Measuring Personal Economic Damages due to Environmental Harm Incurred by Residents of a Lake-Centered Community

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Abstract

A claim for economic damages can occur when an environmental amenity enjoyed by particular individuals is wrongfully impacted. Valuing a useable but non-market-traded asset has historically been difficult. At the national level, legal precedents have been established as a result of several notable cases, especially the Exxon Valdez oil spill. The development of contingent valuation studies has allowed for willingness-to-pay and willingness-to-accept measurements to value environmental assets. In addition, traditional revealed preferences analysis provides indirect measurement by using existing markets (such as the housing market) to analyze differences in prices of properties with and without access to an environmental amenity. We use existing literature and data on both techniques to estimate the pecuniary value of economic harm incurred by residents who experienced adverse impacts upon lake amenities in northeastern United States.

JEL Codes: K4, Q5

I. Introduction

Economists have been studying the economic aspects of the natural environment for decades, and a sizeable literature has developed over that time.[1] In light of the absence of market prices for environmental goods and services, due to their public-goods nature, much of the focus has been on alternative ways to value environmental amenities. Paralleling this research has been the creation of federal and state government agencies designed to regulate the use and treatment of environmental resources such as the seas and waterways, forests and other land areas, and the air.

The value of environmental amenities is often difficult to express in monetary terms. Their valuation depends on techniques generally termed contingent valuation method (CVM) that consist primarily of asking questions of survey respondents regarding the extent of their willingness to pay (WTP) to be assured access to a particular environmental amenity, or the extent of their willingness to accept (WTA) remuneration in lieu of potential reduction of or harm to a particular environmental resource such as the air, a river or public land. The methodology is called "contingent" because each survey question is posed in the form of a "what if" scenario:

> ... it asks respondents to imagine a hypothetical or contingent scenario in which they might personally be required to finance the provision of a public good, or in

[1]The American Economic Association's *Journal of Economic Literature* categorizes research in economics into JEL Classification Codes. Section Q is the classification for "Agricultural and Natural Resource Economics; Environmental and Ecological Economics." Subsection Q2 deals with "Renewable Resources and Conservation" and covers fisheries, aquaculture, forestries, land, water, recreational aspects and government policy. Subsection Q5, "Environmental Economics," includes research on Valuation of Environmental Effects; Pollution Control Adoption and Costs; Distributional Effects; Employment Effects; Air Pollution; Water Pollution; Noise; Hazardous Waste; Solid Waste; Recycling; Climate; Natural Disasters and Their Management; Global Warming; Technological Innovation; Environment and Development; Environment and Trade; Sustainability; Environmental Accounts and Accounting; Environmental Equity; Population Growth; Ecological Economics: Ecosystem Services; Biodiversity Conservation; Bioeconomics; Industrial Ecology; and Government Policy.

> which they might be required to trade away their right to that public good. ... [it] is one of the few empirical methods used in economics for making a quantitative estimate of individuals' benefit from non-traded goods or services. [Doshi, pp. 1, 4.]

Contingent valuations have been shown to differ depending on the perceived property rights of the amenity (Kahnerman and Tversky, 1979). For example, when an individual owns an environmental amenity, like lake access, its stated value is often greater than the stated value of the amenity by those who are not owners and have to pay to access the amenity.

The literature on CV has delineated various forms of benefits from environmental resources. In addition to use of the natural environment (fishing, boating, etc.), non-use benefits include an option-to-use-in-the-future value, altruistic value (knowing that others have access), existence value (e.g., knowing that the Grand Canyon exists), and a bequest-to-future-generations value.

Further, it is sometimes possible to estimate the value of a natural resource by reference to behavior within private markets such as that for housing that, due to its location, happens to provide residents enjoyment of some environmental benefit. Housing property prices in such a region could be compared to the prices of similar housing that does not include access to a comparable natural resource. By inference, therefore, such comparisons provide an indirect yet market-based estimate of the value of the environmental amenity. Because of its focus on access to the use of environmental amenities, this revealed preference method captures only use value and thereby under-estimates the full value of an environmental amenity.

Doshi (2008, pp. 41-2) reminds us that revealed preferences reflect real-world decisions regarding the value of some environmental object. But because they are infrequent, "they cannot be marshaled into action every time the legal system wonders how much a non-tradable

environmental object is worth." Hence, the next best alternative is CVM, despite its shortcomings and potential biases.[2]

With respect to environment-related litigation in the U.S., we may distinguish between mass tort actions, and individual (or personal) damages claims. Given the public-goods nature of environmental amenities, i.e., many people typically benefit from or enjoy use or access to an aspect of the natural environment, mass torts are often the focus of litigation. Hence, a good deal of the reported cases addresses the harm to an affected community and the corresponding compensation to its "average person." In contrast, personal damages suits relating to the environment must address actual, specific harm incurred by particular individuals. It is the latter with which we are concerned here as a result of being retained as damages experts in an environmental-harm law suit.

II. Court Cases

The courts have opined on acceptable methods for measuring the economic value of adverse environmental harm to particular individuals. The most noteworthy case is the multi-year litigation over the Exxon Valdez oil spill off the coast of Alaska. Both Alaska and the federal government brought suit, as did several Native corporations, seafood producers and individual citizens against both the Exxon Corporation and the ship captain.[3] In those cases,

[2] Doshi (2008, pp. 7-12) reviews the criticisms and flaws of CVM that include the hypothetical nature of the payments asked for in CVM studies, internally inconsistent results in a given CVM study between different question formats, susceptibility to external cues and parameters of the CVM questions, and the alleged failure of CVM respondents to correctly take note of the quantities involved

[3] Exxon was prosecuted by the federal government for various environmental crimes: violating the Clean Water Act, 33 U.S.C. §§ 1311(a) and 1319(c) (1); violating the Refuse Act,. 33 U.S.C. §§ 407 and 411; violating the Migratory Bird Treaty Act, 16 U.S.C. §§ 703 and 707(a); violating the Ports and Waterways Safety Act, 33 U.S.C. § 1232(b) (1); and violating the Dangerous Cargo Act, 46 U.S.C. § 3718 (b). Exxon Corporation pled guilty to one count of violating the Migratory Bird Treaty Act. Exxon Shipping pled guilty to one count each of violating the Clean Water

CVM evidence was introduced by the plaintiffs regarding the value of non-use resulting from pollution of the affected natural environment.

Contingent valuation "received a major endorsement in a 1989 D.C. Circuit Court of Appeals case, *Ohio v. Department of Interior*." (Doshi, 2008 p. 14) Soon after, the federal government passed The Oil Pollution Act of 1990. Based on that Act, Kenneth Arrow and Robert Solow prepared a report in 1993 for the National Oceanic and Atmospheric Administration (NOAA) that gave guidelines needed for CVM studies to produce reliable estimates. (NOAA, Proposed Rules: Natural Resource Damage Assessments Under the Oil Pollution Act of 1990, 58 Fed. Reg. 4601 (1993).) These economists recommended, among other requirements, that WTP rather than WTA be used, "based on the idea that the systematically lower WTP estimates are more 'conservative' and thus more desirable." (Doshi, p. 18).

Regarding additional court cases, Doshi (2008, p. 20) reports that in "the post-Daubert world, much of the relevant case law on environmental valuation has related to hedonic damages evidence, rather than CVM." Hedonic damages are based on studies of consumer purchases to reduce risk of harm or death. But the technique is flawed because consumers are not likely to know or be able to estimate the probability of risk-reduction associated with any given product purchase. Kuiper (1996) argues that hedonic damages evidence does not pass the "testability" prong of *Daubert*. He based his ideas, in part, on an article by Ireland, Johnson and Rodgers (1992) that explains the arbitrary assumptions typically made by analysts who attempt to use the hedonics method in litigation.

Act, the Refuse Act, and the Migratory Bird Treaty Act. They were jointly fined $25 million and were ordered to pay restitution in the amount of $100 million.

The civil cases (involving thousands of plaintiffs) were ultimately (but with a few exceptions) consolidated. Municipal claims and some Native corporation claims were tried in state court. [Exxon Qualified Settlement Fund, Litigation History, http://www.exspill.com/news/ litigationhistory/tabid/1918/default.aspx]

Regarding the use of CVM evidence, there are at least two post-Daubert federal cases: *General Electric v. U.S. Department of Commerce* (1997) and *National Association of Manufacturers v. U.S. Department of Interior* (1998). In the first case, it was ruled that CVM, if performed correctly, is acceptable in providing useful and reliable results. In the second, the court permitted use of relatively old CVM studies as the "best available procedures."

III. The Case Study

Our hypothetical case study is based on an actual assignment we undertook a number of years ago. To make our analysis tangible, we study a lakeside community of one-hundred (100) homes in northeastern United States, having an average value of $350,000, where the community had enjoyed access to clean and useful lake amenities such as swimming, boating and fishing, and then lost those amenities due to environmental harm caused by a third party (a business entity). The harm prevented community residents from using the lake for over a year, with continuing residual problems extending for possibly several additional years. We address the questions: Is it possible to measure the impact of the loss of use of the lake amenities? And, is it possible to put this loss in terms of a dollar value?

As noted earlier, the value of environmental amenities is generally difficult to put in monetary terms and estimated values differ based on the perceived property rights of the amenity. Hanemann (1991) confirms that alternative willingness estimates can vary widely and are often not easily substitutable. For example, when an individual owns an environmental amenity, like lake access, its perceived value is often different (usually higher) than the stated value of those who do not own the amenity and have to pay per visit. This paper explores willingness-to-pay measures of the value of a lake amenity, and incorporates indirect revealed

preferences measurement as well. Revealed preferences, i.e., observations of market behavior, when available, are useful in providing indirect measurement of the value of nontradeable goods like environmental quality.

We look at different, previously published measures to evaluate the value of access to clean and usable lake amenities and, inversely, the valuation of a loss in use of these amenities. We extend the forensic economics literature by analyzing the lake amenity value using both willingness-to-pay measures and revealed preferences. There are differences between the two measures, but within each there are lower- and upper-bound estimates that depend on the assumptions used.[4] These are each discussed individually and provide different estimates that can be used to value lake amenities.

The next section values lake amenities under CVM technique. The revealed preferences, market-based approach is developed and applied in the subsequent section. The final section concludes with a summary of the estimated values.

IV. Contingent Valuation Measures for a Lake

Facing the difficulties in valuing non-market resources, Mitchell and Carson (1989) employ a contingent valuation method (CVM) for the valuation of such resources.[5] As different questions are asked, the average willingness-to-pay can be deduced through analysis of the responses. CVM most often seen in the courts makes use of willingness-to-pay (WTP) measures. Studies indicate that the willingness-to-accept (WTA) method, which entails respondents' assessing how much money they would be willing to accept in order to give up an environmental

[4] As defined by Freeman (2003), willingness to pay "is the maximum sum of money the individual would be willing to pay rather than do without an increase in some good such as an environmental amenity. … [It] is constrained by the individual's income …." (p. 9)

[5] Hausman (2012) criticizes the use of contingent valuation method to measure non-market values.

amenity or resource, almost always generates higher valuations than WTP measures do.[6] The federal courts' acceptance of WTP measures is justified, among other grounds, as being more "conservative." i.e., yielding lower values.

As an example, Carson and Mitchell (1993, p. 2447) asked respondents how much they would be willing to pay "to keep the nation's freshwater bodies from falling below the boatable (minimum) level where they are now." The reported values represent willingness-to-pay for a minimum level, but do not reveal the willingness-to-pay for qualities above this minimum level.

When looking at a lake amenity, there are two different values the lake brings: the value of water quality and the recreational use value.

i. The Value of Water Quality

Carson and Mitchell (1993, p. 2449, table 3) report measures of the WTP for water quality at different levels. Moving from non-boatable to boatable is valued between $106 and $141 in total annual household willingness-to-pay. This is the minimum level of water quality. They also provided estimates for higher qualities of water. Moving from boatable to fishable is valued at between $80 and $108, and moving from fishable to swimmable is valued at between $89 and $116, both per household.

Thus, the total annual household's WTP for moving from non-boatable water to swimmable water is between $275 and $365. These values are all expressed in 1990 dollars. Converting to today's (2018, 1st quarter) dollars generates values of between $530.17 and $703.68.[7]

The results of the national sample in Carson and Mitchell (1993) are consistent with the local valuation in Gramlich (1977) on the value of water quality increases to the Charles River in

[6] *See* Elizabeth Hoffman & Matthew L. Spitzer, *Willingness to Pay vs. Willingness to Accept: Legal and Economic Implications*, 71 WASH. U. L. Q. 59 (1993).
[7] We use the Consumer Price Index (All Consumers) provided by the BLS: http://data.bls.gov.

Boston, and the national valuation in Mitchell and Carson (1981) that uses a national sample estimating the value of swimmable water. The results are also close to, but slightly higher than, the valuation found in Smith and Desvousges (1986) who analyze the water quality value for the Monongahela River.

ii. The Recreational Use Value

The New Jersey Department of Environmental Protection (NJDEP, 2006) analyzed the economic literature as it applies to state parks in New Jersey, finding that the research supports values for a 4-hour visit ranging from $17 to $26 per person, with a central estimate of $21 in recreation value alone. This value is consistent with Kaval's (2007) working paper: a 12-hour visit to a park is valued at $60.50 per day (in 2006). In 2018 dollars this is equivalent to $75.62 for a twelve-hour visit, equating to $25.21 for a four-hour visit. We note here that Kaval's estimates are close to the average NJDEP value of $21, which is $26.25 in 2018 dollars for a four-hour visit.

The Kaval (2007) study looked at a variety of activities and provided different values for these activities. Of the twenty-five activities assessed, the range of the value of benefits varied considerably, from a low of $6 to a high of $174/person/day (for Mountain Biking) in 2006 dollars (per day estimates are based on a 12-hour visit).

Given the wide range of benefits, Kaval (2007) divides the activities into groups of high value (>$100/person/day; examples: mountain biking, canoeing, kayaking, and rafting), moderate value ($35 to $100/person/day; examples: motor boating, sight-seeing, fishing, swimming, and going to the beach), and low value (<$35/person/day; examples: hiking, snorkeling, and visiting environmental education centers). The lowest valued activities were

visiting environmental education centers, valued at $6/person/day, and horseback riding, valued at $19/person/day. The next lowest valued benefit was $31/person/day (snorkeling).

Kaval's (2007) estimates come from an analysis of 36 years of studies (1968-2003) and include consumer surplus non-market recreational benefits. These results are separated by type of recreational activity and represent the average estimated value of the activity converted to 2006 dollars. Kaval's data include 1,229 observations on 25 types of activities in 106 locations. These are average figures. Because they are averages, the use of local cost of living, or local amenity costs, should be taken into account when applied to different locations.

For our purposes, among the different activities, we identify the lake-related activities estimated in Kaval (2007; figure 1, page 7) to include: canoeing, kayaking, and rafting, $140; motor boating, $60; fishing, $53; waterskiing, $50; swimming, $44; going to the beach, $40; scuba diving, $37; and snorkeling, $31 (All figures are per person per day). The average water amenity in the Kaval study had a daily use value of $56.88 per person per day ($71.10 in 2018 dollars).

Shrestha, Stein, and Clark (2007) estimate the value of nature-based recreation, finding that the average visitor would pay $74.18 per visit-day for nature-based recreation ($92.72 in 2018 dollars). Use of the two studies gives a range of estimates for daily use value of $71.10 to $92.72 for a four-hour visit.

Hannon (1994) examines geographic discounting: the further away people live from a lake, the less they are willing to pay for the lake itself. Thus, houses that are located on, or within walking distance, exhibit an increased value relative to those houses that require travel to the lake. This is confirmed by Pate and Loomis (1997).

Given that the estimates above apply to state or national parks, and given the findings in Hannon and Pate and Loomis regarding geographic discounting, the range of values cited above represents lower bounds for any properties that have immediate lake access (either lake homes or homes in a lake community).

Having identified a range of values per person per day, for both water quality and recreational use of a water amenity, the next step is to apply the values to our lake users.

iii. Total Value

Depending on the geographic location of the lake community, there are differing amounts of time a lake could be used. In colder climates a lake could be used for about four months, whereas in warmer climates a lake could be used for eight or more months. As noted above, the water quality value itself has a lower-bound estimate of $520.17 per household and an upper bound of $703.68 per household. The recreational amenity use value also has lower and upper bounds, as explained in the previous section.

To apply these recreational use values to our hypothetical lake residents, we first assumed when we conducted our analysis that the average size of the lake resident household is comparable to the average U.S. household, namely, 2.55 people. We further assume that lake community residents use the amenity two times a week for either four hours (lower bound) or 12 hours (upper bound). By applying these assumptions, we arrive at the following calculated values:

	Value of Amenity Use	Average Household Size in U.S.	Visits per Week	Number of useable weeks per year	Total
Lower Bound	$25.21	2.55	2	16	$ 2,057.71
Upper Bound	$92.72	2.55	2	32	$15,131.90

The lower bound is estimated by taking the assumed four-hour visit ($25.21), times the average household size in the U.S. (2.55), times two visits per week, times the lower number of useable weeks per year (16). This yields an estimated lower bound of $2,057.71 (in 2018 dollars) per household for homes that have four months of usable time and whose members use the amenity four hours per visit. Adding this use value to the water quality value ($531.17) gives a total lower bound estimate of $2,588.88 per household per year.

A recreational amenity value's upper bound is based on a twelve-hour visit, two times a week, with eight months of useable time. Thus, multiplying the value of the amenity for a twelve-hour visit ($92.72), times the average household size, times two visits per week, times the number of useable weeks (32) yields a total amenity value of $15,131.90 per household and a total value, including water quality (the upper bound estimate of $703.68 per household), of $15,835.58.

One caveat to these measures is that they do not include a monetary value of the travel time component of the cost of a visit to an environmental amenity (Randall, 1994). However, in our case study, given the close and ready access to the community's lake by its residents, travel cost is a relatively trivial part of the value of the lake amenities.

The CVM technique is one type of measure that reflects a given person's willingness-to-pay to obtain access to a stated benefit, which in this case are a lake and its corresponding amenities. As we have shown, based on various studies, these willingness-to-pay estimates provide lower- and upper-bound estimate values for lake amenities.

A second approach to measuring the value of an environmental amenity is the market-based revealed preferences method, which involves "the estimation of value from observations of behavior in the markets for related goods …." (Freeman, 2003, p. 95). Further, as Kahneman

and Tversky (1979) state, there is a difference in the enjoyment gained by obtaining a new asset, and in the enjoyment of an asset that is already owned. The new asset's value is, in general, smaller than the already-owned asset. In our case study, the lake community residents already "own" use of the lake amenities, so the revealed preferences method would tend to yield higher values than for persons who do not have such lake access. The next section develops valuation based on market transactions.

V. Revealed Preferences Approach

The first approach looked at stated preferences. We now look at revealed preferences by analyzing the values of lake amenities through the value of housing and the increased value of a home that includes lake amenities. Palmquist, Roka, and Vukina (1997) show that housing values can be used as a proxy for amenity (or environmental) values.

When looking at the residential value of a home that includes an existing lake amenity, the value includes both the home and the value of lake use. This value includes not just the value of the lake use at present, but the ability to use the lake in years to come. Thus, determining the increased cost of housing with lake amenities provides a good measure of the value of the amenity itself.[8]

Benson, Hanson, Schwartz, and Smersh (1998) researched the value of water views, both for oceans and lakes. In particular, those houses with lake views were estimated to increase the value of a property by 18.1%. However, they expanded their research to include lake-front

[8] "Because the environmental amenities of interest are location specific but not part of the structure, the values of the environmental amenities should be reflected in the price of land alone. However, at least in the United States, land is not usually traded separately from the structures placed upon it, so the observed prices reflect the values of both the land and its structural improvements." (Freeman 2003, p. 360). In our study, therefore, we made some simplifying assumptions regarding the average value of the house structures themselves, and the comparability of households in the region regarding their socioeconomic characteristics.

homes with lake amenities in addition to lake views. They found that having both lake views and a lake with amenities on it increased the average home's value by 126.7% (with 18.1% of that value being from the lake view itself). The lake-view estimate is consistent with Luttik's (2000) estimate of a 28% increase in value for a yard touching a lake and an 8% to 10% increase in values to homes with a view of a lake (this study did not value the use value of the lake).

Given that housing prices reflect the value of the property (land and structure) and the amenities available to the homeowners, the price reflects both the property itself and the amenities available. Other things being equal, an increase in home values from amenities, expressed on an annual basis, reflects the yearly value of these amenities. Thus, finding the one-year value for a house's amenities represents the lost value to a homeowner for that year's lost use.

For this purpose, we examined the increased annual cost of a mortgage for a home with a lake amenity, relative to the mortgage cost of a house without a lake amenity. If all houses in a given lake community have the equivalent of these like-style amenities, then the median home value would already reflect approximately a 126.7% increase in value for these amenities.

This assumption is based on the lake value being the average lake quality in the area where the housing prices are calculated. Alternatives to this assumption can be calculated and need to be taken into account. For example Boyle, Poor, and Taylor (1999), Michael, Boyle, and Bouchard (2000), and Gibbs et al. (2002) all find that the clarity of the lake's water also impact the housing price for lake homes. Any variants from the average need to be taken into account when solving for the value of the asset, or used to value the impact of changing the value of the asset (i.e., estimating the value lost for a less-clear lake).

In our hypothetical lake community example, there are 100 homes with a median house price of $350,000. The following table shows our estimate of the house price differential, representing the value of the lake amenities:

lake-community median house price	Increased house value	Value of non-lake-community house	Value of lake amenities + view	Value only of lake view
(1)	(2)	(3) = (1) – {(1)/[1+(2)]}	(4) = (1) – (3)	(5) = (4) x (18.1%/126.7%)
$350,000	126.7% (of which 18.1% for lake view)	$195,611	$154,389	$22,056

By applying an assumed 30-year mortgage rate of 4.5%, the values calculated above would represent an increase of $825.75 per monthly mortgage payment for lake access with a view and a $707.79 increase in monthly mortgage payments for houses with lake access but no lake view. Thus, for each home with a lake view and access, our estimate using the market-based approach is this value increase times twelve months, or $9,909 per house per year.[9] And for each home with no lake view but with access, our estimated annual value is $8,493. The mean value of the two is $9,201.

VI. Summary Valuations

Using both CVM and market-based approaches provides different estimates for the value of lake amenities. The lower bound of the stated preference is $2,588.88 per household per year in comparison to an upper-bound estimate of $15,835.58. For revealed preferences we estimate the yearly value of a lake amenity at $9,201 per house per year, a value that falls within the CVM range, providing further support of establishing a reasonable value of the loss of the lake amenities.

[9] Even in areas where the use of the lake is seasonal, the value of lake access is paid in the price of the house of the full year's increased mortgage costs.

Although these estimates can vary widely, the ability to analyze lower- and upper-bound estimates, and establishing values using both CVM and revealed preferences techniques provides a relatively clear understanding of the overall valuation process for lake access in the U.S. in the event that the use of these lake amenities is impacted by a third party.

In our example of 100 homes in the lake community, the aggregated value of loss in 2018 dollars could range from a low of $258,888 to a high of $1,583,558, based on stated preferences. Use of revealed preferences generates a loss figure of $920,100. Such figures would be very helpful to a trier of fact in determining a reasonable value of loss due to the adverse environmental effects of a third party's actions upon lake community residents.[10]

Since our analysis is presented as dollars per household, and bearing in mind the caveats presented in this paper, the methodology explained here can be applied to any sized lake community that has experienced interruption in its access to lake amenities.

[10] The actual case assignment underlying the hypothetical in this paper was settled prior to our giving any expert witness testimony. We are not aware of the final settlement values.

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