Journal of Benefit-Cost Analysis (2022), 13: 1, 107–119
doi:10.1017/bca.2021.14

CAMBRIDGE
UNIVERSITY PRESS

ARTICLE

Demand for an Environmental Public Good in the Time of COVID-19: A Statewide Water Quality Referendum

George Parsons[1,*], Laura A. Paul[2] and Kent D. Messer[2]

[1]School of Marine Science & Policy, University of Delaware, Newark, DE 19716, USA
[2]Department of Applied Economics & Statistics, University of Delaware, Newark, DE 19716, USA
*Corresponding author: e-mail: gparsons@udel.edu

Keywords: COVID, water quality, public goods, stated preference

JEL Codes: H41, Q25, Q26, Q28, Q51, Q53

Abstract

Due to COVID-19, many households faced hardships in the spring of 2020 – unemployment, an uncertain economic future, forced separation, and more. At the same time, the number of people who participated in outdoor recreation in many areas increased, as it was one of the few activities still permitted. How these experiences affect the public's willingness to pay (WTP) for environmental public goods is unknown. During the early months of the pandemic, we conducted a stated preference survey to value statewide water quality improvements in Delaware. While a majority of participants report experiencing hardship of some sort (economic, emotional, etc.), mean household WTP declined by only 7 % by May 2020.

1. Introduction

The impact of COVID-19 on markets has been large. Lost household income and increased uncertainty have caused the demand for many private goods (airline flights, restaurant visits, and haircuts) to drop, often precipitously. At the same time, the demand for other goods and services (hand sanitation products, video conferencing services, and food delivery) has increased significantly. Little has been reported, however, about the pandemic's effect on the demand for public goods. The expected effects are not obvious. Consider the demand for water quality improvement, which we do in this article. Lost income, economic uncertainty, and priorities perhaps shifting to other public expenditures (such as health care) suggest that demand may decrease. On the other hand, increased participation in outdoor recreation activities,[1] which are permitted (and even encouraged) for safety reasons, and a general

[1] Using trail-counter data the Delaware Department of Natural Resources and Environmental Control estimated a 72% increase in visitation to state parks with trails in 2020 over 2019 (Lafferty, 2021).

expectation that governments do more for people in the time of trouble suggests the demand may increase.

Using a stated preference referendum-style valuation survey, we consider how the demand for water quality improvements in the state of Delaware was influenced by the pandemic. Our analysis is particularly germane in that the Delaware legislature was considering a clean water bill at the time. Our referendum was designed to mimic that legislation without sacrificing the basic requirements for a good stated preference survey.

Water quality has been a longstanding issue in Delaware due to agricultural runoff in the south and industrial loads in the north. Delaware frequently ranks near the bottom among states in terms of water quality and meeting federal standards.[2] Water quality matters for drinking, withdrawal uses (agricultural and industrial), recreation, and ecosystems. Previous attempts to pass a water tax on households to fund clean-ups have failed, and so in early 2020, the Governor and legislature announced a new plan to raise funds directly through a budget reallocation. At the time of the announcement, 58 of 70 State Senators had signed on as co-sponsors and the likelihood of the legislation passing seemed high.[3] Then, COVID-19 broke and the outcome became highly uncertain. Economic and budgetary pressure had legislators tilting toward caution, yet an increase in outdoor recreation activities, including many water-based activities, suggested that there may be an increased desire for such use of public funds (Civic Science, 2020; Kecinski *et al.,* 2020).

To help inform the legislature during this time of heightened uncertainty and concern by constituents, we conducted a contingent valuation (CV) study in May 2020 to estimate households' willingness-to-pay (WTP) for improved water quality proposed in the state and included an evaluation of the effects of COVID-19 on the vote. In this way, our findings provide pertinent and timely information for environmental policymakers by presenting empirical evidence of voters' valuations of water quality improvements in the midst of the COVID-19 pandemic. Essentially, we asked respondents to report their current (May 2020) vote and then what their vote would have been prior to the outbreak. Along with the two-part vote we queried people about the impact of COVID-19 on their household in terms of economic, emotional, health, and educational hardship.

At the time of this study, Delaware, like most of the country, was being hit hard by the pandemic. When we collected the data, there were over 2600 cumulative cases and 400 deaths in Delaware (Delaware Environmental Public Health Tracking Network, 2021). These numbers would later skyrocket over the course of the pandemic. Delaware's population is near one million – one year after our survey was conducted, by 17 May 2021, Delaware reported over 107,800 positive cases with nearly 2000 deaths. The governor of Delaware declared a State of Emergency on 12 March 2020 (Carey, 2020).

Our survey follows best practices for stated preference surveys (Boyle, 2017; Johnston *et al.,* 2017*a*, *b*) with the caveat that our analysis intentionally confronts a "loading dock" problem – that is, linking the users (legislators) with the science (CV study) in a timely, credible, and accessible way for a real-world application. In our judgment CV as a tool, given the vast literature and experience, was up to the task, but it meant that some shortcuts ensued

[2] Despite improvements over the last four decades, Delaware's impaired waters include 377 bodies of water that suffer from excess nutrients, low dissolved oxygen, toxins, and/or bacteria that negatively affect human and aquatic life (Kauffman & Belden, 2010; DNREC, 2017)

[3] House Bill 200 (HB200), known as the "Clean Water for Delaware Act," was introduced in the Delaware House of Representatives in May 2019 (Longhurst, 2020).

https://doi.org/10.1017/bca.2021.14 Published online by Cambridge University Press

such as limited follow-up questions, no scope-test, and no focus groups (though there was extensive pretesting). We also provided a less extensive description of the change in resource than we might have done otherwise and did not consider variations in the size of the water quality change.[4] This study, in a sense, is a test of CV in the trenches. When budget and time constraints are tight as is the case in many governmental project analyses and damage assessments, the go-to approach is usually some form of benefits transfer. Original data collection is usually set aside for larger, longer term projects. We are encouraged by the analysis here that quick-turn-around, low-budget surveys of directly affected populations can provide useful approximations.

The COVID-19 pandemic also provided a unique setting for us to explore the impacts of a pandemic on the public's WTP for an environmental public good. Unlike most private goods, the direction and extent of the effect on the demand is uncertain, which complicates the formation of good public policy especially in a time when budgets were shrinking and the demand for other vital public services were on the rise. Improved water quality for recreation use may seem like a luxury good calling for obvious cutbacks to conserve state funds, but on a closer look this may not be good public policy. As substitutes for leisure activities are restricted and a need for relief of stress for mental health is documented, households may have a desire for funds to move in the direction of an improved environment. While the benefits in the near term may be limited (it takes time for water quality improvements to be realized), an increased use of the environment for recreation may heighten the awareness of nature and in turn the demand for its improvement. We shed some light on this issue for the current legislation under consideration in Delaware and for other similar circumstances should they arise in other settings.

The literature on the behavioral and welfare effects of the COVID-19 pandemic is growing. Our contribution to this literature is to provide some evidence of the pandemic's impact on the demand for a public good related to outdoor recreation. Several studies have looked at the effects on outdoor recreation directly. Landry *et al.* (2020) consider impacts on visitation to national parks and found a negative effect. Rice *et al.* (2020) also report a decline in outdoor recreation and distances traveled to sites. Also, the impact in urban areas was larger than in rural areas. These studies run counter to the increase in recreation use at local parks in Delaware reported by Lafferty (2021). Lock (2020) finds an increase in cycling in Australia, and Day (2020) finds that due to lockdown rules people shifted from driving to walking to recreation sites and continued to value greenspace in this way. Irwin and Livy (2021) found little change in the value of open space, and Rousseau and Deschacht (2020) find a short-term decline in concerns for things like pollution (since there was less of it during COVID-19) but a long-term interest in sustainability goals. These offsetting short- and long-term effects should be at play in our survey. In any case, as we sort through the findings on recreation use and values for nature, the results are mixed and our results provide further evidence yet.

Researchers have considered other impacts of the pandemic as well. Thunström *et al.* (2020) conducted a benefit–cost analysis of social distancing early in the outbreak and find large net benefits. Dunton *et al.* (2020) report on negative impacts on children, Sheth (2020) on the long-term effects on consumer behavior, and Bacher-Hicks *et al.* (2021) on the

[4] We thank Kevin Boyle and Rob Johnston for extremely timely (within a day of our request!) and thorough comments on our survey.

https://doi.org/10.1017/bca.2021.14 Published online by Cambridge University Press

impact of on-line learning on students. This list is not exhaustive, but it does demonstrate that it is an active area of research. Finally, we also contribute to the long-standing literature on water quality valuation (Mitchell & Carson, 1981; Gramlich, 1986; Van Houtven *et al.,* 2007; Griffiths *et al.,* 2012; Johnston *et al.,* 2017*b*; Keiser & Shapiro, 2019).

As our discussion of the demand for water quality improvements unfolds, there are several mechanisms to keep in mind. We thought it would be useful to lay these out early. Household demand might decrease due to lost income, fear of COVID-19 transmission, and local travel restrictions (Landry *et al. 2020*). On the other hand, household demand might increase, particularly for local and close-to-home environmental public goods (Rousseau & Deschacht, 2020) because transmission is less likely outdoors, because of decreasing opportunity costs of time, and because of increased need to substitute away from indoor activities (Day, 2020; Dunton *et al.,* 2020; Lock, 2020). Disentangling these *specific* mechanisms is beyond the scope of this article, but we can report that we find that the decrease in demand for water quality improvement is larger than the increase. We can also report evidence of heterogeneity across income groups (a larger impact on WTP in lower income groups), which is consistent with other results in different contexts (Bacher-Hicks *et al.,* 2021).

2 Study design and survey

We used an internet-based survey.[5] In addition to a referendum-style CV question, the survey consisted of questions about water use, the proposed legislation, households' perceptions of the effects of COVID-19 on their welfare, and respondents' demographic characteristics. The survey followed CV protocols – budget constraint reminder, the promise that the results would be shared with stakeholders involved in decision-making (consequentiality), clear definitions of the baseline condition and the change in the resource, majority-rule voting, guards against hypothetical bias (e.g., dissonance minimizer in our response format), and a simple single-shot referendum-style vote. Our goal was a short, defensible survey that would meet the needs of the legislative body.

Since the legislative initiative would apply statewide, the resource change we consider also applies statewide and approximates the largest magnitude of water quality change that might be expected from such an initiative. The baseline was 5 % of state waters being swimmable and 40 % being fishable (game fish, like bass, and perch). Respondents were told that passage of the referendum would result in Delaware's waterways rising to 40 % swimmable and 85 % fishable.[6] Finally, since the legislation includes upgrading some infrastructures and groundwater protections, we included a short passage mentioning protections along those lines.

Our payment vehicle is higher taxes and increases in the cost of living. We randomly assigned one of four bid levels ($15, $55, $207, and $426 – annually and indefinitely).

[5] A copy of the survey is included in Supplementary Material.

[6] These changes may seem large in comparison to Keiser and Shapiro's (2019) estimate that in total, from 1972 to 2001, the share of waters safe for fishing in the U.S. grew by only 12 percentage points. Their estimates, however, are coarser than ours. Most of the improvement in fishing we consider is going from rough fishing (like carp and catfish) to game fishing (like bass and perch). Keiser and Shapiro's estimates exclude these improvements. It is like moving from "good fishing" to "better fishing." On their scale both are considered fishable and so translate as no change in fishable waters.

https://doi.org/10.1017/bca.2021.14 Published online by Cambridge University Press

For some perspective, in earlier versions of the bill, the legislature had debated imposing a water tax of $45 per household to achieve the desired outcomes. More recently, Governor John Carney proposed an initial investment of $50 million in the Clean Water Trust account, which would amount to a cost of $50 per Delaware resident per year (or about $100 per household). Our understanding is that this would be a reoccurring budget allocation and would be up for vote each year by the legislature. In any case, $45–$100 would seem to be good markers for the state's estimate on the cost side.

We also ask participants to report the effects of the COVID-19 pandemic on their households in terms of economic, emotional, physical, and educational impacts, as well as degree of inconvenience. We use a five-point scale from "extreme hardship" to "things improved." Finally, we ask respondents if their vote on the referendum would have been different if they had voted before the pandemic occurred. This allows us to compute pre- and early-COVID-19 yes-response functions and estimates of WTP to address the question of whether the pandemic affected the demand for water quality. We refer to the post-period as "early-COVID-19" instead of "post-COVID-19" to call attention to fact the survey responses were gathered early in pandemic.

The survey was designed and pretested in March and April 2020 with the expectation that the legislature would reconvene in June after a two-month emergency suspension (State of Delaware General Assembly, 2020). We used Dynata's internet-based panel of Delaware households for our sample ($n = 450$). Demographically, the final sample slightly overrepresented higher income groups and older members of the population. The sample was distributed across Delaware's three counties in the same proportions as in the most recent census.

The median time to complete the survey was about 10 minutes, and our follow-up assessment questions suggest that the survey worked well: 83 % of respondents rated it as easy to understand, 86 % found it believable, 85 % reported that it was a good representation of their preferences about water quality, and 89 % found the length reasonable.

3 Results

3.1 Respondent characteristics and COVID-19 experiences

Most of the households in the sample obtained their drinking water from public sources; 21 % relied on private wells, which is close to the percentage of 23 % reported by the state (State of Delaware, 2019). Also, more than 85 % of the sampled households reported taking at least one recreational trip that did not involve contact with water, such as walking or relaxing near a water body. About 50 % reported less than 25 non-water-contact recreational trips per year and 35 % reported more than 25 non-water-contact recreational trips. As expected, the proportions for trips involving contact with water (fishing, swimming, boating) were somewhat lower – 68 % reported making at least 1 trip with 53 % less than 25 trips and 15 % reported more than 25 trips.

Table 1 summarizes respondents' attitudes toward current water quality in Delaware. Perceptions of drinking water were mostly favorable; only 12 % report that it is somewhat unsafe. This is consistent with objective measures and government reports, but there have been isolated cases where private wells suffered contamination. Perceptions of the quality of waterways used for recreation are less positive. About 53 % of the respondents reported that

https://doi.org/10.1017/bca.2021.14 Published online by Cambridge University Press

Table 1. *Perceptions of water quality for drinking and recreation by per cent of respondents.*

	Safety of drinking water (%)		Overall quality of water for recreation (%)
Safe	42.7	Very good	11.8
Somewhat safe	41.6	Good	41.8
Somewhat unsafe	6.9	Fair	32.7
Unsafe	5.1	Poor	6.7
Unsure	3.8	Unsure	7.1
Total	100	Total	100

Notes: The percentages are the share of people choosing this response in each case. So, 84.3 % of the respondents report that the water they drink is safe (42.7 %) or somewhat safe (41.6 %) to drink, and similarly for recreation.

Table 2. *Perceptions of hardship due to the COVID-19 pandemic by per cent of respondents.*

	Hardship at some level (%)	Extreme hardship (%)	Hardship (%)	Modest hardship (%)
Inconvenience	88.0	14.9	29.3	43.6
Emotional	68.0	8.0	18.0	42.0
Economic	57.8	6.0	14.0	37.8
Physical	35.3	2.2	6.4	26.7
Educational	32.8	5.6	11.6	15.6

Notes: The percentages are the share of people choosing this response in each case. For example, 6.0 % of the respondents report extreme economic hardship. The hardship response format ranged from extreme hardship to no hardship (and included a response for "things got better"). "Hardship at Some Level" is the sum of the three hardship levels above.

the quality of recreational waters is good or very good; 33 % reported it as fair, and 7 % as poor.

Table 2 shows responses to the questions about hardships imposed by COVID. These are given in order from the most to least frequently reported hardship. Nearly all respondents (88 %) reported experiencing inconvenience at some level (including extreme to modest hardship). Two-thirds reported emotional hardship, including 26 % who described the emotional toll as a hardship or extreme hardship. More than half reported experiencing economic hardships, including 20 % who described the economic toll as a hardship or an extreme hardship. About a third of the sample reported experiencing physical and educational hardships.

Table 3 presents the coefficient estimates from a series of binary-logit regressions used to explore relationships between hardships caused by COVID-19 and respondent characteristics: income group, age, and county of residence. In each case, the dependent variable is hardship, which takes a value of 1 when hardship at any level was reported and 0 otherwise (see Table 2). The patterns that emerge are intuitive and pronounced. Economic hardships are borne most heavily by households in lower income groups. For example, households earning less $50,000 are approximately 20 % more likely to report economic hardship than

https://doi.org/10.1017/bca.2021.14 Published online by Cambridge University Press

Table 3. *Hardship binary-logit regressions.*

	Hardship				
	Economic	Physical	Emotional	Educational	Inconveniences
Income (excluding less than $50,000)					
$50,000–$100,000	−0.858***	−1.095***	−0.128	−0.570*	−0.0677
	(0.273)	(0.404)	(0.252)	(0.304)	(0.224)
More than $100,000	−1.141***	−1.488***	−0.128	−0.519	−0.247
	(0.361)	(0.572)	(0.302)	(0.374)	(0.266)
Age (excluding those 30 years or younger)					
30–44	0.0732	−0.712	−0.186	−0.651*	−0.243
	(0.381)	(0.529)	(0.333)	(0.348)	(0.316)
45–59	0.162	−0.507	−0.466	−1.358***	−0.202
	(0.372)	(0.500)	(0.340)	(0.387)	(0.313)
60+	−0.347	−0.230	−0.644*	−1.658***	−0.0341
	(0.392)	(0.492)	(0.341)	(0.410)	(0.309)
County (excluding New Castle)					
Kent	0.0966	−0.00214	−0.207	0.139	0.338
	(0.348)	(0.473)	(0.320)	(0.350)	(0.282)
Sussex	0.250	−0.356	−0.316	−0.737**	−0.345
	(0.283)	(0.424)	(0.263)	(0.364)	(0.227)
Constant	−0.880***	−1.276***	−0.459	−0.151	0.0434
	(0.323)	(0.393)	(0.289)	(0.301)	(0.274)
Observations	445	445	445	445	445
Log likelihood	−213.1	−121.8	−250.9	−181.8	−302.2

Standard errors are given in parentheses.
*$p < 0.10$.
**$p < 0.05$.
***$p < 0.01$.

households earning more than $100,000. Those earning between $50,000 and $100,000 are 15 % more likely. These calculations assume a person is living in New Castle County and is between 45 and 59 years old. The reported educational and emotional hardships are strongly correlated with age – impact decreases monotonically with age. A respondent under 30 years old, living in New Castle County, and earning less than $50,000 is 35 % more likely to report educational hardship than a person between 45 and 59 years old, with earning between $50,000 and $100,000 income, and living in New Castle County. Similar calculation can be made for other comparisons using the coefficient estimates.

3.2 Stated preferences and COVID-19 effects

Table 4 shows a non-parametric income-adjusted yes-response function for votes on the water quality referendum pre- and early-COVID-19. To ensure that the yes-response function was representative of the population, we adjust for income by grouping votes on the referendum into three income categories (<$50,000, $50,000–$10,000, >$100,000) and then use population-weighted income classes to redistribute the votes. In an auxiliary logit regression (Table 5), we find that the vote probability is sensitive to income but not to age or county of location. Since adjustments for age and county had little effect, they are ignored in the non-parametric adjustment.[7] The results in Table 4 show a downward (demand-like) slope.

Early-COVID-19, 67 % of the respondents voted yes at $15 annually, the lowest bid offered. At $55, $207, and $426, the yes-votes drop to 58 %, 48 %, and 38 %, respectively. Overall, the yes-vote decreases by about 3 % points versus pre-COVID-19, but there are both yes-to-no and no-to-yes shifts (pre- to early-) in the response data. The non-parametric Turnbull estimator for mean WTP drops from $204 to $189 – about 7 %. The values are significantly different at the 0.01 level using a *t*-test with unequal variances (Haab & McConnell, 2002).

Table 4. *Yes-response functions pre- and early-COVID-19.*

Bid	Pre-COVID-19	Early-COVID-19	Sample size
$15	70.4 %	67.3 %	104
$55	60.7 %	57.5 %	113
$207	51.2 %	47.9 %	118
$426	41.5 %	38.0 %	115
Mean WTP (Turnbull)	$203.53	$189.10	**450**
Variance	$151.06	$154.00	

Notes: The yes-response function shows the per cent of the sample voting "yes" at each bid amount. Since the survey was conducted early-COVID-19, the early-COVID-19 response comes from the question "If the referendum had been held before the outbreak of the virus, would your vote on the referendum have been the same?"

[7] We also considered an adjustment using the following-up certainty question as a control for hypothetical bias. It caused the yes responses to increase only slightly in all categories and the adjustment was not included in the reported yes-response function.

https://doi.org/10.1017/bca.2021.14 Published online by Cambridge University Press

Table 5. *Binary-Logit referendum-response vote model (Yes = 1, No = 0).*

Binary vote for referendum	Model 1	Model 2	Model 3
Bid level (excluding $15 group)			
$55	−0.866***	−0.925***	−0.896***
	(0.308)	(0.313)	(0.317)
$207	−1.248***	−1.390***	−1.331***
	(0.303)	(0.311)	(0.315)
$426	−1.794***	−1.791***	−1.788***
	(0.307)	(0.311)	(0.313)
Income (excluding Less than $50,000)			
$50,000–$100,000	—	0.547**	0.556**
	—	(0.231)	(0.236)
More than $100,000	—	0.912***	0.918***
	—	(0.279)	(0.287)
Age (excluding those 30 years or younger)			
30–44	—	—	0.172
	—	—	(0.340)
45–59	—	—	−0.0927
	—	—	(0.335)
60+	—	—	0.00565
			(0.334)
County (excluding New Castle)			
Kent	—	—	−0.0457
	—	—	(0.300)
Sussex	—	—	−0.120
	—	—	(0.238)
Constant	1.316***	0.941***	0.942***
	(0.240)	(0.267)	(0.354)
Observations	450	450	448

Notes: Standard errors are given in parentheses.
*$p < 0.10$.
**$p < 0.05$.
***$p < 0.01$.

Our estimates are within the range found in the literature. For example, a meta-analysis of 140 observations from 51 stated preference studies in the USA reported means between $8.35 and $397 in 2007 (Johnston *et al.,* 2017*a*, *b*). Keeping in mind that the magnitude and context (time, location, and coverage) of the change in water quality vary across studies, other studies report similar estimates clustered in the $50–$300 range (Carson & Mitchell, 1993; Van Houtven *et al.,* 2007; 2014).

Now, consider the competing hypotheses we laid out earlier. The effects due to economic hardship and concerns about interacting with others in public (downward pressure on the yes-vote) appear to dominate the effects of an increased interest in outdoor activities (upward pressure on the yes-vote). The economic hardship effect is in theory some combination of income, wealth, and uncertainty effects. As we reported in the previous section, households

https://doi.org/10.1017/bca.2021.14 Published online by Cambridge University Press

on the lower end of the income spectrum reported greater economic hardship due to the pandemic. They also have a higher likelihood to switch their vote from yes-to-no, which supports the hardship theory. At the same time, we cited evidence of an increase in outdoor recreation in the state, which may translate to higher WTP for water quality improvements for some respondents, but the effect seems to be less. A few things may be at work here. First, households may exhibit an increase in the demand for water-based recreation, but not necessarily for an improvement water quality – so the quantity demanded may increase without a commensurate increase in quality demanded. Second, the count we reported is for all forms (not just water-based) recreation. Third, the increased demand by itself may be induced (at least in part) by hardship. Households feeling less inclined to spend money may seek lower cost, non-priced goods like outdoor recreation. Also, the added outdoor recreation is presumably (at the margin) lower valued than the existing recreation since the added use was not revealed preferred pre-COVID-19.[8] If so, we might expect hardship-induced and lower-valued added use to carry a lower WTP for improvements in water quality. Early-COVID-19, 54 % of the sample reported water quality for recreation as good to very good and 86 % reported it as fair to very good. So, room for added *use value* due to water quality improvement does not appear to be large. Finally, other effects may be at play that we have not detected.

Our pre- and early-COVID-19 estimates of WTP carry the usual caveat of hypothetical and other biases present in stated preference surveys (Mitchell & Carson, 1989) but may also exhibit some asymmetries (pre- vs. early-) in terms of biases and variance in the estimates. First, we might expect a higher variance on the pre-COVID-19 responses since we are asking people to recall past circumstances. This is inherently more difficult and potentially comes with added inaccuracy compared with current statements of WTP where people have a greater (full) awareness of their circumstances. This adds asymmetry to the accuracy in our measures but not necessarily bias. Biases may appear for other reasons. First, individuals may exhibit "rosy retrospection," which is a tendency to see past circumstances disproportionately better than current circumstances (Mitchell & Thompson, 1994). This form of cognitive bias puts upward pressure on pre-COVID-19 WTP as people distort their view of past circumstances – thinking there were better than they were. This tendency may be exaggerated during the pandemic as people are showered with news about its negative effects, making the "perceived" past look even better. Similarly, we might expect some overreaction early in the pandemic as people take precaution waiting to see how it unfolds and perhaps having a cloudy outlook given the current news – availability bias and diclinism. These effects may be dampened as time passes and people have time to put them in perspective. These hypotheses together suggest that our estimated difference may be on the high side – pre-COVID-19 WTPs biased upward (rosy retrospection) and early-COVID-19 WTPs biased downward (precaution/availability).

Most important for our application, despite the hardship documented in the previous section, the shift in demand does not appear to change the public calculus for investing in water quality. Consider the yes-votes at $55 and $207. In previous attempts to pass the household water tax, the proposed rate was $45 per year per household and more recently the governor's proposed bill was at $100 per household. These give us an approximate target for

[8] This is not strictly true since preferences may be changing with the changing circumstances (shift instead of a movement along a demand curve) and the existing use may carry higher value for water quality improvement in the sense of weak complementarity. Still, we expect some reporting is "lower valued" use.

https://doi.org/10.1017/bca.2021.14 Published online by Cambridge University Press

an amount that would cover capital and ongoing operational costs to improve water quality. If the costs are accurate and if the legislative action does indeed result in the improvements posited in the survey (swimmable waterways increasing from 5 % to 50 % and fishable waterways increasing from 40 % to 85 %), our findings suggest that the water quality initiative is efficient in the Kaldor–Hicks sense both pre- or early-COVID-19. The results are conditional since we are uncertain that these improvements will be fully realized. More evidence that these levels of change would indeed ensue is an important next step.

4 Conclusions

The COVID-19 pandemic that started in early 2020 provided a unique setting to explore the impacts of the hardships and uncertainty created by global pandemic on the public's WTP for environmental public goods. The direction and extent of the effect of the pandemic on the demand for these environmental public goods are uncertain, which make the development of appropriate public policy difficult, especially when government agencies are facing both contracting budgets and expanding demand for other public services, such as medical care, rapid development of testing and vaccines. In these contexts, improved water quality may seem like a luxury good. However, evidence also suggests that due to the nature of the pandemic that made inside activities and interactions with others difficult, if not prohibited, the demand for high-quality outside recreational opportunities dramatically increased perhaps heightening people awareness and concern for the environment.

Along these lines, our study provides timely and important information on the public's WTP for water quality improvements in the context of the COVID-19 pandemic. Using a stated preference survey and a sample of 450 Delaware residents in May 2020, we evaluate support for proposed legislation to improve statewide water quality and find that residents would support the legislation under consideration if the water quality we project is indeed realized (an important condition). We find that the pandemic dampened demand somewhat but not enough to change the benefit–cost or voting calculus. This finding held despite 20 % of the sample reporting economic hardship and 26 % reporting emotional hardship.[9] It will be important to compare these results to other studies conducted during the COVID-19 pandemic to determine whether these findings are widespread in the context of other environmental public goods and in other locations.

Finally, we sought to follow best practices for stated preference surveys (Boyle, 2017; Johnston *et al.,* 2017*a*) while intentionally confronting the "loading dock" problem of academic research, as it sought to provide timely and credible information to the public and policy makers, who otherwise lacked any measurements of public sentiment for environmental public goods in the midst of a pandemic. This study, in a sense, was a test of CV in the trenches. In our judgment, this type of study was up to the task and provided a better estimate than some form of benefits transfer measure, as is often done. Thus, we are encouraged by the analysis here that quick-turn-around, low-budget surveys of directly affected populations can provide useful approximations.

It is difficult to know for sure the impact of our "loading dock" shortcuts. We would need to test our "trenches" version of the survey against a "full" version. We expect a larger variance in our estimates, so some loss in accuracy. This would come thorough different

[9] These are percentages reporting extreme hardship or hardship on a 5-point hardship scale.

https://doi.org/10.1017/bca.2021.14 Published online by Cambridge University Press

channels. First, the description of the resource change may leave too much to people's imagination, which could produce error by people having different interpretations of the change. Second, the lack of follow-up questions often used to identify and then drop faulty responses is a typical correction we did not use. And third, the sample we drew was a convenience sample (adjusted only for income as described). This may have introduced some noise in our estimates as well. On the positive side, consequentiality ran high (we believe) and the survey was short and easy, which probably encouraged response across a broad array of people.

Acknowledgments. This work was funded by the National Science Foundation (EPSCoR Grant No. 1757353). We thank Rebecca Schwartz and Brian Cortes for valuable research assistance.

Competing Interest. none.

References

"State of Delaware Public Drinking Water Annual Compliance Report and Summary for 2018." 2019. Available at http://www.dhss.delaware.gov/dhss/dph/hsp/odw.html (Accessed July 17, 2020).

Bacher-Hicks, Andrew, Joshua Goodman, and Christine Mulhern. 2021. "Inequality in Household Adaptation to Schooling Shocks: Covid-Induced Online Learning Engagement in Real Time." *Journal of Public Economics*, *193*: 104345.

Boyle, Kevin J. 2017. "Contingent Valuation in Practice." In Champ, Patrica A., Kevin J. Boyle, and Thomas C. Brown (Eds.) *A Primer on Nonmarket Valuation*. Dordrecht: Springer, 83–131. https://link.springer.com/chapter/10.1007/978-94-007-7104-8_4.

Carey, John. 2020. "Public Health State of Emergency Declarations – Governor John Carney – State of Delaware." Available at https://governor.delaware.gov/health-soe/ (Accessed July 16, 2020).

Carson, Richard T., and Robert Cameron Mitchell. 1993. "The Value of Clean Water: The Public's Willigness to Pay for Boatable, Fishable, and Swimmable Quality Water." *Water Resources Research*, *29*(7): 2445–2454. http://www.econ.ucsd.edu/~rcarson/papers/CleanWater.pdf%5CnY:%5CLiteratur%5CSuWaRest%5CEconomic%5CEnvironmental valuation.

Civic Science. 2020. "Americans Are Going Outdoors to Fight Covid-19 Cabin Fever."

Day, Brett H. 2020. "The Value of Greenspace Under Pandemic Lockdown." *Environmental and Resource Economics*, *76*(4): 1161–1185. https://doi.org/10.1007/s10640-020-00489-y.

Delaware Environmental Public Health Tracking Network. 2021. "State of Delaware – Coronavirus Dashboard Data Download." Available at https://myhealthycommunity.dhss.delaware.gov/locations/state (Accessed June 8, 2021).

DNREC 2017. "The State of Delaware 2016 Combined Watershed Assessment Report (305(b)) and Determination for the Clean Water Act Section 303(d) List of Waters Needing TMDLs (The Integrated Report)."

Dunton, Genevieve F., Bridgette Do, and Shirlene D. Wang. 2020. "Early Effects of the COVID-19 Pandemic on Physical Activity and Sedentary Behavior in Children Living in the U.S." *BMC Public Health*, *20*(1): 1–13. https://doi.org/10.1186/s12889-020-09429-3.

Gramlich, Frederick W. 1986. "The Demand for Clean Water: The Case of the Charles River." *National Tax Journal*, *30*(2): 183.

Griffiths, Charles, Heather Klemick, Matt Massey, Christopher Moore, Stephen Newbold, David Simpson, Patrick Walsh, and William Wheeler. 2012. "U.S. Environmental Protection Agency Valuation of Surface Water Quality Improvements." *Review of Environmental Economics and Policy*, *6*(1): 130–146.

Haab, Timothy C., and Kenneth E. McConnell. 2002. *Valuing Environmental and Natural Resources: The Econometrics of Non-Market Valuation*. Edward Elgar Publishing.

Irwin, Nicholas B., and Mitchell R. Livy. 2021. "Measuring Environmental (Dis)Amenity Value during a Pandemic: Early Evidence from Maryland." *Journal of Environmental Economics and Management*, *106*: 102417.

Johnston, Robert J., Kevin J. Boyle, Wiktor Adamowicz, Jeff Bennett, Roy Bouwer, Trudy Ann Cameron, W. Michael Hanemann, Nick Hanley, Mandy Ryan, Riccardo Scarpa, Roger Tourangeau, and Christian A. Vossler. 2017a. "Contemporary Guidance for Stated Preference Studies." *Journal of the Association of Environmental and Resource Economists*, *4*(2): 319–405.

https://doi.org/10.1017/bca.2021.14 Published online by Cambridge University Press

Johnston, Robert J., Elena Y. Besedin, and Ryan Stapler. 2017b. "Enhanced Geospatial Validity for Meta-Analysis and Environmental Benefit Transfer: An Application to Water Quality Improvements." *Environmental and Resource Economics*, *68*(2): 343–375. https://link.springer.com/article/10.1007/s10640-016-0021-7.

Kauffman, Gerald J., and Andrew C. Belden. 2010. "Water Quality Trends (1970 to 2005) along Delaware Streams in the Delaware and Chesapeake Bay Watersheds, USA." *Water, Air, and Soil Pollution 208*(1–4): 345–375.

Kecinski, Maik, Messer Kent, Brandon R Mcfadden, and Trey Malone. 2020. "Environmental and Regulatory Concerns During the COVID-19 Pandemic: Results from the Pandemic Food and Stigma Survey." *Environmental and Resource Economics.* https://doi.org/10.1007/s10640-020-00438-9.

Keiser, David A., and Joseph S. Shapiro. 2019. "US Water Pollution Regulation over the Past Half Century: Burning Waters to Crystal Springs?" *Journal of Economic Perspectives*, *33*(4): 51–75.

Lafferty, Lexi. 2021. "The Impact of COVID-19 on White Clay Creek State Park." *The Review.* http://udreview.com/the-impact-of-covid-19-on-white-clay-creek-state-park/ (Accessed June 8, 2021).

Landry, Craig E., John Bergstrom, John Salazar, and Dylan Turner. 2020. "How Has the COVID-19 Pandemic Affected Outdoor Recreation in the U.S.? A Revealed Preference Approach." *Applied Economic Perspectives and Policy*, aepp.13119. https://onlinelibrary.wiley.com/doi/10.1002/aepp.13119.

Lock, Oliver. 2020. "Cycling Behaviour Changes as a Result of COVID-19: A Survey of Users in Sydney, Australia." *Findings*, 1–7.

Longhurst. 2020. *House Substitute 1 for House Bill 200.* Delaware House of Representatives.

Mitchell, Robert Cameron, and Richard Carson. 1989. *Using Surveys to Value Public Goods: The Contingent Valuation Method*. New York: RFF Press.

Mitchell, Robert Cameron, and Richard T. Carson. 1981. "An Experiment in Determining Willingness to Pay for National Water Quality Improvements." *EPA Report*, 1–81.

Mitchell, T., and Leigh Thompson. 1994. "*A Theory of Temporal Adjustments of the Evaluation of Events: Rosy Prospection & Rosy Retrospection." Northwestern Scholars.* Available at https://www.scholars.northwestern.edu/en/publications/a-theory-of-temporal-adjustments-of-the-evaluation-of-events-rosy (Accessed June 8, 2021).

Rice, William L., Timothy J. Mateer, Nathan Reigner, Peter Newman, Ben Lawhon, and B. Derrick Taff. 2020. "Changes in Recreational Behaviors of Outdoor Enthusiasts during the COVID-19 Pandemic: Analysis across Urban and Rural Communities." *Journal of Urban Ecology*, *6*(1): 1–7.

Rousseau, Sandra, and Nick Deschacht. 2020. "Public Awareness of Nature and the Environment During the COVID-19 Crisis." *Environmental and Resource Economics*, *76*(4): 1149–1159. https://doi.org/10.1007/s10640-020-00445-w.

Sheth, Jagdish. 2020. "Impact of Covid-19 on Consumer Behavior: Will the Old Habits Return or Die?" *Journal of Business Research*, *117*: 280–283.

State of Delaware General Assembly. 2020. "State of Delaware General Assembly Announces Plans to Reconvene Legislative Session."

Thunström, Linda, Stephen Newbold, David Finoff, Madison Ashworth, and Jason Shogren. 2020. "The Benefits and Costs of Using Social Distancing to Flatten the Curve on COVID-19." *The Journal of Benefit-Cost Analysis*, *11*(2): 179–195.

Van Houtven, George, John Powers, and Subhrendu K. Pattanayak. 2007. "Valuing Water Quality Improvements in the United States Using Meta-Analysis: Is the Glass Half-Full or Half-Empty for National Policy Analysis?" *Resource and Energy Economics*, *29*(3): 206–228.

Van Houtven, George, Carol Mansfield, Daniel Phaneuf, Roger von Haefen, Bryan Milstead, Melissa Kenney, and Kenneth Recknow. 2014. "Combining Expert Elicitation and Stated Preference Methods to Value Ecosystem Services from Improved Lake Water Quality." *Ecological Economics*, *99*: 40–52.

Cite this article: Parsons, G, Paul, L. A. and Messer, K. D. 2022. "Demand for an Environmental Public Good in the Time of COVID-19: A Statewide Water Quality Referendum." *Journal of Benefit-Cost Analysis* 13: 107–119, doi:10.1017/bca.2021.14