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Public knowledge, contaminant concerns, and support for recycled Water in the United States

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ABSTRACT

Water recycling is one potential solution to meeting the growing global demand for water in an age of dwindling freshwater supplies. However, public opposition has played a key role historically in blunting the broad implementation of water recycling technologies across the United States. Addressing public concerns and overcoming this opposition is critical to the political viability of water recycling programs as a response to growing water insecurity. This analysis builds on existing research on Americans' attitudes toward water recycling in three ways. First, it explores public understanding of basic elements of water recycling and identifies important gaps in public knowledge. Second, it examines the factors that most concern Americans about water recycling. Finally, it investigates how knowledge, specific concerns, and a range of other factors, including Americans' environmental priorities, local context, partisan leanings, and demographic characteristics, combine to influence attitudes toward recycled water. The results identify several promising targets for future educational outreach efforts to build public support for water recycling projects. Policy-relevant knowledge is the single most important predictor of support for water recycling. Yet, there is a stark knowledge gap between a highly informed few and an unaware majority. Bridging this gap could greatly increase support for water recycling. Concerns about sewage contamination were most corrosive to support for water recycling, making them a prime target for further outreach. Finally, our results suggest that future educational campaigns may seek to decouple water scarcity and climate change in the public mind to avoid exacerbating existing cleavages.

1. Introduction

By 2050, global water demand is projected to increase by 55% (WWAP, 2015). Within the United States, a 2014 GAO study revealed that forty state water managers expected significant shortages within at least some region of their states by 2024 (GAO, 2014). Increased adoption of water recycling technologies could help meet this growing demand. However, public resistance has hampered the widespread implementation of water recycling technologies within the United States (Bridgeman, 2004; Bruvold, 1988; Garcia-Cuerva et al., 2016; Jansen et al., 2007; Ormerod and Scott, 2013). As Jansen (Jansen, 2005, 49) notes, "technology is far advanced but obsolete if water reclamation is not accepted by the general public."

Given its critical importance for successful policy implementation, scholars have long examined the factors shaping popular beliefs about, and support for the use of recycled water both in the United States (Bruvold, 1972; Rozin et al., 2015) and around the world (Dean and Fielding, 2016; Dolnicar and Schäfer, 2009; Menegaki et al., 2007; Nijhawan et al., 2013; Ross et al., 2014; Velasquez and Yanful, 2015). These studies have identified several key factors that predict support for the use of recycled water including psychological factors such as disgust (the "Yuck" factor) and contamination (Rozin et al., 2015; Russell and Colleen, 2009; Smith et al., 2018); trust in municipal institutions (Haddad et al., 2009; Hurlimann et al., 2008; Ross et al., 2014; Syme and Williams, 1993); local context (Dolnicar et al., 2011; Garcia-Cuerva et al., 2016); and socio-demographic factors (Dolnicar et al., 2011; McKay and Hurlimann, 2003; Tsagarakis et al., 2007).

However, previous research into the attitudes of Americans toward recycled water has primarily employed focused surveys in drought-stricken regions (Bruvold, 1988; Harris-Lovett et al., 2015; Rock et al., 2012), major metropolitan areas (Haddad et al., 2009; Robinson et al., 2005; Rozin et al., 2015), or managers of water reuse facilities (Bischel

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et al., 2012). These sample cohorts provide important insights into the attitudes of Americans in communities where the need for water is most pressing, and thus the impetus to implement and/or expand water recycling technologies is greatest. However, such a targeted strategy raises questions of generalizability. Only Garcia-Cuerva et al. (2016) have examined some factors driving variation in attitudes toward recycled water among a nationally representative sample of Americans. This prior work attributes opposition to recycled water to the "Yuck Factor," and focuses heavily on demographic factors that influence willingness to use recycled water if there are financial incentives offered.

We build on this literature by conducting only the second nationally representative survey of American public opinion on the use of recycled water. Most importantly, we break new ground by exploring the influence of specific policy relevant knowledge – or lack thereof – as well as the nature of Americans' more pressing concerns about recycled water on their support for expanded implementation of water recycling technologies. In so doing, our findings can inform public outreach and educational efforts to address fundamental gaps in public understanding of water recycling technologies in an effort to build vital public support for this partial response to global water shortages. We also explore the influence of additional factors including concern about climate change and water shortages, local context, and partisan and ideological polarization on support for the use of recycled water. Our goal is to identify ways in which scientists, utilities, and policymakers at the federal, state and municipal level can build support for increased adoption of water recycling by addressing the fundamental gaps in knowledge and the most salient concerns held by the American public.

2. Data and methods

2.1. Survey instrument

To ensure the broad generalizability of our results, we embedded our module within a nationally representative online survey fielded by YouGov. YouGov draws stratified samples from a large opt-in panel to match the characteristics of the overall population in the American Community Survey conducted by the U.S. Census.[1] Our survey was administered from October 20 to October 23, 2017 to a final sample of 1000 Americans. Sample demographics and comparisons to both the 2016 General Social Survey and 2017 American Community Survey U.S. Census data are presented in Appendix A. The complete question wording of the instrument is presented in Appendix B.

2.2. Outcomes: relevant knowledge; risk perceptions; and support for recycled water

Our study explores (1) what Americans know – or don't know – about water recycling; (2) what are Americans' most pressing concerns about the use of recycled water; and (2) what percentage of Americans support using recycled water for a range of beneficial purposes. Knowledge and risk perceptions are dependent variables for the first stage of our analysis. The analysis concludes by examining relationships between knowledge, risk perception, and support for greater use of recycled water.

Most prior research on Americans' support for recycled water has employed a relatively crude proxy, subjects' self-reporting of whether they had heard of water recycling (e.g. Sims and Baumann, 1974). Instead, we follow recent research from Australia (Dean and Fielding, 2016; Dolnicar and Schäfer, 2006, 2009) and examine subjects' factual knowledge about key aspects of water recycling. To measure public knowledge and understanding of recycled water, we adapted approaches from the literature on measuring scientific literacy (see: Laugksch, 2000). Since 1972 the National Science Board has employed a battery of eleven factual knowledge questions, ten of which are true/false, to measure scientific literacy for its *Science and Engineering Indicators* series. Building on this model, we asked respondents a series of four true-or-false questions.

The survey began with the concise definition: "Water recycling is reusing treated wastewater for beneficial purposes." Subjects then received brief instructions on how to answer the four knowledge questions: "For each statement about recycled water below, please tell me if it is true or false. If you don't know or aren't sure, just say so, and skip to the next question." This language was directly adapted from that used by the National Science Board.[2]

Subjects were then asked four factual knowledge questions. The first focused on the economics of recycled water and asked subjects whether or not "recycling water is more expensive than removing salt from sea water." The second pair of questions asked about the extent to which water recycling is used in the United States. The first asked subjects to indicate whether "at least one of the ten largest cities in the U.S. uses recycled water for drinking water." The second asked whether "the United States recycles roughly 10% of the water that it uses." The final question focused on perceived health risks from consuming recycled water. This question asked subjects whether "there are documented cases of people becoming sick as a result of using recycled water that has been treated to meet standards and regulations."[3]

Gauging the level of public understanding of water recycling is important in its own right. However, we also hypothesize that greater levels of knowledge about recycled water will correlate with greater support for using recycled water, all else being equal.

Recycling wastewater requires the removal of a wide range of microcontaminants potentially hazardous to human health, including endocrine-disrupting and pharmaceutically active compounds, carcinogens from lubricants, fuels and pesticides, and human pathogens (Sedlak et al., 2000). Previous research on the public's perceptions of water recycling has identified a range of the concerns that citizens

[1] YouGov interviewed 1,126 respondents from a large opt-in panel, who were then matched down to a sample of 1,000 to produce our final dataset. The respondents were matched to a sampling frame on gender, age, race, education, party identification, ideology, and political interest. The frame was constructed by stratified sampling from the full 2010 American Community Survey (ACS) sample with selection within strata by weighted sampling with replacement. A recent multi-mode analysis showed that estimates from YouGov's opt-in panel were as accurate as those from an RDD telephone survey (with landlines and cell phones) and found only modest differences in estimates of political indicators and their correlates across survey modes (Ansolabehere and Schaffner, 2014).

[2] One concern with this approach questions the encouragement of "don't know" responses (Mondak, 1999; Mondak and Davis, 2001). Krosnick et al (2002) warns that instructions encouraging "don't know" responses may lead to "satisficing," as the option gives subjects an easy out from a cognitively demanding question. As a result, some have argued that researchers should simply omit the "don't know" option (Miller and Shannon, 2008), while others argue that doing so would simply add noise to the resulting knowledge scores (Luskin and Bullock, 2011; Sturgis et al., 2008). In a recent experimental analysis of the effects of "don't know" wordings on the National Science Board scientific literacy scores, Tourangeau et al. (2016) found that encouraging "don't know" responses improved both scale reliability and validity relative to alternate question wordings that either did not offer or actively discouraged "don't know" responses. As a result, our language on "don't knows" closely hews to that used by the National Science Board.

[3] This language was also taken from the EPA: "No documented cases of human health problems due to contact with recycled water that has been treated to standards, criteria, and regulations have been reported." https://www3.epa.gov/region9/water/recycling/#whatis. The correct answers to the first three questions are: recycled water does not cost more than desalinating seawater; the U.S. does not recycle 10% of the water that it uses (it recycles far less than that); and yes, at least one of America's ten largest cities (San Diego) drinks recycled water.

have with recycled water (Dolnicar and Schäfer, 2006, 2009). For example, in a study of Canadian college students Velasquez and Yanful (2015) found widespread concern about the efficacy of procedures for removing pharmaceuticals from recycled water. Understanding the relative importance of various concerns to the American public may help inform educational campaigns to clear up misconceptions and alleviate popular concerns that undermine support for the use of recycled water.

To measure the relative intensity of public concerns about a range of potential contaminants, we first informed all subjects that "recycled water undergoes extensive treatment to remove many potential contaminants." Subjects were then asked to rank order their level of concern from most to least with five potential contaminants – metals, such as lead or arsenic; pharmaceuticals; human waste/sewage; pesticides/agricultural chemicals; and industrial waste.

A greater understanding of what fears motivate public attitudes toward recycled water can help inform efforts at public education. Moreover, given past research on the importance of emotional disgust and fears of contamination in driving opposition to the reuse of urban wastewater (e.g. Rozin et al., 2015), we hypothesize that subjects most concerned with sewage will be the least likely to support the use of recycled water.

Our survey concludes by querying public support for the use of recycled water for a range of purposes. This question began with a prompt reminding subjects that there are regions of the United States where the demand for water exceeds the supply and that water recycling is one potential solution to the problem. Subjects were then asked, "Different people might have different opinions when it comes to using recycled water in their homes. How about you? Would you support or oppose using recycled water for each of the following purposes?" Subjects then indicated on a seven-point Likert scale ranging from strongly support to strongly oppose the use of recycled water for: watering the lawn; watering a vegetable garden; bathing; and drinking.

2.3. Independent variables: environmental priorities, partisanship/Ideology, and local context

In the only prior study of support for the use of recycled water among a nationally representative sample of Americans, Garcia-Cuerva et al. (2016) identified a subset of Americans as "water concerned" – those who selected water shortages as the most important environmental problem facing the United States. These individuals were significantly more likely to support the use of recycled water than subjects who identified a different environmental problem as most pressing. To account for this dynamic, we asked subjects their relative concern with a number of environmental problems. Subjects were first told that "the United States faces many environmental challenges." They were then asked to indicate "on a scale of 1–10, how serious are each of the following problems for the country." The first environmental problem on the list was shortages of clean drinking water. We expect subjects who perceive a more pressing threat to fresh water supplies will also be more supportive of recycled water.

As more and more environmental problems from water shortages (Gosling and Arnell, 2016) to severe weather (Wuebbles et al., 2014) are linked to global climate change, beliefs about the threat imposed by climate change may increasingly shape how Americans assess other environmental challenges. Americans who perceive a greater threat from climate change may be more supportive of efforts to address its consequences, including water recycling. To test this hypothesis, in the question described previously we also asked subjects to indicate how serious of a problem is posed by "climate change/global warming."

Given the intense polarization of many questions of science and environmental policy in contemporary American politics (Bolsen and Druckman, 2015; Christenson et al., 2017; Hart and Nisbet, 2012; McCright and Dunlap, 2011), we also examine the extent to which attitudes toward recycled water are polarized along partisan lines.[4] Accordingly, we asked subjects to indicate their partisan affiliation on a seven-point scale ranging from strong Democrat to strong Republican. If attitudes toward water recycling follow other polarized environmental attitudes, then stronger affiliation with the Republican Party should decrease the likelihood of supporting recycled water.

Past research has found some evidence that local experience with water shortages affects Americans' attitudes toward water and behaviors. For example, subjects from states that were experiencing moderate to severe drought according to the Palmer Drought Severity Index were more likely to identify water shortages as the most important environmental problem facing the country (Garcia-Cuerva et al., 2016). However, little connection existed between state-level drought indicators and support for the use of recycled water. Our geocoded survey data provided each subject's home state as well as ZIP code. We matched each ZIP code to its corresponding county and then merged in county-level drought data from the United States Drought Monitor. We included the number of non-consecutive weeks each county experienced moderate drought conditions over the 12 months prior to our survey entering the field[5] to examine the influence of local experience with drought conditions at a much lower level of aggregation. For example, more than half of California counties experienced moderate drought conditions for the entire year preceding our survey. However, a quarter of California counties experienced 14 or fewer weeks of moderate drought conditions during that time. Our county-level measures allow us to capture this significant intra-state variation and test whether recent local exposure to drought conditions increases support for recycled water.

Finally, our survey instrument also collected background demographic and socioeconomic information that has been shown to affect attitudes toward recycled water in prior research (for an overview, see Dolnicar et al., 2011, 935). Specifically, we collected data on each subject's gender, age, educational attainment, and racial/ethnic background.

2.4. Statistical analyses

A negative binomial event count model is estimated to examine the relationships between political, demographic, and contextual variables and each subject's level of policy relevant knowledge (the number of factual knowledge questions answered correctly, ranging from zero to four).

Because the share of Americans supporting the use of recycled water for drinking is the most policy-relevant variable, we construct a binary dependent variable coded 1 if a subject supports the use of recycled water for drinking and 0 otherwise. A logistic regression model is then used to examine the influence of relevant knowledge, specific concerns, local context, environmental priorities, political ideology and other demographic factors on support for recycled drinking water. Simulations are used to illustrate the substantive effect of each variable on the predicted probability of a subject supporting the use of recycled water for drinking while holding all other variables constant at their

[4] Partisanship and ideology are too highly correlated in our survey to tease out the relative influence of each by including both in our statistical analyses. In the paper, we focus on political partisanship; however, the results are similar if we instead use a measure of ideology on a five-point scale ranging from very liberal to very conservative.

[5] County-level drought data for the period October 21, 2016 to October 20, 2017 obtained from the United States Drought Monitor, https://droughtmonitor.unl.edu/Data/DataDownload/WeeksInDrought.aspx. Moderate drought is category D1. We also collected data on the number of non-consecutive weeks that each county experienced severe drought conditions (category D3) during this period. Most ZIP codes matched uniquely into a single county. For those that spanned multiple counties, we assigned subjects to the county that contained the largest share of the ZIP code's population.

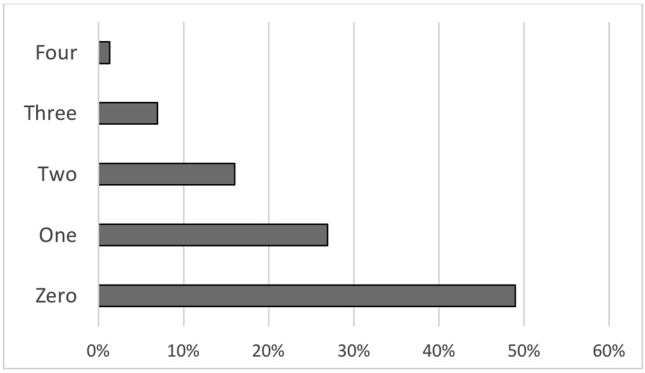

Fig. 1. Number of Policy Knowledge Questions Answered Correctly.

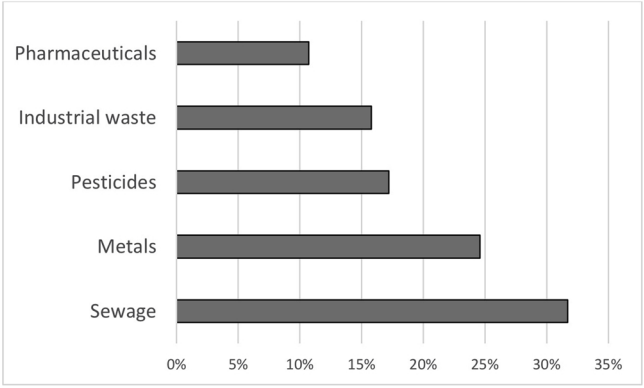

Fig. 2. Most Important Concern about Recycled Water.

median values.

3. Results and discussion

3.1. Policy relevant knowledge

An extensive literature has documented the serious gaps in most Americans' scientific literacy (e.g. Miller, 1983, 1998). Responses to the battery of four factual knowledge questions about water recycling show that when moving from general science knowledge to more policy-specific information there are even greater gaps in public understanding. As shown in Fig. 1, just over 1% of our sample correctly answered all four true-or-false knowledge questions.[6] By contrast, just under 50% failed to answer a single question correctly. Over 35% of our sample correctly answered that one of the nation's ten largest cities (San Diego) already uses recycled water. This was the highest correct response rate of the four questions. By contrast, fewer than 10% correctly identified the statement that the United States recycles roughly 10% of the water that it uses as false. Between half and two thirds of subjects acknowledged that they did not know the answer to each of the four questions.

To put these numbers in comparative perspective, from 2001 through 2014, the average American has correctly answered just under 6 of 9 true-or-false general science knowledge questions on the National Science Board battery (National Science Board, 2016, 7–42), or almost 66% of the questions asked. In our policy-specific battery, the average respondent answered just under one question correctly, or less than 25% of questions asked.

3.2. Public concerns about recycled water

The survey clearly shows that concerns about sewage treatment are paramount when Americans think about recycled water. As shown in Fig. 2, over 30% of our sample identified sewage as the potential contaminant that most concerned them. More than half of our sample identified sewage as either their foremost or second most important concern. This is consistent with an extensive literature on the prevalence of the "Yuck" factor (e.g. Rozin et al., 2015)) and the efficacy of opposition campaigns using the imagery of "toilet to tap" (Menegaki et al., 2009). Metals, such as lead or arsenic, were the second highest contaminant of concern. This perhaps reflects the heavy media salience of the Flint water crisis that dominated headlines throughout 2016-2017. Interestingly, despite growing scientific concern about the safe removal of pharmaceuticals from recycled water (Sedlak et al., 2000; Wu et al., 2015), just over 10% of subjects identified pharmaceuticals as their greatest concern and more than 40% ranked pharmaceuticals as the potential contaminant that least concerned them.

3.3. Support for using recycled water for various purposes

Fig. 3 presents the percentage of subjects strongly or somewhat supporting the use of recycled water for four purposes. Strongly consistent with prior results, the data clearly show that support for recycled water wanes as the degree of human proximity and contact increases (Dolnicar and Schäfer, 2009; Garcia-Cuerva et al., 2016; Hartley, 2006). Whereas more than 70% of subjects supported using recycled water for watering lawns and even vegetable gardens, only 58% of subjects supported using it for bathing. And finally, only 38% of respondents supported the use of recycled water for direct human consumption as drinking water. This figure is very close to the 43% of subjects who supported the use of recycled water in their residence observed by Garcia-Cuerva et al. (2016).

3.4. Modeling support for drinking recycled water

Table 1 presents the results of a logit model that assesses the influence of policy specific knowledge, specific concerns, and a range of other factors on the probability of a subject strongly or somewhat supporting drinking recycled water.[7] Descriptive statistics for the dependent variable and all independent variables included in the analysis are presented in Appendix C.

Strongly consistent with our first hypothesis, the coefficient for relevant knowledge about recycled water is positive and statistically significant. Indeed, first differences derived from simulations show that relevant knowledge is the strongest predictor of support for recycled drinking water. Each additional point on the four-point knowledge index increases the predicted probability of the median respondent supporting the use of recycled water for drinking by ˜10%.

The logit analysis also examines whether subjects' relative concern with various potential contaminants in recycled water correlate with support for water recycling.[8] Consistent with our hypothesis, the coefficient on the variable indicating subjects who identified sewage as the potential contaminant that most concerned them is negative and statistically significant.[9] First differences show that subjects who were most concerned with sewage were 13% less likely to support the use of

[6] All percentages in Figs. 1–3 and reported in the text were calculated using survey weights. Using unweighted percentages yields virtually identical patterns.

[7] Although not the focus of our analysis, identically specified models of support for using recycled water for bathing, watering lawns, and watering gardens are presented in Appendix D.

[8] Subjects identifying pharmaceuticals as the contaminant that most concerned them comprise the omitted baseline category.

[9] Alternately, we re-estimated the logit model with the average ranking of concern with each contaminant. This operationalization yielded substantively similar results.

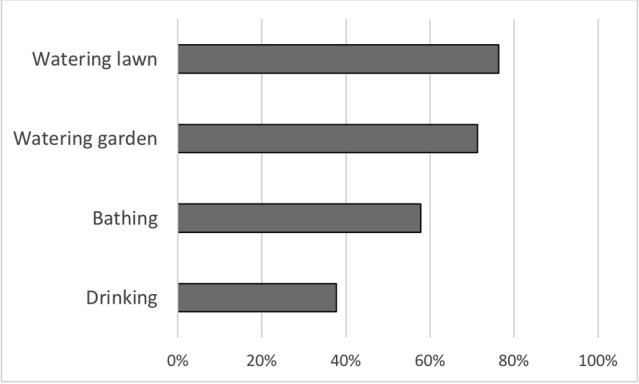

Fig. 3. Support for Using Recycled Water for Various Purposes.

Table 1
Logistic Regression Model of Support for Drinking Recycled Water.

	(1)
Knowledge	0.481***
	(0.070)
MIC Sewage	−0.570**
	(0.237)
MIC Metals	−0.194
	(0.237)
MIC pesticides	−0.172
	(0.260)
MIC industrial waste	−0.139
	(0.265)
Water priority	0.042
	(0.030)
Climate change priority	0.077***
	(0.028)
Weeks of drought	−0.004
	(0.005)
Partisanship	−0.004
	(0.041)
Male	0.504***
	(0.144)
Age	−0.017***
	(0.004)
Education	0.025
	(0.050)
Black	−0.153
	(0.223)
Latino	0.192
	(0.208)
Constant	−1.031**
	(0.479)
Observations	1000

Note: Standard errors in parentheses. All significance tests are two-tailed.
* p < .10.
** p < .05.
*** p < .01.

recycled water for drinking than were those in the baseline group, all else being equal. None of the other contaminant concern coefficients were statistically significant.

Both the coefficient for the priority a subject gave to fresh water shortages and to climate change were positive; however, only the latter was statistically significant. Americans who believe addressing climate change is an acute priority were more likely to support the use of recycled drinking water than were their peers who were less concerned with climate change. First differences reveal that increasing the median subject's climate change priority from its mean value of 7 to its maximum value of 10 (a one standard deviation increase) increases her/his probability of supporting recycled drinking water by 6%.

The model finds no evidence that support for recycled water is influenced by subjects' recent local experience with moderate drought conditions. The relevant coefficient is negative and statistically insignificant. Replicating the analysis with the number of non-consecutive weeks of extreme drought conditions similarly yielded a null result. This is consistent with Garcia-Cuerva et al. (2016) who also found no connection between state-level drought conditions and support for recycled water.

The model also offers little evidence that Americans' partisan affiliations affect their support for water recycling.[10] The coefficient on the partisan measure is negative, but statistically insignificant. This does not mean, however, that there is no partisan gap in support for recycled water. Across the sample as a whole, 41% of Democrats support drinking recycled water versus only 32% of Republicans. However, both the water priority and climate change priority measures are strongly correlated with partisanship. The latter correlation is particularly strong, as the median Democrat rated climate change a ten on the ten-point priority scale versus the median Republican, who rated climate change only a 5 on the priority scale. After controlling for these disparities in environmental priorities, partisanship had no independent impact on support for drinking recycled water.

Finally, the coefficients for two of the demographic variables were statistically significant. Men were significantly more likely to support drinking recycled water than women.[11] First differences reveal that the median male was about 12% more likely to support recycled drinking water than the median woman, with all other variables held constant. Older Americans were also significantly less likely to support drinking recycled water than were younger Americans.[12] First differences show that a one standard deviation increase in age decreases the predicted probability of the median respondent supporting recycled drinking water by about 7%.

4. Conclusions

The results of this nationally representative survey of Americans' attitudes toward recycled water build on past foundations in several important respects. First, the study uncovers the steep knowledge deficit that most Americans confront when asked to evaluate water recycling technologies. Scholars and policymakers have long tracked Americans' basic scientific literacy and warned about significant shortcomings in public understanding of science. However, our results suggest that on many specific science policy areas public knowledge may lag far below long-tracked measures of general scientific knowledge. The median subject in our sample answered only one of four true-or-false factual knowledge questions about recycled water correctly.

Our results suggest that this serious knowledge deficit is also an opportunity. Relevant knowledge was the strongest predictor of support for drinking recycled water in our logistic regression model. Public education efforts on any new technology face an uphill battle. However, our results suggest that the payoffs are considerable. Encouragingly, a sophisticated understanding of the technological hurdles and solutions may not be needed to build popular support for water recycling. Even a modest increase in public understanding of basic facts about water recycling technologies could translate into significant increases in public support for the technology.

Our results also suggest the most promising targets for more focused campaigns tailored to address concerns most corrosive to public support for water recycling. Public outreach campaigns have long battled the

[10] This is consistent with past studies that have found little evidence of major gaps in support for recycled water along partisan or ideological lines ((Haddad et al., 2009; Kasperson and Kasperson, 1977).

[11] This is consistent with past findings both in the U.S. and abroad (e.g. (Dolnicar and Schäfer, 2009; Garcia-Cuerva et al., 2016)

[12] Prior literature has yielded inconsistent findings regarding the direction of the relationship between support for recycled water and age. For an overview, see (Dolnicar et al., 2011, 935).

"Yuck" factor and widespread fears and misperceptions of a technology often labeled "toilet to tap" by its detractors (for an overview, see Po et al., 2003). However, our results suggest that concerns about sewage remain the most pressing for a significant share of Americans. Moreover, Americans who prioritized concerns over sewage were significantly less likely to support recycled water for public consumption than were Americans most concerned with alternate potential contaminants. Recent experimental research in the United Kingdom found little evidence that video messages emphasizing the selection of water treatment technologies to remove specific contaminants measurably increased support for widespread use of reclaimed water (Goodwin et al., 2018). Our results suggest that more targeted messages that focus specifically on concerns about sewage and the technologies may be more successful given its paramount concern to the public. Additional studies on the efficacy of more targeted campaigns could be an important ground for future research.

Finally, our results uncover a significant linkage between attitudes toward climate change and attitudes toward recycled water. The two are far from perfectly collinear. Nevertheless, this linkage raises another potential barrier to widespread implementation of recycled water technologies. As the public debate over climate change only continues to polarize (Dunlap et al., 2016), there is a threat that this polarization will spill over into other aspects of environmental policy that are not yet intensely polarized. Future research should probe this and related linkages further. However, our results suggest that public campaigns seeking to increase public support for water recycling may benefit from decoupling the issue at hand from the larger debate over climate change. This could be crucial to attracting the bipartisan political support that may be essential to broad and sustained government action.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Comparative Sample Demographics

	2017 YouGov	2016 GSS	US Census
Demographics			
Black	13%	17%	13%
Latino	14%	13%	18%
Female	51%	55%	51%
% College degree	26%	32%	32%
Median age	44 years	49 years	38 years
Married	48%	42%	48%
Political Characteristics			
Republican	31%	33%	
Democrat	43%	48%	
Ideology (% moderates)	37%	37%	

Note: Partisan variables include those who "lean" toward a political party. All Census figures taken from the 2017 American Community Survey. Our 2017 YouGov sample included subjects from all 50 states and the District of Columbia, as well as from 945 different ZIP codes.

Appendix B. Complete Questionnaire Wording

Q1: At your home, what is your main source of water?

1 Public supply
2 Private supply (e.g. private well)
3 Don't know

Q2: Water recycling is reusing treated wastewater for beneficial purposes.
For each statement about recycled water below, please tell me if it is true or false. If you don't know or aren't sure, just say so, and skip to the next question.

a.) Recycling water is more expensive than removing salt from sea water.
b.) At least one of the ten largest cities in the U.S. uses recycled water for drinking water.
c.) The United States recycles roughly 10% of the water that it uses.
d.) There are documented cases of people becoming sick as a result of using recycled water that has been treated to standards and regulations.

Q3: The United States faces many environmental challenges. On a scale of 1–10, how serious are each of the following problems for the country:

a.) Air pollution
b.) Climate change/global warming
c.) Domestic waste disposal/trash
d.) Nuclear waste disposal
e.) Industrial contamination

Q4: Recycled water undergoes extensive treatment to remove many potential contaminants.

We would like to know how concerned you are about a number of possible contaminants. Please rank the contaminants below from the one that you are most concerned about to the one that you are least concerned about.

a.) Metals, such as lead or arsenic
b.) Pharmaceuticals
c.) Human waste/sewage
d.) Pesticides/agricultural chemicals
e.) Industrial waste

Q5: As you may know, there are regions in the United States in which the demand for water exceeds the available supply. One possible solution to this problem is expanding the use of recycled water.

Different people might have different opinions when it comes to using recycled water in their homes. How about you? Would you support or oppose using recycled water for each of the following purposes?

a.) Drinking
b.) Bathing
c.) Watering a vegetable garden
d.) Watering the lawn

Response choices:

1 Strongly support
2 Support
3 Somewhat support
4 Neither support nor oppose
5 Somewhat oppose
6 Oppose
7 Strongly oppose

Partisanship and other demographic questions were standard YouGov question wordings.

Appendix C. Summary Statistics

	Mean	Std. Dev.	Min	Max
Support drinking	.37	.48	0	1
Knowledge	.86	1.01	0	4
MIC Sewage	.30	.46	0	1
MIC Metals	.27	.44	0	1
MIC Pesticides	.17	.37	0	1
MIC Industrial Waste	.15	.36	0	1
MIC Pharmaceuticals	.12	.33	0	1
Water Priority	6.87	2.71	1	10
Climate Change Priority	6.90	3.23	1	10
Weeks of Drought	15.06	14.79	0	53
Partisanship	3.72	2.02	1	7
Male	.49	.50	0	1
Age	44.78	17.17	16	86
Education	3.28	1.45	1	6
Black	.13	.33	0	1
Latino	.14	.35	0	1

Note: All means are unweighted.

Appendix D. Models of Public Support for Using Recycled Water for Various Purposes

	Drinking	Bathing	Garden	Lawn
Knowledge	0.481***	0.468***	0.447***	0.460***
	(0.070)	(0.074)	(0.086)	(0.096)
MIC Sewage	−0.570**	−0.583**	0.104	0.215
	(0.237)	(0.236)	(0.249)	(0.272)
MIC Metals	−0.194	−0.384	−0.047	−0.144
	(0.237)	(0.242)	(0.254)	(0.274)
MIC pesticides	−0.172	−0.620**	−0.134	−0.245
	(0.260)	(0.261)	(0.275)	(0.297)
MIC industrial waste	−0.139	−0.215	0.127	0.359
	(0.265)	(0.271)	(0.289)	(0.323)

Water priority	0.042	0.001	−0.026	−0.066*
	(0.030)	(0.028)	(0.031)	(0.034)
Climate change priority	0.077***	0.103***	0.107***	0.125***
	(0.028)	(0.027)	(0.029)	(0.032)
Weeks of drought	−0.004	−0.001	0.000	0.004
	(0.005)	(0.005)	(0.005)	(0.006)
Partisanship	−0.004	0.020	0.030	0.070
	(0.041)	(0.040)	(0.044)	(0.049)
Male	0.504***	0.409***	0.394***	0.291*
	(0.144)	(0.140)	(0.153)	(0.167)
Age	−0.017***	−0.004	0.004	0.019***
	(0.004)	(0.004)	(0.004)	(0.005)
Education	0.025	0.051	0.136**	0.271***
	(0.050)	(0.049)	(0.054)	(0.062)
Black	−0.153	−0.283	−0.919***	−0.787***
	(0.223)	(0.217)	(0.223)	(0.236)
Latino	0.192	0.080	−0.263	−0.047
	(0.208)	(0.207)	(0.219)	(0.237)
Constant	−1.031**	−0.547	−0.701	−1.523***
	(0.479)	(0.464)	(0.501)	(0.548)
Observations	1000	1000	1000	1000

Note: All models are logistic regressions. Standard errors are in parentheses. All significance tests are two-tailed.
* $p < .10$
** $p < .05$
*** $p < .01$

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