



The Existence Value of a Distinctive Native American Culture: Survival of the Hopi Reservation

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Accepted: 18 March 2020 / Published online: 27 March 2020
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Abstract

We measure the value placed by the American public on ensuring the continued existence of the traditional Hopi culture and way of life at the Hopi Reservation in Arizona. The Hopi are the oldest living culture in the United States. The continued existence of the Reservation is threatened by depletion of the groundwater resource underlying the reservation. In the future, without a new source of water, the Hopi will run out of water to support the villages and continue their traditional Hopi agricultural practices. Many Hopi will have to move off the Reservation and give up their traditional culture and way of life. The Reservation will no longer serve as a permanent home for the Hopi Tribe. An expensive pipeline would be required to convey a new source of water to the Reservation, for which the Federal government might pay. The question is: would the expenditure by the federal government to convey water that would ensure the continued existence of the traditional Hopi culture at the Hopi Reservation be justified by the existence value of that culture to the American people? This paper describes the results of a study undertaken to measure that existence value. We show that a simple stated preference design, using only a single monetary amount, is sufficient to provide a bound.

Keywords Aboriginal · Contingent valuation · Cultural values · Indigenous cultures · Native American · Water supply

JEL Classification D6 · Q25 · Q51 · Z1

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1 Introduction

At least since the seminal paper by Krutilla (1967), the concept of existence value has been recognized in economics—the value that people place on some item to ensure its continued existence arising from motives unconnected with their own personal use or interaction with the item.¹ Over the past fifty years, the concept of existence value has been applied to many different things, including inanimate objects (e.g., landscapes, cultural and historical monuments) and living things (birds, fish, animals, plants and insects). In this paper, we apply the concept to value a distinctive human *culture*, that of the Hopi Tribe in Arizona.

The Hopi are the oldest living culture in the United States. The Hopi have lived in the Southwestern United States for several thousand years and believe that they are the descendants of the ancient pueblo people, some of whom constructed Chaco Canyon, Mesa Verde, and the other great pueblo settlements found there. Since at least the twelfth century, they have lived in villages atop three high dry mesas in the Hopi Reservation, located in Northeastern Arizona, east of the Grand Canyon. Oraibi Village is the oldest continuously inhabited settlement in the United States at almost one thousand years old.

Genetic and linguistic evidence suggests that the pueblo people migrated north from Mexico and brought with them the suite of three crops—corn, beans, and squash—that were essential for settled communities in the Southwest and are still cultivated on the Hopi Reservation today. The Hopi religion and culture are founded on agriculture. Regardless of occupation, to be a Hopi is to be a farmer and to grow traditional crops in a traditional manner. Their daily lives, culture, religious rituals and social organization are framed around the agricultural activities associated with growing these crops.

Today, there are about 19,000 Hopi in the United States, half of whom live on the Hopi Reservation. Most of the others live in the Southwest and many travel to participate in traditional ceremonies on the Reservation.

The crops grown by the Hopi are not sold for profit—either on or off the reservation. They are used by the Hopi for subsistence and ceremonial purposes. For the Hopi the physical act of growing these crops is a necessary component of their culture and their religion. Corn is the most widely cultivated of all crops on the Hopi Reservation. Wall and Masayesva (2004) explain, “for [the Hopi] corn is sustenance, ceremonial object, prayer offering, symbol [of life], and sentient being unto itself (...) the Hopi people sustain the corn and the corn sustains Hopi culture.” The Hopi grow distinctive varieties of corn, including white corn, blue corn, red corn, purple corn and yellow corn. These are traditional varieties adapted to the local climate and have specific ceremonial and religious uses. For example, when a new-born baby is brought home, a perfect ear of white corn is placed beside the infant throughout the 20 days of bonding between mother and baby. An ear of yellow corn bought in a supermarket would not be an acceptable substitute.

To grow their crops, many Hopi still use traditional methods such as planting the seeds with a greasewood digging stick. The Hopi mesas are located in a semi-arid, high desert where annual precipitation ranges from 6 to 10 inches on average. Most of the reservation is too dry to grow crops by rainfall alone. The Hopi have developed sophisticated water management practices to farm successfully in that marginal environment. While some fields receive moisture solely from precipitation, and some are located on floodplains adjacent to washes that separate the three mesas, other fields receive water from a combination

¹ For a comprehensive review of the underlying theory see Carson et al. (1999).

of precipitation plus surface run-off directed to crops by earthen berms, check dams, and other constructed features. In addition, there are fields irrigated from springs at the foot of the mesas or on their sides.

In recent decades, however, the traditional sources of water for the Hopi have become imperiled. Between 1968 and 2005, the Peabody Coal Company pumped an average of 1.2 billion gallons of groundwater annually from the N aquifer that underlies much of the Hopi and neighboring Navajo Reservations, causing a significant lowering of the local ground water table (Mason and Macy 2018). A consequence has been diminished flows in the Hopi washes and drying up of springs and seepages along the Hopi mesas traditionally used to irrigate Hopi crops. Some springs have disappeared altogether.

Another problem is arsenic contamination of groundwater used for village drinking water supplies. In 2006, the US EPA lowered the arsenic drinking water standard from 50 to 10 $\mu\text{g/L}$. Before the new standard, arsenic levels in Hopi water from the N aquifer were assumed to be safe. Now, about three quarters of the population on the Hopi Reservation live in communities whose drinking water exceeds the safe standard for arsenic (Sanchez 2017). Moreover, increased levels of dryness have been experienced at the Hopi Reservation. For some Hopi, 2018 was the worst year ever to raise corn (Onsae 2018). With climate change, these conditions will worsen—the Colorado River Basin will experience more severe droughts, there will be reduced surface water flows, and temperatures will be hotter (Garfin et al. 2013). Supplementary irrigation will become essential as longer dry periods occur during the growing season.

Due to the lack of water, the Hopi are now finding it hard to keep growing their traditional crops and to open new businesses. In the future, without a new source of water, the Hopi will run out of water to support the village water supply systems and continue their traditional Hopi agricultural practices. Many Hopi will have to move off the Reservation and give up their traditional culture and way of life. The Reservation will not be economically viable and it will no longer serve as a permanent home for the Hopi Tribe.

There are ways to supply the Hopi reservation with more water. For example, a pipeline could be built to the reservation from the Colorado River or from distant locations to the south where there is ample groundwater from a different aquifer. However, conveying the water to the reservation would be expensive. The cost of bringing a new, clean source of groundwater to the Hopi Reservation is estimated at about \$900 million over the next 50 years (Kunkel 2019). The Hopi are one of the poorest Native American tribes. They are located far from large cities and do not have any gambling casinos as a source of revenue. Therefore, this cost greatly exceeds what the Hopi themselves could afford to pay.

In the past, the U.S. government has paid for bringing water to cities in the Southwest such as Phoenix and, also, to Indian reservations in the Southwest. With regard to the latter, the Federal government has a special relationship with Indian Tribes which legally are separate nations and have important sovereign powers over their territory. The U.S. Constitution gives authority for Indian affairs to the Federal government, not to the state governments. The Indian reservations were established by agreements between the Indian Tribes and the U.S., and the U.S. has a trust responsibility to the Tribes. This special status gave rise to a special type of water right for the Tribes, the Federal reserved water right. Under this right, there is a presumption that, when the Federal government created an Indian reservation in the nineteenth century, it also implicitly reserved the right for sufficient water to fulfill the purpose of that reservation. The Arizona Supreme Court held, in a 2001 decision, that “deference should be given to practices requiring water use that are embedded in Native American traditions. Some rituals may date back hundreds of years, and tribes should be granted water rights necessary to continue such practices into the future.”

To an economist, this justification for Federal action to ensure an adequate water right for an Indian reservation involves the notion that there is an external social benefit when an Indian tribal culture is preserved and the reservation remains a “permanent home and abiding place.” In economic terms, the benefit to most non-Indian Americans from the preservation of an Indian tribal culture is, quite simply, an existence value because most non-Indians never expect to visit the tribal reservation itself.

The question then arises: would a major investment by the federal government to provide conveyance for water that would ensure the continued existence of the traditional Hopi culture and way of life at the Hopi Reservation be justified by the existence value of that culture to non-Indian society in the United States? This paper describes the results of a study undertaken to measure that existence value.

2 Conceptual Framework

What is being valued in the contingent valuation survey reported below is the provision by the Federal government of conveyance for water that would ensure the continued existence of the traditional Hopi culture and way of life at the Hopi Reservation. Two conceptual issues need to be clarified.

First, the pipeline is a means to an end. What is being valued is the end—not the pipeline itself but the continued existence of the Hopi culture and religious traditions on the Hopi Reservation. In this context, water is an essential input. An essential input has the property that, absent a minimum quantity of that input, zero output is produced. A water supply is an essential input both to Hopi village life and to traditional Hopi agriculture for growing traditional Hopi crops. Growing those crops is an essential input to the Hopi culture and religion. And the pipeline is an essential input for making the water allocated to the Hopi Reservation accessible to it. The water allocated to the Reservation is their entitlement under Federal law. The pipeline to convey the water is *not* an entitlement under that law but is a choice by Congress.

Second, the water being delivered by the pipeline will be consumed by the Hopi themselves for residential, commercial and industrial uses and for growing traditional crops on the Reservation. For those who use it, the water is a private good and their use of it is rival (two separate users cannot simultaneously use the same molecule of water). At the same time, however, the supply of water to meet the needs of the Hopi Reservation is also a public good. Water, in fact, is what is known as a *mixed* good—a good having “a mixture of the characteristics of a public good and a private good” (Holtermann 1972). She continues: “The important factor here is the distinction between the availability ... of a public good, and the utilization of it. It may be the case that both the availability of the good and the individual’s utilization or consumption of it are significant but separate factors affecting an individual’s utility. If so, then both factors must be entered into his utility function, but each as a separate variable. Moreover, it is appropriate to treat the total availability as a public good and the individual utilization as a private good.” Thus, for the individual Hopi, the conveyance of a water supply for the Reservation is both a private good (his individual portion of the water supply) and also a public good (the continued existence of his homeland). For non-Hopi who hold an existence value for the Hopi Reservation, the conveyance of a water supply is a (pure) public good.

The upshot of this analysis is that, in measuring the existence value placed on the Hopi Reservation by non-Hopi, we are measuring only a part of the total social benefit accruing

from the Federal government's investment in the water pipeline. There are also benefits to the Hopi people from both their private utilization of the water and from the continued existence of their homeland. Those benefits are not being covered in our valuation.

3 Relation to Existing Literature

There is now a substantial literature on the non-market valuation of items of cultural heritage such as historic buildings, monuments and artifacts—for example, Navrud and Ready (2002) and there is now the *Journal of Cultural Economics* that covers this topic. There is also a small but growing literature on non-market valuation in relation to indigenous peoples, including their cultural heritage. But, to the best of our knowledge, there is nothing exactly like the study presented here.

There is a literature focused on the valuation *by indigenous peoples* of natural resources which they use or rely on for cultural or subsistence purposes. In a US context, Brown and Burch (1992) provide an early survey of this literature in the context of subsistence use of wildlife resources by Alaska Natives, and Hammer (2002) provides a survey of methods that can be used for valuation of American Indian land and water resources valuation. Duffield et al. (2014) present a hedonic compensating wage differential model which estimates Alaska villagers' total value (use value plus cultural value) of their subsistence harvests. Duffield et al. (2019) employ a contingent valuation survey to value the Penobscot Nation's foregone tribal use of the dioxin-contaminated Penobscot River in Maine.

Conceptually similar studies have been performed in Australia (Hatton MacDonald et al. 1995; Zander and Straton 2010; Zander and Garnett 2011), in Canada (Haener et al. 2001; Adamowicz et al. 2004; Spyce et al. 2012)), and in several developing countries (Whittington et al. 1992; Shyamsundar and Kramer 1996; Adamowicz et al. 1997). Interestingly, when studies have compared resource valuations of Aboriginal and non-Aboriginal peoples, controlling for differences in income, the former generally appear to value natural resources more highly than the latter (Adamowicz et al. 1997; Zander and Straton 2010; Burger 2011; Zander and Garnett 2011). For example, Spyce et al. (2012) find that Aboriginal groups in the Southeast Yukon tend to prefer greater generational equity of natural resource distribution (protecting the environment for future generations) than non-Aboriginal groups.

The difficulty of using standard stated preference methods such as contingent valuation or choice modeling to elicit how aboriginal/indigenous peoples value items of cultural importance is well recognized.² Consequently, some researchers have sought to develop alternative approaches using qualitative approaches including narratives, or quantitative ratings (Burger 2011), or extended interactions framed around multi-attribute utility elicitation (Greiner et al. 2005; McDaniels and Trousdale 2005; Gregory and Trousdale 2009; Dyack and Greiner 2012; Satterfield et al. 2013).

There is also a literature valuing indigenous artifacts and cultural objects. Boxall et al. (2003) use stated preference and revealed preference to estimate the use value for non-Aboriginal visitors to a region in eastern Manitoba, Canada where about 400 rock paintings (pictographs and petroglyphs) have been discovered along wilderness canoe routes, some

² See, for example, Adamowicz et al. (1998), Snyder et al. (2003), Awatere (2005), Venn and Quiggin (2007), Winthrop (2014), and Cooper et al. (2016).

of them believed to be 2,000 years old. Rolfe and Windle (2003, 2006) estimate the willingness to pay of both Aboriginals and non-Aboriginals to protect Aboriginal cultural sites with rock art in the Fitzroy Basin in central Queensland, Australia, where there are some 312 rock art locations and many other cultural sites over an area of 142,000 km². While Aboriginals had a positive value for high levels of cultural site protection, non-Aboriginals had negative values for those high levels of protection, but they did have positive values for small increases in protection above current levels. Ulibarri and Ulibarri (2009) conduct a benefits transfer based on those two studies to measure the use and non-use values of a cultural heritage site in the US, the Petroglyph National Monument in Albuquerque NM, which contains some 25,000 petroglyph images over 7,244 acres of open land, some perhaps 3,000 years old, others dating from the period 1300–1600 AD.

By contrast, in this study we measure the existence value of non-Aboriginals not for cultural objects but for an entire Aboriginal culture. Zander and Garnett (2011) use choice experiments to measure the value placed by non-Aboriginals on environmental services provided by Aboriginal peoples in Australia. However, we use stated preference to measure the value of not just the environmental services of the Hopi but, rather, their entire culture, religion, and way of life.

The closest to this study is a recent paper about Australia, Jackson et al. (2019), which conducted a contingent preference survey of households from the jurisdictions of Australia's Murray-Darling Basin and found that 69.2% of respondents support the principle of reallocating a small amount of water from irrigators to Aboriginal people via water market purchases. The authors estimated that households were willing to pay A\$21.78 in a one-off levy to buy water back from irrigators to give to Aboriginal people. But, while the Australian situation is somewhat like ours, there is an important difference. The legal framework for water management in Australia currently offers Aboriginal peoples' limited protection of their water rights. Water law and policy narrowly prescribe Aboriginal rights and contain no substantive restitution measures to redress the historical pattern of exclusion from the water economy. There is no Australian analog of the U.S. Federal reserved water right which explicitly aims to endow Native American peoples with a water right of which they were originally deprived when their reservation was formed. The fund being contemplated in our survey is not aimed at buying water back from existing non-Native holders of water rights. Instead, it focuses on financing a delivery infrastructure to transport to the Hopi Reservation an amount of water allotted to them under the Federal reserved water right doctrine, so as to ensure the continued existence of their traditional culture and way of life at the Hopi Reservation.

4 Survey Design

We want to know whether the American people hold an existence value for the continued existence of the traditional Hopi culture and way of life at the Hopi reservation and, if so, the magnitude of that existence value. To answer these questions, we needed to conduct a survey of a sample of the American public. Given the goal, the survey mode that was most practical for us was an internet survey. For this purpose, we contracted with YouGov, a well-known global public opinion company with a large U.S. presence. YouGov has a proprietary panel of over 8 million people globally, including 2 million people in the United States. YouGov is used by government agencies, and it partners with *The Economist* in the Economist/YouGov poll and with CBS News in CBS political polling. YouGov's surveys

are frequently cited in the national and international press. Our use of YouGov as the survey organization supports the consequentiality of the survey (Carson and Groves 2007) to the extent that respondents may be familiar with YouGov surveys through reporting in the media.

A YouGov panel member participating in the survey would sign in and see two introductory pages. The first page asked for the respondent's zip code. The second page stated: "This short survey should take less than 5 min. We will present you with some information on current events and ask your opinions on this topic. You will be awarded 500 points upon completion. Please read the survey questions carefully. Your answers are important to us."

Having been told that the survey is requesting their opinion on a current event, respondents then went on to the main text of the valuation survey (see Appendix 1 for the full text). The survey described who the Hopi are, and included a map (Insert A) situating the location of their reservation. The map highlights the states in the four-corner area (Arizona, Colorado, New Mexico, Utah). It was important that respondents realize that we were talking about one specific tribe, with a reservation, in one part of the country, rather than thinking of all tribes, all Indian reservations, or the entire United States.

The instrument described the distinctive culture and way of life of members of the Hopi Tribe, and explained the water situation at the Hopi reservation. It then mentioned a possible solution involving importing supplemental water from off the reservation. The instrument explained that, in the past, the U.S. government has paid for bringing water to cities such as Phoenix and to other Indian reservations in the Southwest. It stated that, right now, there is no agreement for the U.S. government to pay for the conveyance of water to the Hopi reservation to ensure it will be a livable home in the future. But that the U.S. Congress could be asked to decide whether to pay to convey additional water to the Hopi reservation. This highlighted the Federal policy action that the survey response might influence, supporting the consequential nature of the of the valuation question.

Several features of the payment scenario should be noted.

Given a choice of whether to use individuals or households as the unit of observations, we chose to make the household the unit of observation, which is known to be the more conservative choice. It is also more realistic since households or families, rather than individuals, usually pay income taxes and bear utility bills.

We were intentionally unspecific about the means of payment because the reality is that payment would likely occur through several different channels and our experience has shown that explaining the details of payment and justifying a specific payment mechanism tailored to respondents' individual circumstances would considerably complicate the survey.³ As such, we chose to frame the payment question simply in terms of the specific monetary cost to your household if the Federal government takes action to convey additional water to the Hopi reservation.

³ For example, for a single-family home owner the payment vehicle could be the monthly water bill, a good payment mechanism because this is impossible to avoid. However, a renter or an apartment dweller may not receive a separate water bill and some other payment vehicle would be required. A property tax payment would not work because that is a state or county payment. A low-income household may escape paying any federal income tax. With the \$5 payment used here, the credibility (and hence incentive compatibility) of the Federal government being able to extract that payment is not likely to have been an issue, but it could become one with a substantially larger payment amount. It would then be necessary to introduce questions into the survey about the source of the household's water supply, how this is paid for, and the household's income tax situation.

With respect to the frequency of payment, we picked an annual payment for 5 years. Use of an annual payment is considered a more conservative framing than breaking the same amount into monthly payments. Most water quality/quantity studies (e.g., Carson and Mitchell 1993) use a perpetual annual payment on the grounds that the provision of the service is on-going and requires regular expenditures to maintain. On the other hand, it is common to use a one-time payment when the commodity provides a stream of (existence value) services with minimal maintenance expenditures, such as setting aside a remote location as a wilderness area. We adopted a middle course here, using a short payment period keyed to the potential construction time for the pipeline project.

The last issue was the selection of the bid amounts. It is possible with a well-chosen set of bid amounts to estimate the entire distribution of willingness to pay (WTP) in the population of interest. We intentionally chose not to do that. Rather than estimating the entire WTP distribution, we aimed for an estimate of a lower bound on the median or mean WTP per household of the American public. We therefore used the simplified design of a single bid value which was presented to all respondents. This maximized the statistical power with which we could estimate one quantile of the WTP distribution. Appendix 3 shows how that information can be exploited using some weak assumptions about WTP distributions that have strong empirical support.

Thus, the choice question, cast in terms of whether the respondent would support Congress voting for the project, is as follows:

If it would cost your household \$5 a year for each of the 5 years of project construction for the Federal government to bring additional water to the Hopi reservation, would you support Congress voting to do this, or would you be opposed to Congress voting to do this?

—Yes, I would support Congress voting to bring additional water to the Hopi reservation.

—No, I would not support Congress voting to bring additional water to the Hopi reservation.

—Not sure

For the sample size, we specified a representative national sample of 1,000 respondents (households). YouGov interviewed 1087 respondents who were then matched down to a sample of 1000 to produce the final dataset.⁴ The respondents were matched to a sampling frame on gender, age, race, and education. The frame was constructed by stratified sampling from the full 2016 American Community Survey (ACS) 1-year sample with selection within strata by weighted sampling with replacements (using the person weights on the public use file). Additional details on the sampling design are contained in Appendix 2.

5 Key Findings

The key statistic is the fraction of the sample who, at a cost to their household of US\$5 per year for 5 years, would support the United States Congress voting to provide a pipeline to convey water to the Hopi Reservation in order for the Tribe to maintain its traditional

⁴ The respondents included 11 Native Americans, none of whom lived in the Four Corners states.

culture and way of life. In our survey, the statistic had a value of 76.40%. Using the sample weights produces only a very small change to 76.41%. The 95% confidence interval is [73.77%, 79.03%] without the sampling weights, and [73.48%, 78.74%] with the sampling weights.

What did a typical respondent see as the total cost of that household commitment? If the respondent did not apply discounting, the commitment would have been seen as a total payment of \$25. But, perhaps a respondent applied discounting to the five-year stream of \$5 payments. For example, if the respondent expected to have to cover the payment by taking funds out of a bank saving account that paid interest of 2%, then the total commitment over 5 years might have been assessed at the discounted present value of five annual payments of \$5 discounted at 2%. Or, if the respondent expected to charge the annual payment to a credit card and the credit card carried a 15% interest rate, then the total commitment over 5 years might have been assessed at the discounted present value of five annual payments of \$5 discounted at 15%. Each of these financing scenarios is possible. We cannot tell which scenario a typical respondent had in mind.

Here we will focus on two scenarios: (i) a scenario in which a typical respondent saw the cost as, simply, a commitment of \$25, and (ii) a scenario in which a typical respondent saw the cost as a commitment to be financed over 5 years at an intermediate interest rate of 7%. In the latter case, the discounted present value of the payment stream amounts to \$21.93. This leads to two alternative interpretations of the survey result: over three quarters of the households in the United States would be willing to pay either US\$21.93 or US\$25 to have Congress provide a pipeline to convey water to the Hopi Reservation to maintain the traditional Hopi culture and way of life.

These dollar amounts correspond to the 76.4th percentile of the WTP distribution of US households to preserve the existence of the traditional Hopi culture. However, the metrics most commonly used in the economic valuation literature are the *mean* or the *median* of the underlying WTP distribution (Carson and Hanemann 2005). The median of the WTP distribution is the dollar amount that 50% of US households would be willing to pay in order to preserve the existence of the traditional Hopi culture. The empirical evidence throughout the economic valuation literature is a downward sloping WTP graph—more households are willing to pay a low dollar amount than are willing to pay a high dollar amount. Therefore, if 76.4% of US households are willing to pay \$21.93 (or \$25), 50% of US households would be willing to pay an amount *larger than* \$21.93 (or \$25). Furthermore, with a non-negative WTP distribution, the experience in the economic valuation literature is that the mean WTP is at least equal to the median and often significantly larger than the median WTP. Therefore, we expect that the mean WTP of US households to preserve the existence of the traditional Hopi culture is significantly larger than \$21.93 (or \$25).⁵

In Appendix 3 we explore how much larger the mean or median WTP might be. Estimates of those statistics are sensitive to both the choice of the single monetary bid amount and also the assumed WTP distribution. If one applies a two-parameter Weibull distribution calibrated so as to make median and mean WTP coincide, the analysis in Appendix 3

⁵ The most conservative estimate of mean WTP consistent with the non-negative distributional assumption is the Turnbull lower-bound estimate of the mean (Carson et al. 1994; Carson et al. 2003). For the single cost amount used here, that estimator makes the implausible assumptions that (1) all respondents who indicated they are willing to pay \$5 are unwilling to pay even one cent more, and (2) all respondents unwilling to pay \$5 are unwilling to pay any amount at all. The Turnbull lower-bound estimate of mean WTP is \$16.76 (\$19.10).

shows that the median WTP for an annual payment is likely to be at least \$6.58 rather than \$5. Employing the value of \$6.58 as an estimate of the median WTP would raise the perceived total household commitment from \$21.93 to \$28.86, or from \$25 to \$32.90. As noted above, mean WTP would generally be expected to be larger than the median. The approach outlined in Appendix 3 shows how information accumulated from existing non-market valuation studies about the relationship between median and mean WTP can be used to develop an estimate of those values from the single percentile of the WTP distribution obtained with a single bid amount.

The U.S. Census Bureau estimate of the number of U.S. households in 2019 based on the Current Population Survey's Annual Social and Economic Supplement conducted in March is 128,579,000. Fewer than 5,000 would be Hopi households. Therefore, we use 128,574,000 as an estimate of the number of non-Hopi households in the US. Multiplying this number of households by a per household value of \$21.93 yields an estimate of the total existence value for the existence of the Hopi culture at US\$2.8 billion. Multiplying the number of households by a per household value of \$25 yields an estimate of the total existence value for the existence of the Hopi culture at US\$3.2 billion.

As just noted above, this is unambiguously an under-estimate of the total existence value for the US public. The existence value for the US public would be calculated using the mean WTP per household, which is likely to be significantly larger than the value computed using the median WTP per household, which in turn is at least 31% larger ($=6.58/5$) than \$21.93 (or \$25). Using this median WTP per household would raise the estimate of aggregate existence value to US\$3.6 (\$4.2) billion.

6 Construct Validity

Survey respondents were asked three knowledge questions before they were presented with the CV scenario and the valuation question. To the first of these questions, 68.4% of respondents indicated they were aware of Native American Reservations in the Southwest region of the United States, while 37.5% indicated that they were aware of water shortages in the Southwest. The third knowledge question asked respondents if they were aware that the Federal government had played a large role in paying for water projects in the Southwest with 33.9% indicating yes. For all three of these knowledge variables, bivariate crosstabulations with respondents' answers to the valuation question are significant at the $p < .01$ level, with greater knowledge being associated with a greater propensity to support Congress voting to go ahead with the pipeline project.

It is possible to estimate a construct validity equation using the binary discrete choice variable indicating support for the pipeline project as the dependent variable. The three knowledge questions are obvious candidate predictors. Economic theory suggests that income should play a role, but the one amount asked about, US\$5, is unlikely to price many people out of the market. Other demographics of interest are age, which is often related to income, being female, single, employed, or white. Almost all policy decisions in the United States these days seem to have an ideological/political component. Native American and natural resource issues tend to be more associated with liberals (Democrats) than conservatives (Republicans). There is a well-known interaction between being liberal and single, i.e., singles are more liberal than married individuals. The Hopi's cultural way

Table 1 Construct validity regression with policy choice as dependent variable

Variable	Coefficient	St. error	t-statistic	P > t
Constant	.50303	.04634	10.85	0.000
SW_Reservation	.06403	.02960	2.16	0.031
US_PayWater	.06023	.02790	2.16	0.031
Age	.00240	.00082	2.94	0.003
Single	-.09400	.04113	-2.29	0.022
Liberal	.15014	.03089	4.86	0.000
Liberal*Single	.13060	.07333	1.78	0.075
PartyID_NotSure	-.26996	.06382	-4.32	0.000
Religion_NotProtestant	.10341	.03195	3.24	0.001
Protestant	.03278	.03155	1.04	0.299
Seldom	.07396	.03155	2.34	0.019

N = 1000; R-square 0.1120

of life has well-known links to Native American religions suggesting that religious-oriented variables may be of help predicting responses.

Table 1 displays the construct validity equation in the form of a linear probability model⁶ with insignificant predictors generally dropped. The first two variables are from the set of three knowledge questions specifically asked in the survey. There is a substantial correlation between the three variables and only the two knowledge questions involving knowing that there are Indian reservations in the Southwest (SW_Reservation) and that the U.S. Federal government routinely pays for water projects in the Southwest (US_Pay) retain independent significance. The probability of favoring the policy at the US\$5 bid level (for 5 years) is increasing with age. Gender, employment status, education ethnicity/race and income are all insignificant.⁷ The indicator variable for living in a single-person household is associated with being less supportive, but note that the positive interaction term in the model between liberal and single suggests that this finding only holds for single individuals who do not self-identify as being liberal.

There are three possible ideological/political variables that can be used. They all measure much of the same variance, so we have chosen to work with the ideological variable that has five response categories (plus “not sure”) and have created a Liberal indicator variable that equals one if the respondent chooses very liberal or liberal. The Liberal indicator variable also enters the model interacted with Single. We have also created an indicator, PartyID_NotSure, that takes on a value of one if the respondent indicates “not sure” rather

⁶ Logit and probit variants of the model, as expected, provide similar fits to the data. Insignificant variables have generally been dropped from the model unless useful to address a specific purpose. While the variables in the model are all exogenous in the sense of not being influenced by the answer to the valuation question, the construct validity equation should not be taken as causal as the causal forces may be variables correlated with those included and key drivers may not have been measured.

⁷ The coefficients on income categories increase initially from the lowest category which is normalized at zero but are largely flat over much of the relevant income range. Respondents in the far-right tail of the income distributions are substantially less supportive but they are a very small fraction of the sample. Women are somewhat more supportive than men, but the effect is small and not significant. With respect to employment status, there are some signs that students and temporally unemployed are somewhat more supportive, but these groups are small in size. Coefficients on all education categories are close to zero. This is also true of different ethnic/racial groups.

than one of the 7 party ID categories ranging from strong Democrat to strong Republican with independent in the center. To some degree, this variable picks up a tendency of some respondents to select the not sure/don't know category on all the political variables, suggesting a lack of engagement on political issues.

The results of this regression describe some of the factors associated with willingness to pay for conveyance of water to the Hopi Reservation to preserve Hopi culture. Knowledge of Indian reservations in the Southwest and Federal support for water projects there is associated with stronger support for the project. Liberals are, as expected, more supportive. Older respondents are more supportive and single households are less supportive except when the respondent is liberal. Those who are not sure of where they fall on the commonly used 7-point strong Democrat to strong Republican scale tend to oppose the project. Formal religious affiliation is associated with support for the project, but this is stronger among non-Protestant religions, and among those who seldom attend religious services (rather than frequently or never). The construct validity equation suggests that the data collected are not random. Instead, the model has a reasonable R-square (0.11) for a model estimated using cross-sectional survey data, and coefficients on variables that are plausible in terms of sign and magnitude.

7 Conclusions

Indigenous cultures are being lost throughout the world. Oddly, environmental economists have not engaged in attaching monetary values to these losses. Environmental economists have spent much effort valuing the existence value of landscapes, cultural monuments and artifacts, and living non-human species. The contribution of this paper is that it measures the existence value of a threatened human culture, that of the Hopi Tribe in the United States. We find that the US public does have an existence value for the continued existence of this culture, and this existence value amounts to at least US\$3 billion. This paper opens up an important new area of research valuing not just individual indigenous artifacts but indigenous cultures writ large.

Two points should be noted. First, this study estimates households' willingness to pay to avoid a loss (i.e., the loss of an existing, distinctive Native American culture). It is not surprising that our valuation estimate is large because people value welfare losses significantly more than they value welfare gains of a similar magnitude. Secondly, if one were performing a social benefit–cost evaluation of the pipeline project to convey new water to the Hopi Reservation to maintain the traditional Hopi culture, the benefit ledger would include both the existence value that we have measured here on behalf of the non-Hopi population and also the economic value of preserving their reservation to the Hopi themselves. However, the existence value measured in this paper clearly outweighs the likely cost of the pipeline.

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Appendix 1: Survey Instrument

The Hopi are a Native American Tribe whose reservation is in northern Arizona.

They have lived in the Southwestern United States for more than 2,000 years. The Oraibi village on the Hopi reservation is the oldest continuously occupied settlement in the United States at almost one thousand years old.

This map shows where the reservation is located.



The Hopi have a unique religion and culture with elaborate ceremonies organized around the agricultural seasons. They grow several types of corn, beans and squash, not for sale but for personal and ceremonial use on the reservation. Over hundreds of years, these traditional crops have been adapted to grow in the dry climate of the Hopi reservation.



There are about 19,000 Hopi in the United States. Half live on the Hopi reservation. Most of the others live in the Southwest and participate in traditional ceremonies on the reservation.

Before this survey, did you know there were Indian reservations in the Southwest?

Yes, No, Not sure

For their water, the Hopi depend entirely on groundwater and natural springs on their reservation.

Heavy water use outside the Hopi reservation in the past, including for coal mining, is causing the groundwater on the reservation to run out and the natural springs to dry up. Had you heard anything about water shortages in the Southwest?

Yes, No, Not sure

Due to the lack of water, the Hopi are now finding it hard to keep growing their traditional crops and to open new businesses. In the future, without additional water many Hopi will have to move away and end their traditional culture and way of life. In that case, the reservation will not be able to serve as a permanent home for the Hopi Tribe.

There are ways to supply the Hopi reservation with more water. For example, a pipeline could be built to the reservation from the Colorado River or from distant locations where there is more ample groundwater.



However, bringing water to the reservation would be expensive and the Hopi are one of the poorest tribes. They are located far from large cities and don't have any gambling casinos.

In the past, the U.S. government has paid for bringing water to cities such as Phoenix and to other Indian reservations in the Southwest.

Did you know that the U.S. government has played a large role in paying for water projects in the Southwest?

Yes, No, Not sure

Right now, there is no agreement for the U.S. government to pay for bringing additional water to make sure the Hopi reservation will be a livable home in the future. However, the U.S. Congress could be asked to decide whether to pay to bring additional water to the Hopi reservation.

If it would cost your household \$5 a year for each of the 5 years of project construction for the Federal government to bring additional water to the Hopi reservation, would you support Congress voting to do this, or would you be opposed to Congress voting to do this?

Yes, I would support Congress voting to bring additional water to the Hopi reservation.

No, I would not support Congress voting to bring additional water to the Hopi reservation.

Not sure

Appendix 2: Sampling Methodology



YouGov Sampling Methodology

Sampling and Sample Matching

Sample matching is a methodology for selection of representative samples from non-randomly selected pools of respondents. It is ideally suited for Web access panels, but could also be used for other types of surveys, such as phone surveys. Sample matching starts with an enumeration of the *target population*. For general population studies, the target population is all adults, and can be enumerated through the use of the decennial Census or a high quality survey, such as the American Community Survey. In other contexts, this is known as the *sampling frame*, though, unlike conventional sampling, the sample is *not* drawn from the frame. Traditional sampling, then, selects individuals from the sampling frame at random for participation in the study. This may not be feasible or economical as the contact information, especially email addresses, is not available for all individuals in the frame and refusals to participate increase the costs of sampling in this way.

Sample selection using the matching methodology is a two-stage process. First, a random sample is drawn from the target population. We call this sample the *target sample*. Details on how the target sample is drawn are provided below, but the essential idea is that this sample is a true probability sample and thus representative of the frame from which it was drawn.

Second, for each member of the target sample, we select one or more *matching* members from our pool of opt-in respondents. This is called the *matched sample*. Matching is accomplished using a large set of variables that are available in consumer and voter databases for both the target population and the opt-in panel.

The purpose of matching is to find an available respondent who is as similar as possible to the selected member of the target sample. The result is a sample of respondents who have the same measured characteristics as the target sample. Under certain conditions, described below, the matched sample will have similar properties to a true random sample. That is, the matched sample mimics the characteristics of the target sample. It is, as far as we can tell, “representative” of the target population (because it is similar to the target sample).

When choosing the matched sample, it is necessary to find the closest matching respondent in the panel of opt-ins to each member of the target sample. Various types of matching could be employed: exact matching, propensity score matching, and proximity matching. Exact matching is impossible if the set of characteristics used for matching is large and, even for a small set of characteristics, requires a very large panel (to find an exact match). Propensity score matching has the disadvantage of requiring estimation of the propensity score. Either a propensity score needs to be estimated for each individual study, so the procedure is automatic, or a single propensity score must be estimated for all studies. If large numbers of variables are used the estimated propensity scores can become unstable and lead to poor samples.

Appendix 3: Inferring the Median and Mean from a Single Quantile of the WTP Distribution

It is not unusual, as is the case here, for respondents in a survey to be asked about whether they support a program at the same specific cost amount. The question we address here is what can be inferred about mean and median WTP given a precise estimate of the fraction of the public willing to pay the specific cost used in the survey? The answer is quite a bit if one is willing to make reasonable assumptions about the general nature of the distribution of WTP that are well supported in the literature on non-market valuation.

A key assumption is that, for all respondents, individual WTP is non-negative. In the present context, this assumption implies that no one feels worse off if the Hopi culture is preserved. This does not exclude the possibility that any number of respondents have a zero WTP for the preservation of the Hopi culture.

Another key assumption concerns the shape of the WTP distribution, namely that the mean WTP is not smaller than the median WTP. The statistical expression of this assumption is that the WTP distribution is not negatively skewed. If the WTP distribution is symmetric, such as the normal distribution, then the mean is the same as the median. However, a right-skewed distribution of WTP is often found in the stated preference literature, which implies that the mean WTP exceeds the median. This comes about, for example, if WTP is an increasing function of income, given that income distributions are commonly right-skewed.

The usual assumption with a distribution defined on the non-negative real line is that the mean is a function of the scale parameter (e.g., variance) of the underlying distribution.⁸ This result effectively ties the quantiles of the distribution to its mean. Not all distributions have this property. For example, the normal distribution, which is defined over the entire real line, does not have this property—knowing the mean, μ , of a normal distribution tells nothing about the 95th quantile. But, the log-normal distribution does have this property; in that case, the mean is given by $\text{EXP}(\mu + .5\sigma^2)$, where μ is the location parameter and σ is the scale parameter, and the estimate of the median is $\text{EXP}(\mu)$. The key insight in the log-normal case is that information on the mean of the distribution can also be used to calculate the quantiles of the distribution.

Another possible piece of information about WTP distributions concerns the coefficient of variation, defined as the standard deviation divided by the mean. The coefficient of variation is a measure of how spread out a distribution is relative to its mean. For WTP distributions, the literature has found (Mitchell and Carson 1989, Table C-1) that estimated values of the coefficient of variation generally fall between 1 and 3. Estimates below 1 tend to come from very homogenous populations, while those above 3 tend to be driven by a small number of large outliers in the response data.

Given that 76.4% of the respondents are willing to \$5 per year for 5 years, it follows that the median annual WTP is an amount larger than \$5 per year for 5 years. And, from the first two assumptions, it follows that the mean annual WTP is at least as large as the median annual WTP. If one is willing to assume a parametric distribution for WTP, more informative results are available.

⁸ This is true for the boundary case of the one parameter exponential distribution, though in a special sense. The variance is the square of the mean, so that knowing either statistic provides an estimate of the other.

Natural choices for a WTP distribution are the two-parameter Weibull and log-normal distributions. Both are proper survival distributions, defined only on the non-negative real line, and they are the most important special cases of more flexible survival distributions like the Gamma and Generalized F. Both are heavily used in the literature as WTP distributions. The log-normal can only approximate the shape of a normal distribution as its estimated scale parameter approaches zero. In contrast, the Weibull is a more flexible two parameter distribution that can take on a wide range of shapes and approximate many distributions including those that are skewed right, or are approximately normal, or are skewed left. Hence, we focus here on the Weibull.

The Weibull has the distribution function:

$$F_X(x) = 1 - \text{EXP}[-(x/b)^c], \quad (1)$$

where b is the scale parameter, and $c > 0$ is the shape parameter. The formula for the mean is:

$$b\Gamma[(c + 1)/c], \quad (2)$$

where $\Gamma[\]$ is the standard gamma function, and the formula for the median is:

$$b\ln(2)^{(1/c)}. \quad (3)$$

The shape parameter, c , determines the skewness of the distribution. The mean and the median are equal when the shape parameter takes the value of $c = 3.44$; when $c < 3.44$, the mean is larger than the median; and when $c > 3.44$, the median is larger than the mean (Groeneveld 1986).

Some approaches to estimating the Weibull parameters use empirical percentiles. An approach proposed by Seki and Yokoyama (1993) uses the 31st and 63rd percentiles. Their method exploits the empirical fact about the two-parameter Weibull that the scale parameter coincides in value with the 63rd percentile regardless of the value of the shape parameter. Thus, Seki and Yokoyama's approach is to set b equal to whatever is the 63rd percentile of the empirical distribution and then calibrate the shape parameter, c , using the 31st percentile of the empirical distribution, denoted x_{31} , and solving the following equation for c , given the value of b :

$$0.31 = 1 - \text{EXP}[-(x_{31}/b)^c]. \quad (4)$$

George (2014) shows that the Seki and Yokoyama estimator performs quite well, especially for sample sizes of 100 or larger, although not as well as the maximum likelihood estimator.

Since we know only one percentile of the WTP distribution, we need to do something conceptually similar to Seki and Yokoyama but which relies on different information about the distribution. We make use of the percentile that we know (corresponding to \$5) together with an assumption about the relation between the mean and the median of the WTP. We consider three alternative assumptions about the relationship between the mean and median or about the coefficient of variation.

In our first analysis, we assume that the mean and median coincide, which implies that $c = 3.44$. The value of the scale parameter, b , is found by calibrating the distribution function such that there is a 76.4% probability that x has a value of at least \$5, and a probability of 23.6% that its value is less than \$5:

$$0.236 = \Pr \{x \leq 5\} = 1 - \text{EXP}[-(5/b)^{3.44}]. \quad (5)$$

This yields a value of $b=7.32$. Plugging that value along with $c=3.44$ into (3) yields an estimate of median and mean annual WTP amounting to \$6.58 per year for 5 years. This is surely a conservative estimate because mean WTP is far more likely to exceed median WTP than to equal it.⁹

For our next analysis, we make the assumption that the mean WTP is twice the median WTP (it is not uncommon in the literature for the ratio of mean to median WTP to be greater than this). The value of the shape parameter that brings about this exact relationship for a Weibull variate, using (2) and (3), is $c=0.73$. Plugging that value of c instead of 3.44 into (5) generates a value for b of $b=30.19$. This value of b generates a median annual WTP of \$18.27 and a mean annual WTP of \$36.78.

A third approach to inferring the median and mean annual WTP from the 76.4-percentile of \$5 while still using the two-parameter Weibull distribution employs information on the typical range for the coefficient of variation. With a Weibull distribution, the coefficient of variation (COV) is:

$$\text{COV} = [\text{Gamma}[(c+2)/c] / \{\text{Gamma}[(c+1)/c]\}^2 - 1]^{.5}. \quad (6)$$

Using the two endpoints of the reasonable range [1, 3] for the COV from early CV studies taken from Table C-1 of Mitchell and Carson (1989) in conjunction with (6), each of those COV values translates into a particular value for the shape parameter, c . A COV of 1 generates the value of $c=1$; while a COV of 3 generates the value of $c=0.41$. From (2) and (3), lower values of c translate into higher values for mean and median annual WTP. Therefore, we focus on the case of $c=1$, which corresponds to $\text{COV}=1$.¹⁰ Using $c=1$ and noting that $\text{Gamma}(2)=1$, Eq. (2) implies that the parameter b coincides with the Weibull mean. Using (5) with $c=1$ instead of $c=3.44$ to calibrate b , we obtain $b=\text{mean annual WTP}=\18.57 . From (4), with $c=1$ and $b=18.57$, median annual WTP equals \$12.87.

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⁹ It is important to note that mean WTP estimates using this approach may be quite sensitive to the specific single cost amount used. If mean WTP > median WTP and the percent in favor at the cost amount used is greater than 27%, then the estimate of b will increase from below toward its true value as the cost amount increases toward the amount where only 27% are in favor. If the mean WTP > median WTP and the Weibull assumption holds, then, in expectation terms, this estimator, even if sensitive to the cost amount used, cannot overestimate mean WTP. The only way to reconcile disparate estimates of b obtained using different cost amounts is to allow the shape parameter to decrease from 3.44. This allows the estimate of mean WTP to become larger than median WTP. If the Weibull assumption is valid and mean WTP > median WTP, then the estimate of b and mean WTP will not (statistically) change as the cost amount used changes.

¹⁰ When $c=1$, the Weibull becomes the Exponential distribution.

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