

**THE ECONOMIC VALUE OF IMPROVING
THE ENVIRONMENTAL QUALITY OF GALVESTON BAY**

A Report to the Galveston Bay National Estuary Program

by

Dale Whittington
Glenn Cassidy
Deborah Amaral
Elizabeth McClelland
Hua Wang
Christine Poulos

Department of Environmental Sciences and Engineering
The University of North Carolina
at Chapel Hill

June, 1994

Chapter 6: Estimates of the Economic Value of Improvements in the Environmental Quality of Galveston Bay

6.1 Introduction

In this chapter we use the results of the multivariate analyses presented in Chapter 5 to estimate the mean household willingness to pay for the management plan for different groups of respondent households in the Greater Houston-Galveston Area. We then use these results to estimate the total willingness to pay of the entire population of Greater Houston-Galveston Area for the implementation of the management plan. This aggregation requires that we account for the fact that our sample respondents were not entirely representative of the area population and that preferences for the management plan may differ between respondents and nonrespondents. We must thus weight the willingness to pay of the various respondents in the data set according to their socioeconomic representation in the five-county study population and perform sensitivity analyses to account for unobserved differences between the respondent and nonrespondent populations. In this chapter we describe how this was done.

6.2 Mean Respondent Household Willingness to Pay (Unweighted Sample Only)

The multivariate models presented in Chapter 5 can be used in two different ways to derive estimates of mean respondent household willingness to pay for the management plan. First, we can define a "typical" respondent household and, using average or assumed values for the explanatory variables in the model, calculate the typical respondent household's willingness to pay using equation 5.4. For example, we could use the estimated model to calculate the willingness to pay of a household that uses the bay for recreational purposes and has the mean income and mean education level of households in the Greater Houston-Galveston Area. This approach is most useful for observing the magnitude of the differences in willingness to pay of individuals in different groups of respondent households. For example, we can compare the willingness to pay of a typical respondent household that used the bay for recreational purposes and one that did not, or the willingness to pay of a typical respondent household that watched the video on Galveston Bay and one that did not.

Table 6.1 presents estimates of the willingness to pay of different groups of respondent households using this method. All of the estimates assume that the "typical" respondent household had the same education and income level as the average household in the Greater Houston-Galveston Area (based on 1990 U.S. Census data). Table 6.1 presents these estimates under each of the two assumptions employed for the treatment of the "not sure" responses that were discussed in Chapter 5 (Option 1 and Option 3). Table 6.1 shows the significance of these assumptions: the mean values of willingness to pay are substantially higher if the "not sure" responses are dropped from the sample. We will focus our remaining discussion in this chapter

on results for Option 3, which we consider "better" estimates of willingness to pay than those for Option 1, for the reasons explained in Chapter 5.

Table 6.1 Comparison of Valuation Differences Under Both Treatments for Users and Nonusers (Typical* Respondent Household, Monthly Willingness to Pay)

Category	Option 1: "Not Sure" to "No"	Option 3: "Not Sure" deleted
Mail/In-person follow-up		
Users with video	\$19.61	\$21.04
Users with no video	\$19.49	\$21.92
Nonusers with video	\$10.85	\$13.48
Nonusers with no video	\$10.74	\$14.36
Mail-only		
Users with video	\$ 2.87	\$12.75
Users with no video	\$ 2.76	\$13.63
Nonusers with video	(\$5.89)	\$ 5.18
Nonusers with no video	(\$6.00)	\$ 6.07

} # 5-13

* Income and education variables have been set at mean values for persons in the Greater Houston-Galveston Area to allow for direct comparison between groups.

The results in Table 6.1 show that if a typical respondent household participated in the mail/in-person follow-up survey, it would give a substantially higher mean willingness to pay (\$21 for users; \$13 for nonusers) than if it participated in the mail-only survey (\$13 for users; \$5 for nonusers). The results from the mail/in-person follow-up survey and the mail-only survey cannot both be correct: reliable estimates of willingness to pay should not depend on which type of survey instrument the respondent received. We cannot be sure which of the two sets of estimates is most accurate, so we present both. However, we believe that it is prudent to be conservative, and so we would advise that the results from the mail-only survey be given greater emphasis.

The results in Table 6.1 suggest that the typical respondent household that uses the bay for recreational purposes is willing to pay 60-100 percent more per month than a similar respondent household that does not use the bay. For the mail/in-person follow-up survey, the typical user was willing to pay about \$21 per month versus \$13 per month for the typical nonuser. In the mail-only survey, the comparable estimates are \$13 versus \$5-6. Many analysts have suggested that including "passive use" or "existence" values in estimates of the economic value of

environmental improvements will greatly inflate the estimates, and that such nonuse values will overwhelm or dominate more traditional estimates of use value. These estimates suggest otherwise. In fact, the relative values of environmental quality improvements to the bay for users and nonusers seem quite reasonable.

The fact that receiving the video did not affect respondents' willingness to pay in either the mail/in-person follow-up survey or the mail-only survey is significant because this finding suggests that people's willingness to pay for environmental quality improvements in Galveston Bay may not be easily changed by public education campaigns or by receiving more information about the bay. However, it may be that those who did participate in the survey did so because they already knew something about the condition of the bay. Those who did not participate might still benefit from additional information.

A second approach to calculating mean household willingness to pay is to use equation 5.4 to calculate the willingness to pay of each individual in the sample, and then take an average of these values. In other words, we take the income and education that each respondent reported, and whether or not his or her household used the bay, and substitute these values into equation 5.4. This gives an estimated willingness to pay for that single household in the sample. We repeat this calculation for every household in the sample and then calculate the mean willingness to pay of all sample households. Table 6.2 presents the results of these calculations for both the mail/in-person follow-up and mail-only respondents, and for the two options for handling the "not sure" responses.

Table 6.2 Unweighted Mean Respondent Willingness to Pay for Galveston Bay Management Plan By Questionnaire Type and Options for Accommodating "Not Sure" Responses

Questionnaire Type	Option 1	Option 3
Mail/in-person follow-up	\$19.75 (n=233)	\$20.44 (n=227)
Mail-only	\$3.36 (n=390)	\$12.24 (n=281)

The mean willingness-to-pay values in Table 6.2 are similar in magnitude to those using the first approach. For those respondents participating in the mail/in-person follow-up survey, the mean household willingness to pay was \$20; for households participating in the mail-only survey, the mean willingness to pay was \$12. In interpreting the results in Table 6.2, it is important to keep in mind two points. First, the socioeconomic characteristics of the two samples (i.e., the households that participated in the mail/in-person follow-up survey and those that participated

in the mail-only survey) were not exactly the same (see Table 6.3). Second, these estimates are not accurate reflections of the mean willingness to pay of households in the Greater Houston-Galveston Area because we have not taken account of the fact that our sample respondents were more highly educated and had higher incomes than the typical household in the area. In addition respondents may have been motivated to participate by their interest in or concern for the issue, and nonrespondents may well have values considerably less than respondents.

6.3. Mean Respondent Household Willingness to Pay (Using Sample Weights)

As noted, the respondents who actually completed the surveys had higher incomes, were better educated, and were less likely to be Hispanic or African-American than the overall population of the Greater Houston-Galveston Area as reflected in the 1990 census. Residents with less than eight years of education were severely underrepresented. Our sample did not include any observations of individuals with less than an eighth-grade education who were of a racial/ethnic origin other than Caucasian, African-American, or Hispanic (approximately 1 percent of the five-county area population). Table 6.3 shows the extent of this sample selection bias in terms of selected socioeconomic characteristics for the mail/in-person follow-up and mail-only surveys, under both options for handling "not sure" responses.

Table 6.3 Comparison of In-Person and Mail-Only Survey Respondents With Houston Area Profile (1990 Census) Showing Effect of Option 1 and Option 3 on Demographic Make-up of Sample

	Mail/ In-person Whole Sample (Option 1)	Mail/ In-person Reduced Sample (Option 3)	Mail-Only Whole Sample (Option 1)	Mail-Only Reduced Sample (Option 3)	Greater Houston- Galveston Area Profile
Number of Respondents	234	227	393	281	3.3 mill.
Mean Age of Respondent	47.6	47.3	48.3	48.0	40.7
% Male/% Female	66/34	66/34	68/32	73/27	50/50
Mean Household Size	2.49	2.5	2.69	2.6	2.75
Mean Number of Children in Household	0.60	0.60	0.63	.56	0.785
Education of Respondent					
% Through High School Only	24.90	23.9	21.0	18.0	49.3
% With Some College Only	36.50	36.3	29.5	28.1	26.6
% Completed College/More	38.60	39.8	49.5	54.0	24.0
Mean Income	\$55,095	\$55,720	\$54,817	\$56,443	\$41,064
Median Income	\$44,695	\$44,695	\$44,695	\$44,695	N/A
% Homeowners/Renters	77/23	77/23	84/16	86/14	54/46
Mean House Value (Home- owners Only)	\$64,704	\$64,224	\$82,279	\$82,316	N/A

Mean Rent (Renters Only)	\$471	\$471	\$416	\$429	N/A
Racial Breakdown					
% Caucasian	81.1	81.0	84.3	85.7	56.87
% African-American	11.2	11.1	6.5	5.5	18.2
% Hispanic	6.4	6.6	4.5	4.0	21.0

To correct for this sample bias, we first assumed that the responses of those who did participate in either the mail-only or mail/in-person follow-up survey accurately reflect the attitudes and values of others in their socioeconomic group, at least up to the proportion of the population that responded to each survey type. We then used the 1990 Census data to tabulate percentages of the study-area population by race and educational attainment, and calculated weights based upon these relative proportions.²⁴ The weights were calculated using inverse proportions, where

$$\text{Weight}_i = \frac{(\text{Proportion of study area population in socioeconomic group}_i)}{(\text{Proportion of respondent population in socioeconomic group}_i)}$$

We then used the second approach described in the previous section for calculating mean household willingness to pay, substituting each households' characteristics into the valuation function. In this case, however, we also multiplied the estimated willingness to pay for each household by the corresponding weight assigned to the household according to the race and education of the respondent. We then calculated the mean of these weighted values. Because the weights on the observations for underrepresented groups were large (in some cases greater than 5), the results can be substantially affected by the valuation responses of a very few individuals in these underrepresented groups. We used two approaches for dealing with this problem:

- (1) Simply presenting the weighted results and cautioning the reader that they may be sensitive to a few individuals' answers;
- (2) Deleting the highly weighted observations. (This assumption might be justified on the grounds that we learned very little about the value that underrepresented groups place on improving the environmental quality of Galveston Bay.)

The results of the calculation of mean respondent household economic value for both approaches are presented in Table 6.4 for Option 3. As shown, if the highly weighted observations are included, the result of weighting the sample responses is to reduce the mean household willingness to pay for both the mail/in-person follow-up survey (from \$20 to \$19) and for the mail-only survey (from \$12 to \$10). If the highly weighted observations are deleted, the result of weighting the sample responses is to leave the mean household willingness to pay essentially unchanged from the unweighted means for both the mail/in-person follow-up survey and for the

²⁴ Since education and income are correlated, we used schooling as a proxy for overall socioeconomic status in the calculation of the sample weights.

mail-only survey. This shows that the effect on the mean value calculation of our correction for underrepresented groups is not great.

Table 6.4 Weighted Mean Monthly Respondent Willingness to Pay for the Hypothetical Galveston Bay Management Plan By Questionnaire Type and Options for Treating Heavily Weighted Observations (Using Option 3 Treatment of "Not Sure" Responses)

Questionnaire Type	Weighted Mean Monthly WTP (Heavily Weighted Observations Included)	Weighted Mean Monthly WTP (Heavily Weighted Observations Deleted)
Mail/in-person follow-up	\$19.02	\$19.92
Mail-only	\$10.45	\$11.51

6.4 Estimates of Aggregate Annual Willingness to Pay for the Greater Houston-Galveston Area

The calculation of aggregate willingness to pay estimates for the Greater Houston-Galveston Area required two steps. We first determined an equivalent annual mean respondent household willingness to pay by discounting the monthly estimate by a 4 percent annual rate over twelve months. The per-household annual figures are presented in Table 6.5 for Option 3. As shown, the estimates of mean annual willingness to pay per respondent household for the hypothetical management plan fall in the range of \$123-235 depending on the assumption made about the representativeness of highly weighted observations for underrepresented groups and the type of survey used.

Table 6.5 Weighted Mean Annual Willingness to Pay Per Respondent Household By Questionnaire Type and Options for Treating Heavily Weighted Observations* (Option 3 Only)

Questionnaire Type	Weighted Mean Annual WTP (Heavily Weighted Observations Included)	Weighted Mean Annual WTP (Heavily Weighted Observations Deleted)
Mail/In-person follow-up	\$224	\$235
Mail-only	\$123	\$136

* Monthly estimated mean willingness to pay, discounted at 4 percent per year.

Each cell in Table 6.5 is calculated for a slightly different subset of the study area population. Since Option 3 is the underlying assumption for all cells, the respondents who answered "not sure" were deleted from the data set for all calculations. Removing these observations from the mail-only survey increased the number of socioeconomic categories for which there were zero respondents from one to three. The number of unrepresented socioeconomic categories in the mail/in-person follow-up survey remained unchanged at six. Some socioeconomic categories (i.e., Caucasian residents with less than eight years of schooling) had several respondents but were poorly represented relative to the proportion of this category in the population of the study area as a whole (i.e., Caucasians with less than eight years of schooling were 0.5 percent of the mail-only sample compared with 10.7 percent of the 1990 study area census population). Thus, these observations for under-represented groups were heavily weighted (weights greater than 5). If we assume that these observations reflect the behavior and attitudes of at least the proportion of the population represented by each survey type, we can still use these observations in our calculation of the aggregate willingness to pay. This is the assumption made in calculations shown in the first column of Tables 6.4 through 6.6.

On the other hand, if we assume that the heavily weighted observations are not sufficient to represent their respective groups and we drop these observations from the data set as well, the total number of respondent households to be included for aggregation decreases. In the second column of Tables 6.4 and 6.5, we calculate estimates of value only for the respondent population that is sufficiently well represented.

The second step in aggregating our sample responses to the general population was to multiply the weighted mean annual values by the number of households in the Greater Houston-Galveston Area that were represented by the respondents from each survey type. The 1990 U.S. Census reports the total number of households in the study area as being 1,198,973; we have used this figure as a basis for our calculations. To simply aggregate to the whole population assumes that the values that nonrespondents place on an improvement to the bay is equivalent to respondents' values. However, respondents may well have cared more about the bay than nonrespondents. To accommodate the possible differences in preferences between the respondent and nonrespondent populations, the research team conducted a sensitivity analysis using three different assumptions about the nonrespondents:

- (1) that they had the same values as respondents;
- (2) that they placed one half the value on environmental improvements as respondents; and
- (3) they placed no value on environmental improvements.

The results of these calculations of aggregate annual economic value are presented in Table 6.6.

Pp- 88-89
missing from
Original

nonusers, and that people in general were less likely to vote for the management plan when they were given a higher price (i.e., monthly surcharge).

These results suggest that respondents paid attention to the questions being asked and increase our confidence in the quality of the information obtained. They are not, however, evidence that respondents' answers to hypothetical questions are good predictors of how they would actually vote in a real referendum. As with any public opinion poll, there is the possibility that respondents misrepresented their answers in order to influence the results of the study, or misinterpreted the questions that were asked.

The reader will have to make his or her own assessment of the confidence that can be placed in the answers to the valuation questions. We want to emphasize, however, that we do not believe there was any obvious reason why respondents would want to misrepresent their preferences for the management plan. Our personal judgment, based on over two hundred in-person interviews, is that the vast majority of these respondents thought carefully about their answers to the valuation questions and, to the best of their ability, gave honest answers.

The most worrisome finding regarding the accuracy and reliability of the contingent valuation results is the significant difference in household willingness to pay between the mail/in-person follow-up survey and the mail-only survey. Our analysis suggests that a typical household that received the mail/in-person follow-up survey was willing to pay approximately 60 percent more than if it had received the mail-only survey (\$21 per month versus \$13 per month). One plausible explanation for this difference is that in the in-person interviews respondents sought to please the enumerators, and were more likely to vote for the management plan because they felt that this is what the enumerators wanted to hear. This is, however, only speculation. There has been very little other empirical work examining the effect of in-person versus mail interview formats on respondents' answers to contingent valuation questions. In our survey respondents who took part in the in-person interviews were specifically and pointedly told that there were no right or wrong answers to the valuation questions, that people had different and valid reasons for voting for and against the management plan, and that the enumerator wanted to record what they really thought. At the end of the questionnaire we asked respondents whether they felt that the questions had been biased in any way; 80 percent said that the questions were not biased. Nevertheless, the difference in the results of the mail/in-person follow-up and mail-only surveys introduce an additional element of uncertainty into our estimates of economic value because we do not know which set of results is the most accurate.

Third, a series of econometric and analytical procedures were used to calculate estimates of economic value from respondents' answers to the referendum question. These procedures require that additional assumptions be made. As described in Chapters 5 and 6, the treatment of the "not sure" responses to the mail-only questionnaire has a large effect on the estimates of economic value. The fact that we do not know how these respondents would have actually voted in a real referendum--or if they would have voted at all--adds another element of uncertainty. Similarly, our assumptions regarding the construction of the weights used to aggregate our estimates of households' economic value to the population of the entire Greater Houston-

Galveston Area affect our results somewhat.

Fourth, even if respondents gave accurate answers to the valuation questions, their preferences for environmental quality improvements in Galveston Bay may change. They may not have thought carefully about how much they would be willing to pay for cleaning up Galveston Bay. If there were an extended public debate on this issue, some people might change their mind on how they would vote (of course, they could change their mind in either direction). In other words, people's preferences may be unstable and amenable to persuasion. Yankelovich (1991) makes a distinction between mass opinion and public judgment. Before members of the public have carefully considered an issue, public opinion polls often reveal internal contradictions in mass opinion and unstable results that can be influenced by changes in the wording of questions. However, once an issue has been carefully thought through by the public, Yankelovich finds their opinions are quite stable and not easily manipulated by pollsters. He describes this process as "coming to public judgment" on an issue.

Many environmental and ecological experts believe that the average citizen does not have a sufficient understanding of systems ecology to fully appreciate the benefits of improving the environmental quality of an estuary system such as Galveston Bay. They thus believe that people's values based on a contingent valuation survey are only a reflection of their ecological ignorance and are of little use for thoughtful policy deliberations. Some environmentalists and ecologists may feel, as Thomas Jefferson described in the above quotation, that people have to be educated with regard to the value of such environmental improvements whereas others may believe that such decisions are best left in the hands of experts. In Yankelovich's terms, these environmentalists may believe that the public has not reached a reasoned judgment about how much to invest in the clean-up of Galveston Bay, and that it may be unlikely that they ever will.

We do not know whether respondents have reached such a public judgment about the benefits of cleaning up Galveston Bay, and this introduces another source of uncertainty into our estimates of the economic value of cleaning up the bay. It is possible that our estimates of economic value could change during the course of a broad public debate and/or education campaign. The high percentage of respondents who gave a "not sure" response in the mail-only survey lends some support to the argument that many people in the Greater Houston-Galveston Area may be uncertain about the economic value of cleaning up Galveston Bay.

On the other hand, we would caution against drawing the conclusion that public education campaigns can easily generate much higher levels of support for the management plan, and thus higher estimates of economic value. This is because we provided respondents in our contingent valuation survey with a considerable amount of information--more than most people are likely to obtain in a public debate--and we gave many of them time to read and reflect upon these materials. In fact, almost two thirds of the respondents in the mail/in-person follow-up survey said that they had discussed the information in the questionnaire with other family members or

their neighbors. Moreover, almost half of our respondents watched the video.²⁵ Respondents who watched the video did not answer differently than those who did not receive it.²⁶

Most respondents described themselves as sympathetic to environmental concerns, and slightly less than half already used the bay for recreational purposes.²⁷ Almost 60 percent of the respondents agreed with the statement "Protection of the environment should not be sacrificed for jobs."²⁸ The vast majority (90 percent) of the respondents reported that they had been exposed to information from the media over the last year about pollution in Galveston Bay; about 40 percent estimated that they had received such information five times or more. All of this evidence suggests to us that providing the public with more information on Galveston Bay is not likely to lead to significantly greater support for the management plan.

A related reason why it may prove difficult to increase support for the management plan is that people generally do not feel responsible for the environmental problems of Galveston Bay. All respondents were asked a direct question about whether their own household affected Galveston Bay: two thirds said that their household's activities did not have a negative impact on the bay. In response to a question about whether they felt a responsibility to pay for a management plan, almost two thirds of the respondents said that they did not feel very responsible.

Table 7.1 provides a summary of the sources of uncertainty that affected our results, along with what was done to preempt or counteract their effects, and implications for the study results. In spite of these major sources of uncertainty, our estimates of the economic value of the management plan appear to us to be quite reasonable. Based on the results of the mail-only survey, the average household in the Greater Houston-Galveston Area is estimated to be willing to pay approximately \$7 per month for the management plan described in the questionnaire, assuming that nonrespondent households value the proposed plan at one half that of respondents. This is about \$80 per year for five years.

²⁵ Almost 90 percent of the respondents who received a video watched it.

²⁶ In the mail/in-person follow-up survey, we asked respondents who watched the video whether in fact they felt it had changed their vote for or against the management plan. Seventy-five percent of these respondents reported that it had not affected their willingness to pay for the plan.

²⁷ Only about 5 percent reported that they were unsympathetic to environmental causes.

²⁸ Only about 10 percent agreed with the statement "Creating and protecting jobs is more important than preserving the environment." Over 20 percent indicated that they were "not sure."