale water recycling projects. We are unaware of any prior studies that have explored the stigma-mitigating effects of passing recycled water through a physical environmental barrier in a non-hypothetical demand-revealing experimental setting in which the study participants' decisions have real outcomes.

Second, we examine whether the trophic level of a food product affects consumer concerns about recycled water. Trophic level refers to an organism's place in the food chain. Plants are categorized as trophic level 1 because they generally do not consume other living organisms. Cattle, being herbivores, are categorized as trophic level 2 because they consume organisms from trophic level 1. 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, show that simple processing, such as drying and liquefying, could alleviate some consumers' concerns about the use of recycled irrigation water for food products. Lease et al. (2014) likewise find that cooking meatballs prepared with recycled water removes the stigma. Thus, a product's trophic level could also act as a stigma-mitigating barrier against the negative perception consumers 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 due to the use of recycled water in its production.

The results of our two studies contribute to the growing body of literature on ways to mitigate the stigma associated with potable and non-potable uses of recycled water by introducing two additional strategies policymakers and industry stakeholders can use in their efforts to mitigate the stigma associated with recycled water. 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 important for the success of large-scale water recycling projects and is timely because policymakers in the United States are considering several large-scale projects that will produce and pass recycled water through aquifers for potable and non-potable uses (U.S. Bureau of Reclamation, 2019; U.S. Environmental Protection Agency, 2019; WaterWorld, 2018, 2019).[3] Our analysis also provides evidence that consumers perceive crops irrigated with recycled water as having significantly less stigma than the recycled water itself, and the animal that eats the crops as having even less stigma. That is, in the minds of consumers, the stigma associated with recycled water lessens as the steps in the food chain between an organism and the use of recycled water increases. This is a valuable finding for agricultural producers, the food industry, and water managers as it implies that consumers will be least stigmatized by food products such as meat and cheese, compared to potable recycled water or crops grown with recycled water intended for human consumption. It also assists policymakers and planners who are encouraging agricultural producers to expand their use of recycled water for irrigation by alleviating producers' concerns that the resulting meat and dairy products will receive the same resistance as some potable water recycling projects.

This paper also contributes to the methodological literature on how to recruit a reasonably representative sample of adult consumers in experimental studies (Boas et al., 2020; Brink et al., 2019; Coppock, 2019). Study II replicates the incentive-compatible design of Study I but converts the in-person field experiment into an online field experiment. The methods in Study II involve a novel twist to data collection that we show to be an effective way to collect representative samples in non-hypothetical experimental settings. This approach to data collection is particularly relevant for studies with non-hypothetical purchase decisions involving actual products as they have traditionally only been conducted in person.

1 | EXPERIMENT DESIGN

1.1 | Methods

We conducted two framed field experiments to assess the impact of stigma mitigation strategies on consumer preferences for potable recycled water and foods produced with recycled water. Study I was conducted with participants from the mid-Atlantic region of the United States, whereas Study II collected a sample of consumers representative of the entire country. Both experiments relied on a revealed-preference, single-bounded, dichotomous-choice design. Dichotomous-choice designs use a posted-price mechanism to mimic consumers' usual purchasing decision of whether to purchase a product at the listed price or not. Formally, each participant i was offered purchase opportunity j at listed price P and chose either to make a purchase ($D=1$) or pass on the opportunity ($D=0$):

$$D_{ij}=\begin{cases}1\ if\ P_{ij}\leq EU_{ij}\\ 0\ if\ P_{ij}>EU_{ij}\end{cases}. \tag{1}$$

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 all purchase opportunity dimensions K, such as taste, healthfulness, sense of disgust, and self-image. The model assumes that:

$$EU_{ij}=\sum\nolimits_{k\in K}W_{ij}C_{jk}(k), \tag{2}$$

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

$$EU_{ij}=\sum\nolimits_{k\in K}W_{ij}(s)C_{jk}(k,s). \tag{3}$$

1.2 | Study I

Study I was conducted at three locations in New Castle County, Delaware: a motor vehicle office, a large shopping mall visited by close to 20 million people a year, and a farmer's market (an indoor facility, open year-round that sells discount foods and hosts a flea market). We employed convenience sampling in multiple field locations to collect a sample of adult consumers that was more representative of the general population than would be possible using the standard approach of recruiting students for experiments conducted in a university laboratory. A diverse array of consumers frequented all three of the selected experiment locations (see Table 1). In addition, consumers from surrounding states, particularly Maryland, New Jersey, and Pennsylvania, patronized the shopping mall and the farmer's market (see Figure 1). The experiment was successfully completed by 314 adult participants, producing 4710 observations.

Over the course of the experiment, participants were offered 15 purchase opportunities consisting of five products produced with three different types of water (see experiment instructions in Appendix S1). Participants were presented with these products and entered their responses using tablet computers running Python-based software. All products, with their branding labels removed, were displayed in a central location during the experiment so participants could view and compare them. The instructions informed participants that 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 all their purchase decisions were equally likely to be binding, with one randomly selected for implementation at the end of the experiment. The presentation of the purchase opportunities was on a single page to prevent any bias related to the discovered preference hypothesis (Plott, 1996) with the order of the presentation randomized across participants to avoid any ordering effects.[4] This enabled participants to change any decision after contemplating all purchase opportunities.

Three types of water were chosen for the experiment to explore the stigma-mitigating effect of passing recycled water through a physical barrier: (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

TABLE 1 Summary statistics

		2018 American Community Survey		Sample		
		Mid-Atlantic (DE, MD, NJ, & PA)	United States	Study I	Study II (mid-Atlantic)	Study II (rest of United States)
	Total participants			314	546	560
Sex	*Female*	52%	51%	51%	57%	53%
Educational attainment	*High school or less*	41%	40%	30%	34%	42%
	Some college	17%	21%	33%	21%	21%
	Associates degree	7%	8%	9%	8%	9%
	Bachelor's degree	21%	19%	13%	22%	18%
	Graduate degree	14%	12%	14%	16%	10%
Ethnicity	*Non-Hispanic White*	64%	61%	46%	70%	66%
	Black	16%	12%	29%	17%	17%
	Hispanic	12%	18%	8%	6%	11%
	Asian	6%	5%	7%	4%	4%
	Other	2%	3%	10%	3%	2%
Annual Household Income	*$49,999 or less*	35%	42%	51%	39%	45%
	$50,000 to $99,999	29%	30%	28%	32%	34%
	$100,000 to $149,999	17%	15%	11%	16%	13%
	$150,000 and above	19%	13%	10%	12%	8%
Age	*18–34*	28%	30%	46%	31%	32%
	35–54	33%	33%	37%	37%	35%
	55 and above	38%	36%	17%	32%	33%

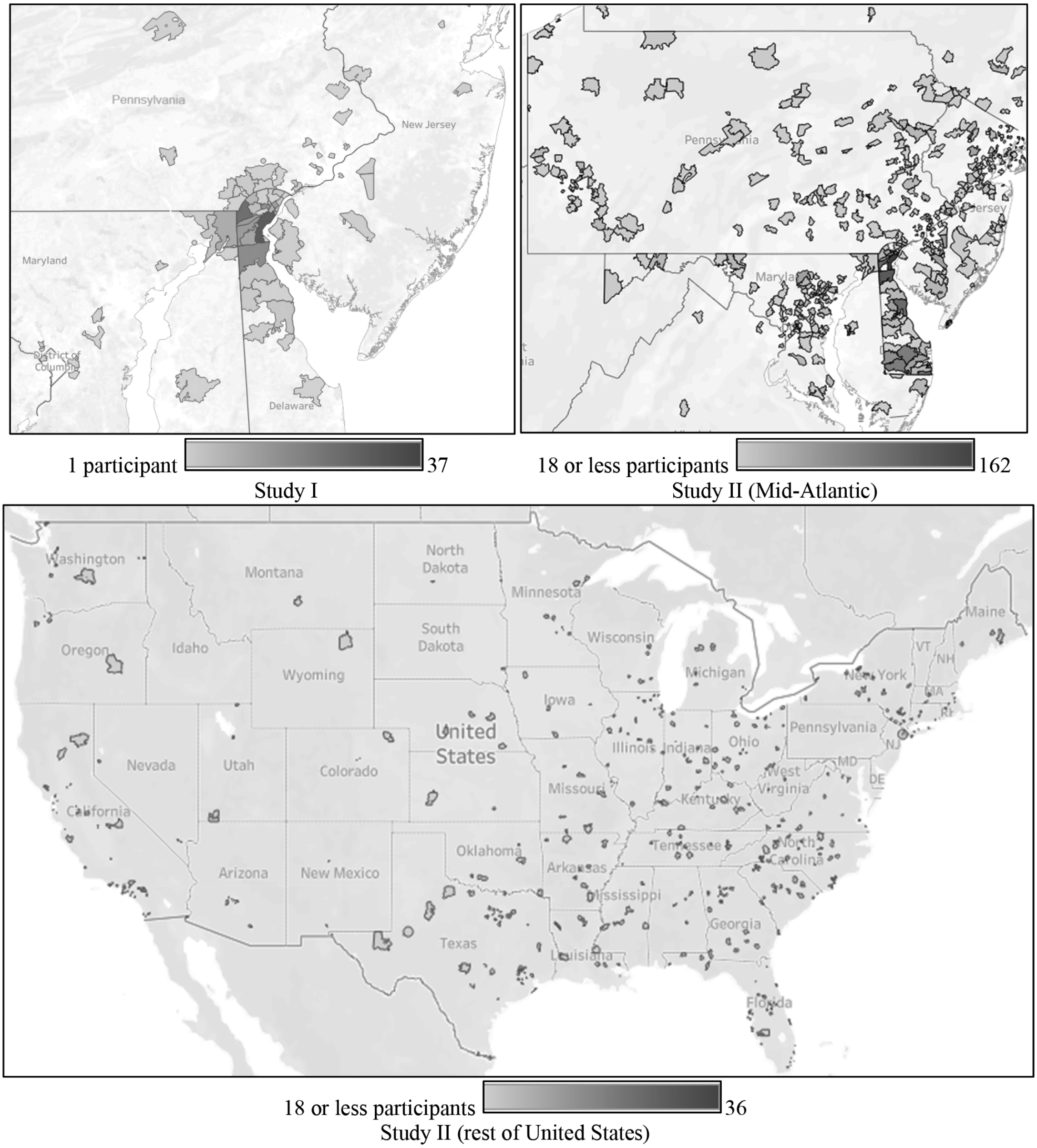


FIGURE 1 Participants' zip codes

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,[5] fresh spinach, lamb chops, cheddar cheese, and hot chocolate mix—are used to test the effect of a product's trophic level (see Figure 2), as well as the degree of separation from recycled water, on consumers' stigmatization of the product. Trophic levels technically do not apply to bottled water because water is a chemical substance rather than an organism. Therefore, we refer to water here as belonging to trophic level 0. Spinach, as a primary producer in the food chain, or in other words, an organism that converts energy (i.e., light) into organic matter, belongs to trophic level 1. Lamb chops, cheddar cheese (made with milk from cows), and hot chocolate mix (made with dehydrated milk from cows) belong to trophic level 2 as byproducts of herbivores.

Bottled water is included as one of the products to make a direct comparison between consumers' stigmatization of a type of water and of a product produced with it. Spinach is included as the trophic level 1 product and lamb chops, cheddar cheese, and hot chocolate mix are included as the trophic level 2 products because these were the products whose water source we could verify. Best practices in experimental economic research do not allow deception (Rousu et al., 2015), meaning the products were produced using the type of water for which they were labeled in the experiment. This requirement constrained our choice of products at trophic levels 1 and 2.

The purchase opportunities in the experiment were phrased to emphasize a product's trophic level and described the water used as "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 eight 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 $_____?

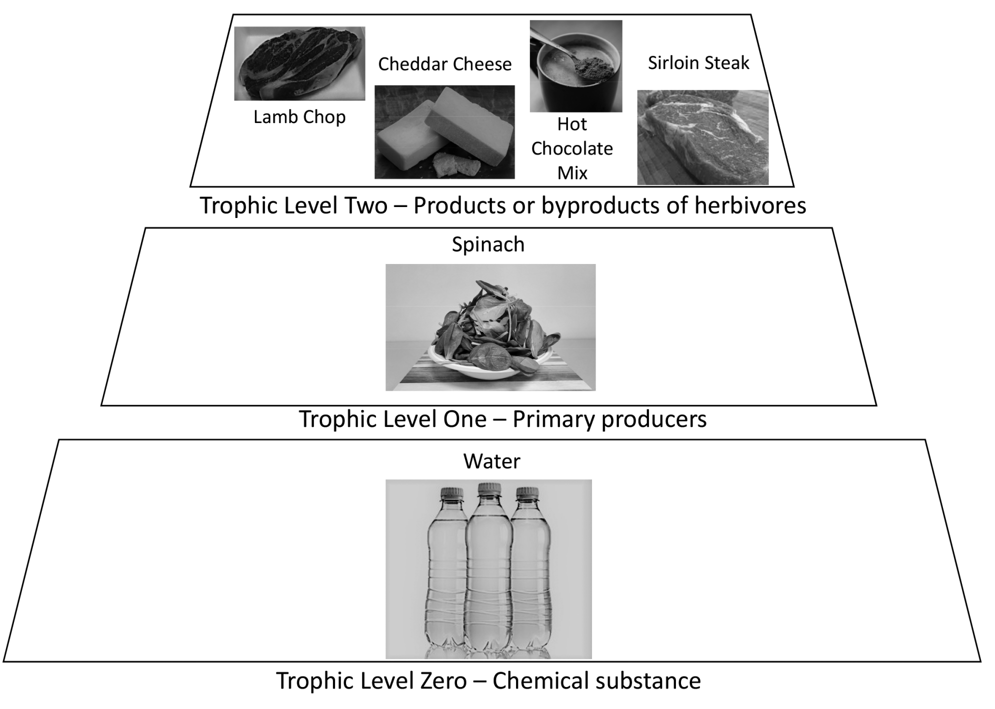


FIGURE 2 Products and their trophic levels

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 from a normal distribution ranged from $0.01 to $10.00,[6] with a standard deviation of one-half of the mean price.[7] 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 participants made their purchase decisions, the software presented them with a survey that collected their sociodemographic information (see Appendix S1). After completing the survey, participants rolled a digital die displayed on the computer screen; this randomly determined which purchase decision to implement. If during the experiment a participant chose "yes" to purchasing the product in the randomly selected binding option, they received the product and the remainder of the $10 participation fee after deducting the cost of the product. For example, if the listed price were $4, the participant received the product and the remaining $6. However, if during the experiment a participant chose not to buy the product in the randomly selected binding option, they received the $10 participation fee and no product because they chose not to purchase the product.

1.3 | Study II

To strengthen the external validity and check the robustness of Study I's results, we conducted a second non-hypothetical, demand-revealing experiment. Study II replicated the design of Study I but collected a representative sample of adult consumers from the entire United States. To achieve this, we employed a novel twist to data collection that demonstrates an effective way to collect representative samples in non-hypothetical experimental settings. Delaware, Maryland, New Jersey, and Pennsylvania, the four mid-Atlantic states where most participants from Study I were drawn, were oversampled so that a direct comparison could be made between the two studies (Study I and Study II).

Prior to data collection, a power analysis using parameter estimates from Study I and involving 1000 simulations of the experiment was conducted to ensure Study II was fully powered. At the 80% power level, the results showed that a sample of 543 participants was necessary to detect changes statistically significant at the 1% level or less for the key trophic level and water type treatments. Study II was successfully completed by 546 adult participants in the mid-Atlantic region and 560 adult participants across the rest of the United States (see Figure 1) for a total of 1106 participants, producing 19,908 observations.

To obtain a nationally representative sample, the in-person field experiment was converted into an online experiment administered through Qualtrics. As in Study I, at the beginning of the experiment, we informed participants that their purchasing decisions were real, with one decision randomly selected for binding implementation. We maintained incentive compatibility by asking participants to provide a valid mailing address and informing them that we would ship their cash and/or products to them free of charge at the conclusion of the experiment. Of the 1106 participants that successfully completed the experiment, an additional 297 participants completed the experiment but provided invalid mailing addresses. Those who provided invalid mailing addresses were removed from the sample, as they were not making real purchasing decisions with real money if they could not receive the cash and/or products.

To further test the robustness of the findings in Study I, we added an additional product option in Study II. In addition to lamb chops, which is not a popular meat in the United States

(U.S. Department of Agriculture, Economic Research Service, 2020), we included sirloin steak as a fourth trophic level 2 product. This expanded the number of purchase opportunities from 15 to 18. Like the original 15, the three additional options were phrased to emphasize the product's trophic level and described the water used as "recycled water," "groundwater," or "groundwater from an aquifer recharged with recycled water" in the following question.

6. Do you want to purchase approximately 6 ounces of sirloin steak from cattle that grazed on grass irrigated with [**recycled water**] for $_____?

We also updated the mean prices and standard deviations of the products to reflect the most recently available national mean prices.[8] The sociodemographic questions concerning age, sex, employment, political affiliation, ethnicity, household income, and educational attainment were moved to a pre-experiment survey so that participants could be screened to obtain a representative sample. We also streamlined the post-experiment survey to reduce cognitive load (see Appendix S1).

In both studies, we randomly assigned each participant either to a control group or to one of three social marketing treatment groups. The results of these between-subject treatments were null in both Study I and Study II. Including the dummy variables for the social-marketing treatments in the analysis described below does not change the coefficients of interest, and the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) both indicate that not including them in the models is the better fit. Further discussion of the between subject social marketing treatments can be found in Appendix S1 of this paper.

2 | RESULTS

2.1 | Study I

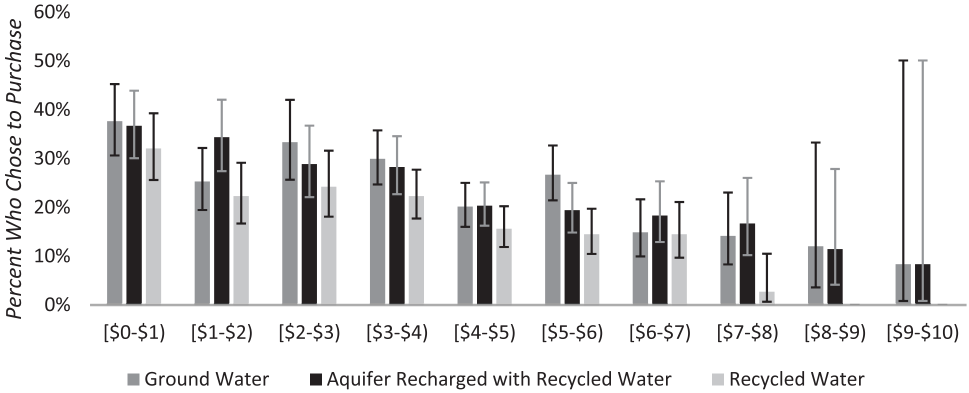
Summary statistics for the demographic characteristics of the Study I sample are presented in Table 1. Although the sample is representative regionally and nationally based on sex, it is skewed toward non-white consumers aged 18 to 34 years old earning $49,999 or less annually. It also oversampled those with some college education, while undersampling those with a high school diploma or less and those with a bachelor's degree. Figure 3 displays the percent of participants who, when given the opportunity, purchased (vertical axis) products produced with each type of water within a given price range (horizontal axis). The top panel of Figure 3 suggests that participants did not distinguish between groundwater and groundwater drawn from an aquifer recharged with recycled water. However, the percent of consumers willing to purchase products produced with recycled water was consistently lower across all price ranges.

Because the data collected in the experiment are binary (yes/no purchase decisions), we use a logit model to analyze the effects of the stigma-mitigation strategies. To account for the within-subject design (15 observations per participant in Study I), a logit model is estimated with a random effects' specification (Charness et al., 2012; Duffy et al., 2019) and clustered standard errors:

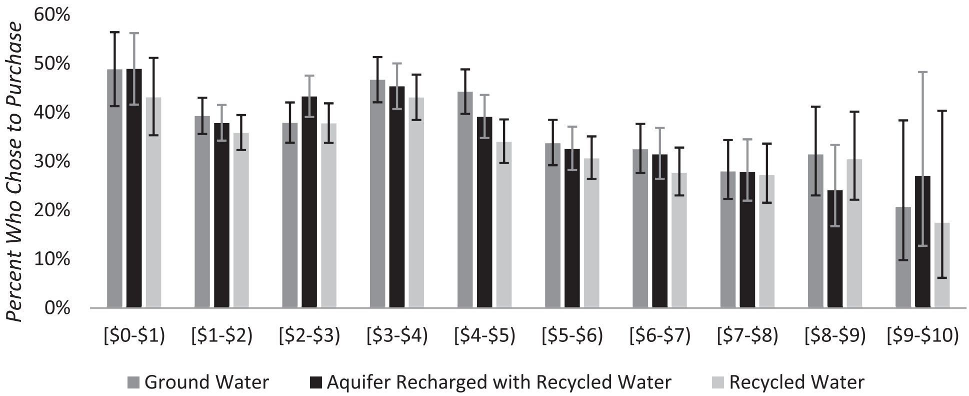
$$\log\left(\frac{D_{ij}}{1-D_{ij}}\right) = \alpha + \beta_1{}'P_{ij} + \beta_2{}'W_{ij} + \beta_3{}'T_{ij} + \beta_4{}'X_i + \mu_i + \varepsilon_{ij} \tag{4}$$

where $\mu_i \sim \mathrm{N}(0, \sigma_\mu^2)$ and $\varepsilon_{ij} \sim \mathrm{N}(0, \sigma^2)$, W_{ij} is a vector of dummy variables for irrigation water type, T_{ij} is a vector of dummy variables for trophic levels, and X_i is a matrix of control variables that can include how frequently participants generally consume each product and their sociodemographic characteristics.

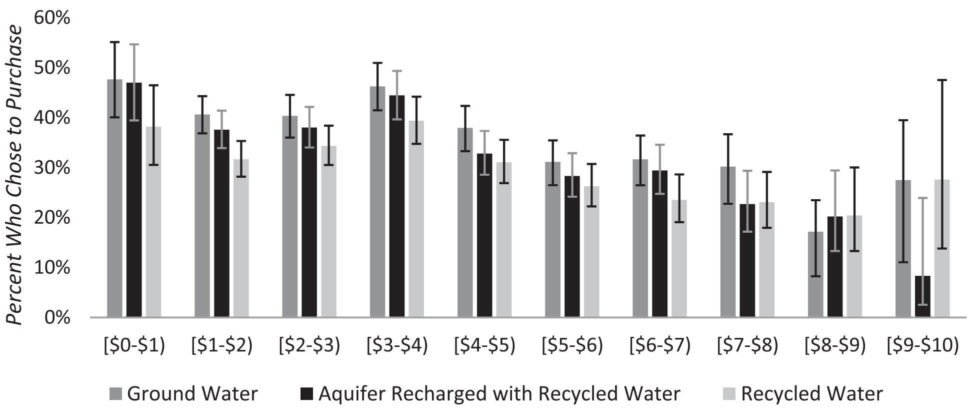
The estimates and Wald test results from Equation 4 are reported in Tables 2 and 3, respectively. Our analysis involves multiple simultaneous comparisons, which increases the likelihood of a Type I



Study I



Study II (Mid-Atlantic)



Study II (rest of United States)

FIGURE 3 Percent of participants willing to purchase products by water type and price

error. To account for the family-wise error rate and guard against the rejection of a true null hypothesis, we use a Bonferroni correction of the Wald test probability values (BCP).[9] We find that participants prefer ($BCP \leq 0.007$) groundwater and groundwater drawn from an aquifer recharged with recycled water over recycled water for potable and irrigation purposes. Our results also show that there is no significant difference ($BCP = 1.000$) in participants' preferences for groundwater and groundwater drawn 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.

We find that the frequency of a participant's consumption of trophic level 1 (spinach) and trophic level 2 (lamb chops, cheddar cheese, hot chocolate mix) products has a statistically significant ($p \leq 0.006$) and positive effect on participants' likelihood of purchasing a product. However, the frequency of participants' consumption of trophic level 0 (bottled water) products has a marginally statistically significant effect ($p = 0.071$). This is likely because healthy adults regularly drink water on a daily basis, with "daily" being the most frequent category of consumption participants could choose. Other control variables tested, such as sex, age, ethnicity, household income, educational attainment, political affiliation, having a child under 18 years old in the household, previous knowledge about the different types of water, whether participants grow their own food, the type of water participants most often drink, and experimental site had no statistically significant effect on participants' purchasing decisions.

To determine whether a product's trophic level can have a mitigating effect on the stigma associated with recycled water, we estimate an iteration of Equation 4 that includes a matrix of interaction terms between trophic level and water type ($W_{ij}T_{ij}$).

$$log\left(\frac{D_{ij}}{1-D_{ij}}\right) = \alpha + \beta_1{}'P_{ij} + \beta_2{}'W_{ij} + \beta_3{}'T_{ij} + \beta_4{}'W_{ij}T_{ij} + \beta_5{}'X_i + \mu_i + \varepsilon_{ij} \tag{5}$$

The regression results for Equation 5 are reported in Table 2. Wald tests for Equation 5 are presented in Table 4. We find no statistically significant difference in consumers' preferences for the trophic level 0 (bottled water) and trophic level 1 (spinach) products regardless of water type ($BCP = 0.439$ for groundwater, $BCP = 1.000$ for groundwater drawn from an aquifer recharged with recycled water, and $BCP = 0.583$ for recycled water). This suggests participants do not view food crops as a barrier between them and the water with which they were irrigated. For all water types, we find that participants prefer the products from trophic level 2 (lamb chops, cheddar cheese, and hot chocolate mix) over the product from trophic level 0 (bottled water) ($BCP \leq 0.020$). This indicates that the herbivores in trophic level 2 provide enough separation from the recycled irrigation water to mitigate consumers' stigma. Animals that eat crops irrigated with recycled water possess significantly less stigma than the water itself.[10]

2.2 | Study II

The data from Study II are divided into two fully powered subsamples—the four oversampled mid-Atlantic states of Delaware, Maryland, New Jersey, and Pennsylvania, and the rest of the United States. Descriptive statistics for the sociodemographic characteristics of both subsamples are presented in Table 1. Both subsamples are representative of their respective regions based on educational attainment, ethnicity, household income, and age. The rest of the U.S. subsample is also representative based on sex, whereas the mid-Atlantic subsample has a slight overrepresentation of women.

The second and third panes of Figure 3 show the percent of consumers willing to purchase products produced with different types of water in the two subsamples collected during Study II. Similar to what we found in Study I, Figure 3 suggests that although consumers may not differentiate between groundwater and groundwater drawn from an aquifer recharged with recycled water, the percent of participants willing to purchase products produced with recycled water tends to be lower across all price ranges. To test this, we estimate Equation 4 for each subsample. Regression results are presented in Table 2 and the corresponding Wald test results are reported in Table 3. Study I's findings are largely replicated using a nationwide sample. In both subsamples, participants prefer

TABLE 2 Results of stigma mitigation strategies

	Study I				Study II (mid-Atlantic)				Study II (rest of United States)			
	Equation 4		Equation 5		Equation 4		Equation 5		Equation 4		Equation 5	
	Coef.	*S.E.*	*Coef.*	*S.E.*	*Coef.*	*S.E.*	*Coef.*	*S.E.*	*Coef.*	*S.E.*	*Coef.*	*S.E.*
Price	−0.398***	(0.041)	−0.400***	(0.041)	−0.359***	(0.026)	−0.359***	(0.026)	−0.326***	(0.026)	−0.326***	(0.026)
Trophic level												
1	0.448**	(0.175)	0.484*	(0.232)	0.540***	(0.082)	0.713***	(0.132)	0.554***	(0.089)	0.706***	(0.153)
2	0.856***	(0.179)	1.092***	(0.212)	1.318***	(0.103)	1.366***	(0.141)	1.269***	(0.111)	1.373***	(0.140)
Water type												
Recharged aquifer	−0.059	(0.175)	0.174	(0.228)	−0.208*	(0.106)	0.018	(0.177)	−0.066	(0.100)	0.100	(0.173)
Recycled	−0.612***	(0.178)	−0.426	(0.260)	−0.480***	(0.116)	−0.530**	(0.186)	−0.295**	(0.111)	−0.176	(0.190)
Interactions												
Recharged Trophic level 1*			−0.115	(0.265)			−0.371	(0.193)			−0.300	(0.210)
Recharged Trophic level 2*			−0.362	(0.206)			−0.247	(0.168)			−0.173	(0.170)
Recycled Trophic Level 1*			0.036	(0.307)			−0.143	(0.190)			−0.156	(0.223)
Recycled Trophic Level 2*			−0.334	(0.235)			0.111	(0.162)			−0.139	(0.171)
Frequency of consumption												
Trophic level 0	0.187	(0.103)	0.187	(0.103)	0.143	(0.075)	0.143	(0.075)	0.105	(0.085)	0.105	(0.085)
Trophic level 1	0.291**	(0.106)	0.292**	(0.106)	0.206*	(0.085)	0.206*	(0.085)	0.369***	(0.093)	0.369***	(0.093)
Trophic level 2	1.040***	(0.183)	1.042***	(0.183)	1.316***	(0.158)	1.317***	(0.158)	1.086***	(0.169)	1.087***	(0.169)
Constant	−4.873***	(0.638)	−5.017***	(0.642)	−5.168***	(0.475)	−5.235***	(0.479)	−5.109***	(0.548)	−5.206***	(0.553)
Total N	4710		4710		9828		9828		10,080		10,080	
Individuals	314		314		546		546		560		560	
AIC	3905		3910		9521		9523		9631		9637	
BIC	3970		4000		9593		9624		9704		9738	

Note: Sex, age, ethnicity, household income, educational attainment, political affiliation, having a child under 18 years old in the household, previous knowledge about the different types of water, and the type of water participants most often drink had no statistically significant effect on participants' purchasing decisions and excluding them does not affect the coefficients of interest. For Study I, the same is true for whether participants grow their own food; data collected at experiment site. In Study II, participants were not asked whether they grow their own food; all data were collected online. These results are available upon request.
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

TABLE 3 Wald tests from Equation 4

Wald test	χ^2	Prob.	BCP
Study I			
Ground = Recharged aquifer	0.11	0.738	1.000
Ground = Recycled	11.78	0.001	0.007
Recharged aquifer = Recycled	14.41	0.000	0.002
Study II (mid-Atlantic)			
Ground = Recharged aquifer	3.90	0.048	0.581
Ground = Recycled	17.03	0.000	0.000
Recharged aquifer = Recycled	9.82	0.002	0.021
Study II (rest of United States)			
Ground = Recharged aquifer	0.44	0.507	1.000
Ground = Recycled	7.12	0.008	0.092
Recharged aquifer = Recycled	8.96	0.003	0.033

Abbreviation: BCP, Bonferroni Corrected Probability Value.

TABLE 4 Wald tests from Equation 5

	Study I								
	Ground			**Recharged aquifer**			**Recycled**		
Wald test	χ^2	**Prob.**	**BCP**	χ^2	**Prob.**	**BCP**	χ^2	**Prob.**	**BCP**
Tropic level 0 = Tropic level 1	4.37	0.037	0.439	2.53	0.112	1.000	3.89	0.049	0.583
Tropic level 0 = Tropic level 2	26.39	0.000	0.000	11.41	0.001	0.009	9.87	0.002	0.020
Tropic level 1 = Tropic level 2	12.01	0.001	0.006	5.55	0.019	0.222	1.63	0.202	1.000
	Study II (mid-Atlantic)								
	Ground			**Recharged aquifer**			**Recycled**		
Wald test	χ^2	**Prob.**	**BCP**	χ^2	**Prob.**	**BCP**	χ^2	**Prob.**	**BCP**
Tropic level 0 = Tropic level 1	29.33	0.000	0.000	6.13	0.013	0.160	15.84	0.000	0.001
Tropic level 0 = Tropic level 2	93.27	0.000	0.000	68.14	0.000	0.000	115.54	0.000	0.000
Tropic level 1 = Tropic level 2	27.02	0.000	0.000	37.57	0.000	0.000	51.68	0.000	0.000
	Study II (rest of United States)								
	Ground			**Recharged aquifer**			**Recycled**		
Wald test	χ^2	**Prob.**	**BCP**	χ^2	**Prob.**	**BCP**	χ^2	**Prob.**	**BCP**
Tropic level 0 = Tropic level 1	21.37	0.000	0.000	7.42	0.007	0.078	12.05	0.001	0.006
Tropic level 0 = Tropic level 2	96.64	0.000	0.000	68.77	0.000	0.000	61.67	0.000	0.000
Tropic level 1 = Tropic level 2	24.00	0.000	0.000	32.42	0.000	0.000	27.49	0.000	0.000

Abbreviation: BCP, Bonferroni Corrected Probability Value.

groundwater and groundwater drawn from an aquifer recharged with recycled water over recycled water for potable and irrigation purposes ($BCP \le 0.021$ for the mid-Atlantic subsample, $BCP \le 0.092$ for the rest of the U.S. subsample). Results also show that there is no statistically significant difference in participants' preferences for groundwater and groundwater drawn from an aquifer recharged with recycled water ($BCP = 0.581$ for the mid-Atlantic subsample, $BCP = 1.000$ for the rest of the U.S. subsample). The results from both subsamples also indicate that passing recycled water through an aquifer before using it for drinking, and irrigation can remove the stigma associated with recycled water, consistent with the findings in Study I.

In line with the results in Study I, consumption frequency of trophic level 1 (spinach) and 2 (lamb chops, cheddar cheese, hot chocolate mix) products has a statistically significant and positive effect on participants' likelihood of purchasing a product ($p \leq 0.015$ for the mid-Atlantic subsample, $p = 0.000$ for the rest of the U.S. subsample). Participants' consumption frequency of trophic level 0 (bottled water) products remains marginally statistically significant ($p = 0.058$) for the mid-Atlantic subsample, similar to the findings in Study I, and is statistically insignificant ($p = 0.220$) for the rest of the U.S. subsample.

To check the robustness of the trophic level findings in Study I, we estimate Equation 5 for both subsamples (see Table 2 for regression results). Wald test results for Equation 5 are displayed in Table 4 and indicate that a product's trophic level has a stronger mitigating effect on the stigma associated with recycled water than Study I suggested. With groundwater and recycled water, we find that participants prefer ($BCP \leq 0.001$ for the mid-Atlantic subsample, $BCP \leq 0.006$ for the rest of the U.S. subsample) products from trophic level 1 (spinach) over those from trophic level 0 (bottled water). Whereas with groundwater drawn from an aquifer recharged with recycled water, there is no statistically significant difference ($BCP \leq 0.160$) for the mid-Atlantic subsample and only a marginally statistically significant difference ($BCP \leq 0.078$) for the rest of the U.S. subsample. For all water types, participants from both subsamples prefer ($BCP \leq 0.000$) products from trophic level 2 (lamb chops, cheddar cheese, hot chocolate mix, and sirloin steak) over those from trophic level 0. These results imply that crops irrigated with recycled water do not inherit all the stigma attached to recycled water itself and the animal that eats the crop inherits even less. Each trophic level above recycled water is a barrier that significantly reduces the concerns about the negative effects of recycled water.

2.3 | Effects of drought and environmental views on purchasing decisions

The post-experiment survey in Study II includes questions regarding the frequency of drought experienced by participants and whether they perceive the types of water used in our analysis as environmentally friendly. Previous studies have found that drought can influence consumer behavior and demand toward water. Dascher et al. (2014) find that perceived consumer effectiveness on drought has a direct impact on consumers' stated consumption of water, and Callison and Holland (2017) observe that those who have experienced water scarcity are more willing to change their future behavior regarding water conservation. Dorner et al. (2019) show that among Australian consumers who frequently experience drought, source-specific risk significantly influences preferences for alternative water sources. Furthermore, Garrone et al.'s (2019) meta-regression analysis indicates that water scarcity is a significant driver of the price elasticity of water demand, albeit to a lesser extent in environmentally concerned communities because they are already consuming below their desired level of usage.

To examine whether frequency of drought and environmental views impact consumers' purchasing decisions, we estimate an expanded version of Equation 4 that includes a variable for drought frequency ranging from one (never experience drought) to five (year-round drought), dummy variables indicating participants' perceptions of a specific water type and interactions of these variables with water types (see Table 5). Regression results reported in column 1 of Table 5 suggest that participants from the mid-Atlantic subsample who live in a community with a higher frequency of drought are more likely to make a purchasing decision ($p = 0.040$). However, the frequency

TABLE 5 Effects of drought and environmental views on purchasing decisions

	Study II (mid-Atlantic)				Study II (rest of United States)			
	(1)		(2)		(3)		(4)	
	Coef.	*S.E.*	*Coef.*	*S.E.*	*Coef.*	*S.E.*	*Coef.*	*S.E.*
Price	−0.359***	(0.026)	−0.363***	(0.026)	−0.327***	(0.026)	−0.332***	(0.027)
Trophic level								
1	0.541***	(0.082)	0.551***	(0.083)	0.554***	(0.089)	0.561***	(0.091)
2	1.318***	(0.103)	1.335***	(0.105)	1.272***	(0.111)	1.293***	(0.112)
Water type								
Recharged aquifer	−0.208*	(0.106)	−1.078***	(0.257)	−0.066	(0.100)	−1.058***	(0.253)
Recycled	−0.480***	(0.116)	−1.471***	(0.292)	−0.295**	(0.111)	−1.136***	(0.298)
Experience and perceptions								
Drought frequency	0.190*	(0.092)	0.163	(0.110)	0.122	(0.087)	0.040	(0.104)
Env friendly Recharged	−0.038	(0.205)	−0.029	(0.256)	−0.095	(0.245)	−0.245	(0.279)
Env friendly Recycled	0.526**	(0.223)	−0.286	(0.272)	0.593**	(0.227)	0.084	(0.271)
Interactions								
Recharged Drought Frequency*			0.012	(0.098)			0.164	(0.086)
Recycled Drought Frequency*			0.082	(0.106)			0.090	(0.094)
Recharged Env Friendly Recharged*			0.243	(0.256)			0.426	(0.238)
Recycled Env Friendly Recharged*			−0.266	(0.295)			0.041	(0.256)
Recharged Env Friendly Recycled*			1.088***	(0.268)			0.615*	(0.255)
Recycled Env Friendly Recycled*			1.518***	(0.312)			0.979***	(0.271)
Frequency of consumption								
Trophic level 0	0.035	(0.091)	0.036	(0.093)	0.076	(0.102)	0.075	(0.103)
Trophic level 1	0.201*	(0.087)	0.207*	(0.089)	0.301**	(0.098)	0.304**	(0.099)
Trophic level 2	1.248***	(0.165)	1.270***	(0.168)	0.977***	(0.179)	0.989***	(0.180)
Demographic Controls	Y		Y		Y		Y	
Constant	−5.662***	(0.594)	−5.174***	(0.614)	−5.398***	(0.749)	−4.867***	(0.771)
Total N	9828		9828		10,080		10,080	
Individuals	546		546		560		560	

Note: Demographic control variables include sex, age, ethnicity, household income, educational attainment, political affiliation, having a child under 18 years old in the household, previous knowledge about the different types of water, and the type of water participants most often drink. These variables have no statistically significant effect on participants' purchasing decisions.
$^{*}p < 0.05$. $^{**}p < 0.01$. $^{***}p < 0.001$.

TABLE 6 Wald tests for effects of drought and environmental views on purchasing decisions

Study II (mid-Atlantic)		
Wald test	χ^2	**Prob.**
View groundwater from aquifer recharged with recycled water as environmentally friendly		
Yes = No (ground)	0.01	0.911
Yes = No (recharged aquifer)	0.70	0.404
Yes = No (recycled)	1.21	0.271
View recycled water as environmentally friendly		
Yes = No (ground)	1.11	0.293
Yes = No (recharged aquifer)	8.25	0.004
Yes = No (recycled)	17.77	0.000
Study II (rest of United States)		
Wald test	χ^2	**Prob.**
View groundwater from aquifer recharged with recycled water as environmentally friendly		
Yes = No (ground)	0.77	0.380
Yes = No (recharged aquifer)	0.42	0.516
Yes = No (recycled)	0.50	0.478
View recycled water as environmentally friendly		
Yes = No (ground)	0.09	0.758
Yes = No (recharged aquifer)	7.15	0.007
Yes = No (recycled)	14.94	0.000

of drought in their community has no impact on their likelihood to purchase products produced with recycled water or groundwater drawn from an aquifer recharged with recycled water ($p \geq 0.441$). This result is unsurprising considering these four states are in a region of the United States that is historically water rich. Interestingly, participants from the rest of the U.S. subsample with a higher frequency of drought in their community are more likely to purchase products produced with groundwater drawn from an aquifer recharged with recycled water ($p = 0.056$). This suggests that as droughts become more common in consumers' communities, their willingness to purchase products made with this type of water may increase.

Wald test results reported in Table 6 (generated from the regression estimates presented in columns 2 and 4 of Table 5) show that participants in both subsamples who view recycled water as environmentally friendly are more likely to purchase ($p = 0.000$) products produced with it than are participants who do not share this view. Participants who hold this view are also more likely to purchase ($p \leq 0.007$) products made with groundwater drawn from an aquifer recharged with recycled water than are their counterparts. However, viewing groundwater drawn from an aquifer recharged with recycled water as environmentally friendly has no significant effect ($p \geq 0.271$) on the purchasing decisions of participants from either subsample.

Finally, we explore whether a set of sociodemographic characteristics has any effect on consumers' purchasing decisions. As noted above, the sociodemographic characteristics tested in Study I do not have any significant effects on participants' purchasing behavior. This is true for Study II as well—the control variables sex, age, ethnicity, household income, educational attainment, political affiliation, having a child under 18 years old in the household, previous knowledge about the different types of water, and the type of water participants most often drink have no statistically significant effects on participants' purchasing decisions.

3 | DISCUSSION

3.1 | Policy implications

The analysis presented in this paper shows evidence of the effectiveness of two strategies to mitigate the stigma associated with recycled water. As the number of states and water utilities actively exploring the feasibility of water recycling projects grows rapidly (U.S. Environmental Protection Agency, 2018), so does the need to understand how to gain public acceptance of recycled water and to evaluate cost–benefit tradeoffs of water recycling projects for potable and non-potable purposes. Our finding 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, provides valuable and, most importantly, actionable information for policymakers. Given that public acceptance of recycled water is critical for successful implementation of water recycling projects, our analysis suggests that policymakers should focus on indirect potable and non-potable water recycling projects that alleviate the stigma attached to recycled water.

Indirect potable and non-potable water recycling projects can play an important role in the integrated water management approach that is increasingly employed by U.S. municipalities and water utilities. Integrated water systems manage rising water demand through the diversification of water sources and the simultaneous implementation of demand reducing measures. Such projects have the potential to be implemented at scale and provide substantial volumes of high-quality water in a cost-effective manner. For example, the Groundwater Replenishment System (GWRS) facility in Orange County, California supplies enough potable water for 600,000 residents in the northern and central parts of Orange County. In 2010, the annual cost of groundwater recharge with recycled water at GWRS was \$0.39/m^3 (\$478/AF), and the cost of treated imported water was \$0.65/m^3 (\$800/AF) (Lazarova et al., 2013). Although the cost effectiveness of indirect potable reuse (IPR) projects is largely site specific, recycled water produced through IPR is generally less expensive than other alternative sources of water supply such as desalination (Cooley & Phurisamban, 2016) or importing water (Lazarova et al., 2013). It is, however, more expensive than direct potable reuse (DPR), which conveys recycled water directly into an existing water supply system, avoiding the additional costs associated with passing the water through a physical environmental barrier. This is true in both large coastal communities (Cooley & Phurisamban, 2016) and small-to-medium sized arid inland communities (Herman et al., 2017). However, the cost of public opposition to DPR projects is likely to be high.

Although estimates of capital and operational costs associated with water recycling projects are available, a lack of economic valuation related to the social costs and benefits of these projects precludes comprehensive economic analyses (Declercq et al., 2020). This implies that the benefits associated with implementation of water recycling projects, such as decreases in pollution discharge, improvements in groundwater quality, or mitigation of stigma related to recycled water are not taken into account when policymakers weigh the cost–benefit tradeoff of different water recycling schemes.

TABLE 7 U.S. consumers' mean willingness-to-pay

	Study I	Study II (mid-Atlantic)	Study II (rest of United States)	Study II (entire United States)
	Mean WTP (\$) [confidence interval]	*Mean WTP (\$) [confidence interval]*	*Mean WTP (\$) [confidence interval]*	*Mean WTP (\$) [confidence interval]*
Recycled	−2.39*** [−3.423, −1.365]	0.09 [−0.372, 0.562]	0.29 [−0.222, 0.799]	0.20 [−0.145, 0.537]
Recharged aquifer	−1.00* [−1.811, −0.199]	0.85*** [0.456, 1.249]	0.99*** [0.545, 1.436]	0.92*** [0.628, 1.211]
Ground	−0.86 [−1.659, −0.056]	1.43*** [1.066, 1.801]	1.19*** [0.760, 1.628]	1.33*** [1.051, 1.608]

Note: 95% confidence intervals were obtained using a bootstrap method.
$^*p < 0.050$. $^{***}p < 0.001$.

To help inform cost–benefit analyses of water recycling projects, we use a representative sample of the entire United States to quantify the value of the stigma-mitigating practice of passing recycled water through a physical barrier. Specifically, we estimate U.S. consumers' mean willingness to pay (MWTP) for products produced with three types of water under our analysis (Table 7). U.S. consumers' MWTP for products produced with recycled water ($0.20) is significantly smaller ($p < 0.001$) than both the MWTP for products produced with groundwater drawn from an aquifer recharged with recycled water ($0.92) and with groundwater ($1.33). Although the MWTP for products produced with groundwater is higher than that for groundwater drawn from an aquifer recharged with recycled water, this difference is only marginally statistically significant ($p < 0.060$).

We also find that participants' MWTP values vary across Study I, Study II (mid-Atlantic subsample), and Study II (rest of the U.S. subsample). For example, MWTP for products produced with recycled water among the Study II (rest of the U.S. subsample) participants ($0.29) is significantly higher ($p < 0.000$) than that among the Study I participants (−$2.39). Participants in the rest of the U.S. subsample are also willing to pay more for products produced with groundwater drawn from an aquifer recharged with recycled water ($0.99) than are the Study I (−$1.00) and Study II (mid-Atlantic subsample) ($0.85) participants, respectively. Although these differences are statistically significant only for Study I ($p < 0.000$), the results are in line with our finding that the participants in the rest of the U.S. subsample who experienced more frequent droughts are more likely to purchase products produced with groundwater drawn from an aquifer recharged with recycled water.

Estimates of MWTP values from the entire United States, and each of the subsamples also confirm our earlier analysis that consumers stigmatize recycled water and products produced with it. They also demonstrate the economic value consumers place on the stigma-mitigation technique of passing recycled water through a physical barrier. These estimates are useful for cost–benefit analyses of indirect potable and non-potable water reuse projects.

The second stigma mitigation strategy that we tested reveals that herbivores (trophic level 2) consuming crops irrigated with recycled water significantly reduces consumers' negative associations with recycled water.[11] Our results show that crops irrigated with recycled water do not inherit all stigma attached to recycled water itself, and the animals that consume the crop inherit even less stigma. Therefore, trophic levels act as a barrier that significantly reduces participants' concerns about the negative effects of recycled water. These results also have important policy implications, suggesting that agricultural producers should focus on using recycled water for feed and non-edible crops first and edible crops last. For example, in 2019, recycled water accounted for only 1.9% of the nearly 6 million irrigated acres in the United States that year (U.S. Department of Agriculture, 2020). Given that in California, the cost of non-potable recycled water, including the construction of a separate distribution system to deliver it to customers, is cheaper than construction of direct and indirect potable water recycling schemes (Cooley & Phurisamban, 2016), our results suggest the opportunity to substantially expand the use of recycled water without causing consumer backlash.

Finally, our analysis shows that as consumers experience more frequent droughts in their communities, their willingness to purchase products produced using groundwater drawn from an aquifer recharged with recycled water increases. They are also willing to pay more for products produced with this type of water. These results are intuitive and may partly explain why indirect and direct potable recycling projects receive more acceptance in semi-arid areas.

3.2 | Recruitment of representative samples in non-hypothetical experimental settings

Findings from field experiments that rely on convenience sampling are often subject to criticism as they may produce results that are not representative of the general population and lack external validity (Coppock, 2019). In Study II, we employ a novel twist in data collection—we recruit a representative sample in a non-hypothetical field experimental setting by soliciting mailing addresses from participants and informing them they would receive their cash and/or products through the mail at the conclusion of the experiment. This way we could maintain incentive compatibility when converting an in-person field experiment to an online field experiment administered through Qualtrics. We successfully replicate the results of Study I in Study II by collecting a nationally representative sample based on gender, educational attainment, household income, ethnicity, and age. This result supports previous studies that obtained consistent estimates from convenience and national samples (Coppock, 2019). It also contributes to the growing number of studies on replicability of experiments across different platforms, such as MTurk, Qualtrics, and YouGov.

Although this method proves effective and demonstrates a means to collect representative samples in non-hypothetical settings, it comes with additional financial costs. Collecting the Study II sample cost approximately 14% more per participant than the Study I sample. These additional costs are due to Qualtrics' fee for recruiting participants and the postage and materials to send participants their cash and/or products through the mail. This method of data collection also takes considerably longer. In Study I, it took three days to collect data from 314 participants, a rate of nearly 105 participants per day. For Study II, it took 63 days to collect data from 1106 participants, a rate of less than 18 participants per day. Part of this deceleration in the rate of data collection is because Study I used convenience sampling and Study II targeted nationally representative demographic quotas. Asking individuals in the online experiment for their mailing addresses resulted in a large number providing invalid addresses and an even greater number declining to participate. One of the strengths of in-person field experiments is the legitimacy that an administrator's presence lends the experiment. Future studies that employ this novel twist to data collection could ask participants for their email addresses rather than their physical mailing addresses. Participants may be more willing to provide an email address to receive payment through services such as PayPal or Venmo. Mailing addresses for those who purchase products could then be solicited through email.

4 | CONCLUSION

Though recycled water 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 type of water. However, those mitigation strategies do not typically eliminate consumers' feelings of disgust. Rather, how recycled water is framed and presented to consumers determines how *much* they are consciously disgusted (Ellis et al., 2019a, 2019b; Wester et al., 2016). Therefore, this study explores mitigation strategies that stress the barriers between a consumer and the contagions associated with recycled water.

Using an in-person field experiment and an online field experiment involving 1420 adult participants, we test several stigma-mitigation strategies using a revealed-preference, incentive-compatible mechanism. The findings show that consumers prefer products produced with groundwater and groundwater drawn 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.

We also find that the trophic level of an organism affects the degree of stigma consumers attach to products derived from it. Our results indicate that the greater the steps in the food chain between an organism and the use of recycled water, the less it is stigmatized. Crops irrigated with recycled water do not inherit all the stigma attached to recycled water itself and the animal that consumes the crop inherits even less. Each trophic level above recycled water is a barrier that significantly reduces participants' concerns about the negative effects of recycled water. These findings introduce two additional strategies policymakers, water managers, and industry stakeholders can use in their efforts to mitigate the stigma associated with recycled water. We also employ a novel twist to data collection in our online experiment that demonstrates an effective way to collect representative samples in non-hypothetical experimental settings.

These results provide valuable and, more importantly, *actionable* information for policymakers, water managers, and the agricultural and food industries. In our analysis, we 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 both remove the stigma attached to recycled water and contribute to solving the growing environmental problem of saltwater intrusions into aquifers. Artificial groundwater recharging is used by some water districts in California (California Association of Sanitation Agencies, 2019; Orange County Water District, 2019), but the success of the projects has been mixed due to public opposition to recycled water. This information is particularly valuable to policymakers and planners promoting these types of large-scale water recycling projects. Additional research is needed to see if consumers' responses to potable drinking water drawn 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 water 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 or sheep) 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. Statistically, fresh produce irrigated with recycled water is less stigmatized than potable recycled water but is more stigmatized than the byproducts of herbivores. If widespread adoption of recycled irrigation water is to succeed, producers should prioritize its use for feed and non-edible crops first and for produce last.

ACKNOWLEDGEMENTS

This study received ethics approval from the Institutional Review Board at the University of Delaware (1186504-1). Funding support for this research was provided by the USDA National Institute for Food and Agriculture (#20166800725064), which established CONSERVE: A Center of Excellence at the Nexus of Sustainable Water Reuse, Food, and Health, USDA National Institute for Food and Agriculture (#2019-67023-29854) that supports the Center for Behavioral and Experimental Agri-Environmental Research (CBEAR), and the National Science Foundation's EPSCoR Grant (#1757353 entitled "Water in the Changing Coastal Environmental of Delaware". The authors acknowledge the support of Natalie Brassill for obtaining potable reclaimed water, and Nathaniel Moneymaker and Wendy M.H. Ellis for their assistance with carrying out the online experiment.

ENDNOTES

[1] As part of the CONSERVE project, this study builds on the ideas and findings of past research on recycled water. However, all data presented in this article are original and have not been used in any other published article or unpublished manuscript.

[2] These findings have been consistent for a wide variety of produce, both those high in water content, such as strawberries (92%), spinach (92%), broccoli (91%), and baby carrots (87%), as well as those lower in water content, such as grapes (81%), dates (60%), and almonds (6%) (Almond Board of California, 2014; Barreveld, 1993; Bastin & Henken, 1997).

[3] The U.S. Environmental Protection Agency's National Water Reuse Action Plan encourages adoption of recycled water by municipalities across the United States (U.S. Environmental Protection Agency, 2019). It also includes plans to build five water-recycling projects in California, Hawaii, and Texas with the support of $16.98 million provided by the U.S. Bureau of Reclamation (U.S. Bureau of Reclamation, 2019).

[4] Results indicate that presentation order had no effect on purchase decisions in Study I or II.

[5] 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.

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

[7] For Study I, the mean price of bottled water (16 ounces) was \$0.96 (SD \$0.48), the mean price of spinach (8 ounces) was \$2.04 (SD \$1.02), the mean price of lamb chops (half pound) was \$5.93 (SD \$2.97), the mean price of cheddar cheese (1 pound) was \$4.26 (SD \$2.13), and the mean price of hot chocolate mix (16 ounces) was \$4.66 (SD \$2.33).

[8] For Study II, the mean price of bottled water (16 ounces) was \$1.45 (SD \$0.73), the mean price of spinach (8 ounces) was \$1.92 (SD \$0.96), the mean price of lamb chops (half pound) was \$5.50 (SD \$2.75), the mean price of cheddar cheese (1 pound) was \$4.34 (SD \$2.17), the mean price of hot chocolate mix (16 ounces) was \$4.36 (SD \$2.18), and the mean price of sirloin steak (6 ounces) was \$5.76 (SD \$2.88).

[9] The Bonferroni correction for the family of hypotheses displayed in Tables 3 and 4 is $\frac{p}{12}$.

[10] A breakdown of purchase decisions by product type can be found in Appendix S1.

[11] Using trophic levels as a stigma mitigation technique for recycled water has direct benefits to the general population. However, for vegetarians and vegans the benefits are more indirect. Our finding suggest that recycled water resources should be focused on animal feed operations first and potable drinking water projects last. If vegetarians and vegans are stigmatized by recycled water, this prioritization minimizes their interaction with stigmatized products. For vegetarians who consume animal byproducts, such as cheese, our trophic level findings are directly relevant to them, albeit in a more limited manner. When consuming produce irrigated with recycled water, vegetarians and vegans, like the wider population, can still use other proven mitigation strategies, such as drying, liquefying, and cooking with heat.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

How to cite this article: Ellis, Sean F., Olesya M. Savchenko, Kent D. Messer. 2022. "Mitigating stigma associated with recycled water." *American Journal of Agricultural Economics* 104(3): 1077–1099. https://doi.org/10.1111/ajae.12256