The Value of Improved Water Quality To Chesapeake Bay Boaters

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WP 03-16

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WORKING PAPER

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Running Head: Water Quality and Boating

Keywords: contingent valuation, water quality, boating

JEL Classification Code(s): Q26

Financial support for this study was provided by the Marine Trades Association of Maryland, the Maryland Department of Natural Resources and the Maryland Sea Grant Extension Program. The author wishes to acknowledge the anonymous peer reviews which contributed significantly to the improvement of the manuscript.

Abstract

As part of an economic survey of Maryland registered boat owners, an open ended contingent valuation question was posed regarding willingness to pay for an improvement in water quality in Chesapeake Bay. The boaters ranked their perception of water quality on a scale of one to five, and the payment was for an improvement of one unit. Boaters also indicated the type of concern poor water quality raised, ranging from no concern to concern about long term effects of exposure to toxic chemicals. Median willingness to pay for a one step improvement in water quality was $17.50 per year and the mean was $63, with 38% expressing a zero willingness-to-pay. A tobit model was estimated to determine what factors influenced willingness to pay amounts. Sailboaters and boats that were kept in the water rather than trailered were willing to pay more for water quality improvements. Additionally, the lower the individual ranked water quality and the greater concern for the health effects from water quality, the more the willingness to pay for a water quality improvement. In aggregate, Chesapeake Bay boaters in Maryland were willing to pay approximately $7.3 million per year to achieve the stated water quality improvement. The present value of this improvement, at a 5% discount rate is a $146 million.

Introduction

Boating is one of the most important water-dependent recreational activities in the United States. According to statistics available from the National Marine Manufactures Association, there were approximately 17.4 million boats in use in 2002, and almost 72 million people participated in some form of recreational boating. There is general recognition by those involved in the boating industry that clean water is an important facet of the boating experience. As a result, states like Florida and Maryland have successfully launched Clean Marina Programs, where marinas voluntarily comply with standards established to protect the aquatic environment. Recognition of the importance of clean water to boaters may not be shared by all. In a major national assessment of eutrophication in estuaries, boating wasn't even listed as a potential impaired use due to poor water quality, although boating dependent uses such as recreational fishing, swimming and tourism were mentioned (Bricker et al. 1999). In a full accounting of the costs and benefits of water quality improvements, it will be important to determine the value of such improvements to boaters as well as other users.

Despite the high level of participation in boating and the interest in improved water quality, a search of the economic literature on the value of boating revealed only a handful of studies and few that linked changes in boating values to changes in water quality. In a comprehensive review of outdoor recreation studies from 1968-1988, Walsh, Johnson and McKean (1992) found five studies on the value of motorized boating and eleven on non-motorized boating. Subsequently, in looking at studies that relate the value of boating to water quality, Freeman (1995) found only two that matched this criterion. Lipton and Hicks (1999a) used a multinomial logit discrete choice model of boat documentation to demonstrate that the choice of state of principal use by documented vessel owners was significantly affected by the boat owners' perception of overall boating quality in a state. Thomas and Stratis (2002) in a study that examined the cost to boaters of new speed limit regulations state that, to their knowledge, theirs is the first application of random utility modeling to recreational boating.

In contrast to the lack of studies related to boating, Freeman found 21 studies that estimated the value of marine recreational fishing. The National Marine Fisheries Service is in the process of estimating the value of recreational fishing throughout the United States on a regular basis (Haab, Whitehead and McConnell 2001). The emphasis on studies of the value of recreational fishing relative to the value of boating may have some justification. A large percentage of boat owners use their boats frequently for fishing. In their study on recreational boating in Chesapeake Bay, Bockstael, McConnell and Strand (1992) found that 72% of trailered boat owners and 38% of in-water boat owners used their boats always or usually for fishing. If one is interested in determining the benefits of policies that lead to improved water quality, the link can be made between improvements in water quality and the health of fish stocks and angler catch rates (Karou and Smith 1995; Lipton and Hicks 1999b; Lipton and Hicks 2003).

There are several reasons why a closer look at boating values related to water quality is warranted. One is that we tend to impute the entire value of a boating trip on which fishing occurred to the fishing activity. Many boaters may fish as part of a general recreational outing on the water, and they benefit from the entire experience. Secondly, as noted above, there are some segments of the boating population, particularly non-trailered boats and especially sailboats, where fishing is not the major reason for boating. Boaters may value improved water quality for reasons other than increased catch rates while fishing. In 2003, during a summer with higher than usual rainfall, several major boating and swimming regions in the Maryland portion of the Chesapeake Bay had warnings from health officials regarding contact with waters with high concentrations of blue-green algae (Baltimore Sun 2003). These highly publicized concerns, similar to the scare in 1997 related to Pfiesteria, overlay a more general concern among boaters and others about water quality.

This paper reports on the value of hypothetical water quality improvements to Chesapeake Bay boaters based on a contingent valuation survey that was conducted in concert with an expenditure survey designed to obtain information for an input-output analysis of Maryland boating. The limited resources available to conduct the contingent valuation part of the survey necessitated a relatively simple format (see Whitehead, Haab and Huang 1998) as opposed to the more complex and expensive approach such as that suggested by the NOAA panel on Contingent Valuation (Arrow et al., 1993). In particular, the willingness to pay for improved water quality was elicited with an open-ended question as part of a mail survey, as opposed to a referendum format elicited in an in-person interview. While open-ended questions have fallen out of favor with some practitioners of contingent valuation (Haab and McConnell 2002), any of the payment elicitation methods—open-ended, dichotomous choice, payment card, etc. —are subject to their own set of issues as to how the elicitation method affects the response and how the responses are interpreted by the researcher (Halvorsen and Saelensminde 1998).

Below we briefly describe the theoretical basis for the use of contingent valuation to determine the value of improved water quality to boaters. Next the survey methodology is presented along with the general descriptive results of boating in the Maryland portion of Chesapeake Bay. Responses to the contingent valuation are analyzed in detail with implications for policy setting related to water quality.

Contingent Valuation of Boating Water Quality

We assume that boaters maximize their utility from boating trips taken, conditioned on their perception of the water quality they experience, subject to a budget constraint:

(1) $u(b, q_0, z)$ s.t. $m=p_b b+z$

where u() is the utility function, b is the number of boating trips, q_0 is the perception of water quality, z is a composite of all other goods, m is the budget constraint and p_b is the cost of boating normalized on the price of the composite good. The indirect utility function can be written as $v(p_b, q_0, m)$. The compensating variation is the amount of money (y) that satisfies:

(2) $v(p_b, q_0, m) = v(p_b, q_1, m-y)$

where q_1 is the boater perception of improved water quality.

For this study, the compensating variation is estimated using a contingent valuation question in a mail survey primarily intended to obtain boater spending patterns (Lipton 2001). The boaters surveyed were first asked to provide a percentage breakdown of their boating activity in four categories: cruising, fishing, swimming/skiing/tubing or other activity. Since the survey was sent to a sample of Maryland boaters, they were also asked what percentage of their boating activity was conducted on the Chesapeake Bay or its tributaries as opposed to other water bodies such as inland lakes, coastal bays or the Atlantic Ocean. In order to focus on Chesapeake Bay water quality issues, only boaters who used their boats 50% or more of the time in Chesapeake Bay and its tributaries were included in the analysis that follows. The boaters were presented with an ordinal ranking of water quality on a scale of 1 to 5 (poor, fair, good, very good, excellent) in relation to the extent it impacted their boating activities. The text of the water quality ranking question with potential responses is given below:

Q9. *Please rate the water quality related to your boating and boating-related activities:*

(Note: Water quality refers to level of pollution, not to natural nuisances such as jellyfish.)

1 Poor, my boating activity is severely curtailed due to water quality conditions.

2 Fair, my boating activity is restricted and I avoid many areas.

3 Good, there are areas I actively avoid, but with some effort, I can do whatever I want.

4 Very good, I rarely have to worry about water quality conditions.

5 Excellent, I have no concerns about water quality where and whenever I go boating.

To determine what it was about the water quality that concerned boaters, they were asked whether or not they altered their boating behavior and activities due to water quality conditions and what the primary concern was. If the boater did alter behavior, the choices they were given for doing so related to water quality were:

Q10. *If you avoid some areas due to your concerns about water quality, what issue concerns you THE MOST in those areas:*

1. I do not avoid areas due to concerns about water quality

2. The water is unpleasant for swimming and other contact, but does not pose a health threat

3. I'm afraid that someone in my party will get sick from contacting or swallowing the water.

4. I'm concerned about long term health effects from toxic chemicals that may be in the water or sediments

5. I'm concerned that Pfiesteria or some harmful algal bloom is likely to be present in those waters

The contingent valuation question, which required an open-ended response, was worded as follows:

Q11. *Suppose Maryland was able to implement a new pollution-reduction program that would improve the water quality one step from how you ranked it on Q9, e.g., an improvement from 3-Good to 4-Very good. What is the maximum amount you would be willing to pay per year in state or local taxes for such a program?*

Maryland Boater Survey

Questions for a mail survey was developed in consultation with a panel of eight industry experts affiliated with the Marine Trades Association of Maryland. Between May 2000 and February 2001 the Survey Research Center at the University of Maryland administered the survey to the target population of owners of recreational boats registered or documented in Maryland. The sampling frame was a random sample of 2,510 records out of 220,800 from the boater registration database maintained by the Maryland Department of Natural Resources.

There were four waves of data collection, covering the following periods of boat usage: January 2000 - April 2000 (wave 1), May 2000 - June 2000 (wave 2), July 2000 - August 2000 (wave 3), and September 2000 - November 2000 (wave 4). The initial mailing of the survey for a wave was typically two to three weeks after the period of boat usage being sampled ended. With the exception of wave four, in which a sufficient number of returns were obtained in two mailings of the questionnaires, each wave of data collection consisted of three mailings of the questionnaire and one mailing of a reminder postcard.

Overall, in four waves of data collection, 1163 completed surveys were collected for a response rate of 50%. Table 1 shows the detailed disposition of 2,510 sample units by wave and in total.

Survey Results

Eighty-percent of Maryland boaters use their boats principally (50% or more) on the Chesapeake Bay and its tributaries, and 67% use their boats exclusively in the Bay. Based on the survey responses, the typical Maryland boater on the Chesapeake Bay owns a twenty-two foot powerboat that is somewhat more likely (49%) to be kept on a trailer during the boating season than kept in the water at a marina (41%). Over the course of the year, the boater takes an average of approximately 27 separate trips, with 45% of the time being devoted to cruising, 39% to fishing, 9% to swimming/tubing/skiing, and 7% to other types of activities. Swimming, tubing or waterskiing is not an activity for 73% of the boaters.

The median response to the contingent valuation question was $17.50 per year and the mean was $63, with 38% expressing zero willingness-to-pay (Table 2). The percentage of boaters ranking water quality as good (39%) was the same as the percentage ranking water quality very good (Table 3). Fewer than 10% of the boaters perceived Chesapeake Bay water quality as fair or poor, and 12% ranked water quality as excellent. Contrary to expectations, the mean compensating variation for those who rated water quality poor ($103) was less than for those who rated water quality fair ($124). This result may be due to the effect of the relatively small number of non-zero observations for the poor water quality category. Individuals who perceive water quality as poor also may have less confidence in any type of program that attempts to restore water quality to a higher level, and are thus less likely to respond to the question at all, contributing to a non-response bias. This survey response related bias is a particular problem for mail surveys (Messonnier, Bergstrom and Cornwell 2000).

The mean compensating variation for a water quality improvement declined when the perception of existing water quality improved over the fair to excellent range. There are two explanations for a positive willingness-to-pay for someone who already rates water quality as excellent. One is that responders understand that the categories are discrete descriptions of a continuous variable, so they may respond with an excellent, but still see room for improvement. The other explanation is that this is evidence of a warm-glow effect (Carson 2000).

Most boaters (67%) are not concerned about either short or long-term health effects associated with their boating activity and water quality (Table 4). The mean compensating variation for water quality improvements increased with the severity of the type of concern for the impact of water quality on the boating activity. For example, boaters concerned about short term illness such as gastroenteritis due to exposure to polluted water had a compensating variation of $80.92 for an improvement in water quality; whereas, boaters concerned about exposure to toxic substances were willing to pay $113.42 for a water quality improvement.

Statistical Analysis

A more detailed statistical analysis of the contingent valuation results by type of boater and their concerns not only provides important information in developing marine pollution policy, but also serves as an indicator of the validity of the contingent valuation approach, generally, and the open-ended format, specifically, in this boating context. For example, one of the criticisms of contingent valuation is the problem of embedding (Carson and Mitchell, 1993; McFadden 1994; Carson 2000) or the related insensitivity to scope (Whitehead, Haab and Huang 1998). Both are related to the expectation that willingness-to-pay should be increasing in the extent, scale, scope or magnitude of what is being valued. In our case, greater improvements in water quality should be valued more than small improvements. Since we did not specify a geographic extent to the hypothetical water quality improvement, we cannot test whether boaters in their responses are willing-to-pay more for Bay-wide water quality improvements as opposed to only local improvements. However, one test of sensitivity to scope we can perform is whether or not the marginal value of water quality improvement decreases as the perceived water quality improves. Another scope is to determine whether willingness-to-pay for water quality improvement increases with the severity of concern related to the health effects of water quality.

We estimate a censored regression or tobit model (Tobin 1958) that takes into account the type of boater (i.e., power or sail) the perception of water quality and the concern about water quality effects on health. A censored model is used because negative responses to the contingent valuation question are not realized. In the tobit model:

$$\hat{y}_i = x'_i \beta + \varepsilon_i$$

$$y_i = \begin{cases} \hat{y}_i \text{ if } \hat{y}_i > 0 \\ 0 \text{ if } \hat{y}_i \leq 0 \end{cases}$$

where y_i is the observed contingent valuation bid by individual i, , $\hat{y}_i$ is the latent measure, x'_i are the independent variables, β is a vector of parameters, and ε_i is the error term distributed as independent normal with mean 0 and variance σ^2.

The explanatory variables in the regression model are a dummy variable for whether or not the boat is trailered or kept in water at a marina or residence, a dummy variable for whether the vessel is a sail or powerboat, and a set of variables that represent a cross between the inverse of the water quality rating with a set of dummy variables regarding the type of concern about water quality. Demographic variables such as income levels and education were not collected as part of the expenditure survey, so they were not available for inclusion in the model. In one version of the model, the number of boats owned by the respondent was included as an explanatory variable, but this proved to be insignificant. The expectation is that boat owners who keep their boats in the water during the season (non-trailered) will have a higher willing-to-pay for a general improvement in water quality than trailered boat owners who have more flexibility in choosing areas to use their boats. We have no a priori expectation about the influence of power or sail on the willingness-to-pay, but included this because we do anticipate a difference in preferences between the two groups. The set of variables that cross water quality rating with the type of health concern are expected to increase willingness to pay for water quality improvements as the severity of concern on health increases and the poorer they believe the water quality to be. The null case for comparison of these latter parameters is for the boaters who indicated that water quality had no impact on their boating behavior. Colinearity between type of health concern and ranking of water quality necessitated combining these effects in one term rather than looking at them separately. Thus, boaters who had major health concerns from contact with water tended to rank water quality lower.

Results from the regression analysis are given in Table 4. All estimated parameters had the expected sign and were significant at the 95% confidence level. Sailboaters had a significantly higher willingness to pay for improved water quality than power boaters, and as expected, owners of boats kept in the water during the season had higher willingness to pay for improvements in water quality than boat owners who mainly trailered their boats. Willingness to pay for water quality improvements were greatest amongst those boat-owners who were concerned about exposure to toxic chemicals, whereas there was not a significant difference between those concerned with appearance of the water or short-term illness issues. The lowest willingness to pay for water quality improvements was among those owners who indicated they were concerned about health effects from Pfiesteria exposure.

To extrapolate the above results into estimates of boat owner willingness to pay for improvements to water quality we had to estimate the number of boat owners in Maryland. We sampled from a database of 220,800 registered boats, but 24.6% of the respondents to our survey indicated they owned two or more boats. Since a multiple boat owner is more likely to receive a survey than a single boat owner, we had to account for that bias in determining the number of unique boat owners. After adjustments, we found that 81% of Maryland boaters own only one boat, 15% own two boats, 3% own three boats and 1% own four or more boats. From this, we were able to calculate that there are 167,742 owners of Maryland registered boats. Another adjustment is made for the fact that only 80% of the boaters use the Chesapeake Bay as their principal boating area. For boaters that indicated they use the Chesapeake Bay less than 50% of the time, the average usage was only 5%, with 75% indicating they never use the Chesapeake Bay for boating. Based on the above, we estimate that there were 134,194 owners who principally use their boats in Chesapeake Bay.

Table 5 summarizes the willingness to pay by type of boater for an improvement in Chesapeake Bay water quality. Across sailboats, in-water power boats and trailered power boats, the total annual willingness to pay for a one step improvement in water quality was approximately $7.3 million. The mean willingness to pay for all boaters is lower in table 5 because this is weighted by the actual boating population, whereas, our sample was apparently biased in that there was under representation of trailered boat owners. The present value of the willingness to pay for a relatively permanent water quality improvement, assuming a 5% discount rate is approximately $146 million. Note that this amount only includes the value to boat owners, and not family members and others that also engage in boating. The total value may be higher also because the sample only includes boat owners and not potential boat owners who would choose to participate in boating if they perceived improvements in water quality conditions. Finally, the boaters excluded from the sample who use their boats less than 50% of the time in Chesapeake Bay might have a positive willingness to pay, as would boaters registered in other states that use the Chesapeake Bay for some part of their boating activities.

Conclusions

An open-ended contingent valuation experiment has provided reasonable estimates of boater willingness to pay for improvements in water quality. The improvement in water quality is based on the boaters' current perceptions regarding water quality levels and the type of impact that water quality has on their boating activities. In general, the poorer the boater feels current water quality is, the more they are willing to pay to see an improvement in that quality. Additionally, the more serious the concern about the impacts of water quality on health, the more the boater is willing to pay for an improvement.

Our results can be compared to Thomas and Stratis (2002) who found that annual compensating variation for boaters ranged from \$353-\$424, depending on the marginal wage rate, for reducing access to boating from 37 sites to 19 due to speed limit changes. Although their figures are higher than the \$55-\$93 range we obtained for water quality improvements in Chesapeake Bay, the average number of trips taken per boater is about twice as high in their Florida sample compared to the Maryland sample. Their compensating variation estimates probably overstate the lost value because they are based on a simulation of completely shutting down areas to boating, but in reality these areas would still be accessible to boaters.

Water quality, the focus of much of the restoration activities for Chesapeake Bay, is a public good that mostly serves as an input to the production of goods and services valued by Bay users. Boating activity is one of the more obvious and potentially measurable of these services, yet is has not been studied in terms of boater response to changes in water quality. The evidence presented here is that water quality does impact the enjoyment of boating and that boaters would benefit by a significant amount if it were to improve. Water quality improvements would also have benefits to other Chesapeake Bay users and non-users as well, and these benefits would have to be accounted for in a complete cost/benefit accounting of any policy or program that addresses water quality improvements.

Much needs to be done to take this information to the next level where it can start to be helpful to policymakers in specific situations involving changes to water quality. A directed study, as opposed to the opportunistic situation described here, could obtain better information about what the basis is for boater perceptions about water quality and correct for some the shortcomings previously discusses in relying on a mail survey. Contingent valuation and revealed preference studies of boater behavior similar to Thomas and Stratis' (2002) prediction of boater response to changes in the boater speed limit can provide useful information regarding a neglected component of the value of water quality.

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Table 1

Sample Disposition and Response Rates

Wave	**Period**	**Surveys Sent**	**Returned**	**Bad Addresses**	**Ineligible**	**Response Rate**
1	January-April	525	253	14	14	51%
2	May-June	525	255	29	11	53%
3	July-August	730	320	51	19	48%
4	September-November	730	336	39	11	49%
1-4	January-November	2,510	1,163	133	55	50%

Table 2

Response Frequency to Contingent Valuation

Willingness to Pay	Frequency (%)
$0	290 (38%)
$1-$5	17 (2.3%)
$10-$20	58 (11.5%)
$25-$50	159 (20.8%)
$60-$100	135 (17.7%)
$120-$200	31 (4.1%)
$250-$500	30 (3.9%)
$1,000	9 (1.2%)
No Response	163

Table 3

Boater Water Quality Rankings Mean CompensatingVariation

Water Quality Rating	Number (%)	Mean WTP	Median WTP	% Zero Response	S.D.
Poor	26 (3%)	$103		45%	170
Fair	63 (7%)	$124	$22.50	35%	248
Good	358 (39%)	$70	$22.50	37%	146
Very Good	360 (39%)	$51	$17.50	36%	105
Excellent	110 (12%)	$38	$3.00	48%	75

Table 4

Water Quality Concerns for Chesapeake Bay **B**oaters and Mean Compensating Variation

Principle Water Quality Concern	Number (%)	Mean Compensating Variation for Water Quality Improvement
None	234 (37%)	$35.62
Unpleasant	197 (29%)	$72.55
Short-term illness	60 (9%)	$80.92
Chronic exposure to toxic substances	79 (12%)	$113.42
Pfiesteria	92 (13%)	$67.77

Table 5

Parameter Estimates from Tobit Regression[1]

(WQR^{-1} = inverse of water quality ranking, ** indicates significance at 95% confidence level).

Parameter	Estimate	Standard Error
Intercept	-66.7504	17.6539**
Inwater boat	56.1019	20.3185**
Sailboat	43.6381	19.3502**
Unpleasant X WQR^{-1}	174.5405	38.7345**
Illness X WQR^{-1}	176.3481	63.2389**
Toxic X WQR^{-1}	191.2109	48.2093**
Pfiesteria X WQR^{-1}	179.5581	63.1095**
N = 755		
Log Likelihood	-3303	

1 (WQR^{-1} = inverse of water quality ranking, ** indicates significance at 95% confidence level).

Table 6

Average and total willingness to pay from tobit model for improvements in water quality by type of boat owned.

	Number	Mean willingness to pay	Total willingness to pay
Sailboat Owners	12,250	$93.26	$1,142,398
Trailered Powerboat	69,431	$30.25	$2,100,294
Inwater Powerboat	52,513	$77.98	$4,094,948
TOTAL	134,194	$54.68	$7,337,640