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Total Economic Values of Increasing Gray Whale Populations: Results from a Contingent Valuation Survey of Visitors and Households

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Abstract *The consistency of an individual's willingness to pay (WTP) responses for increases in the quantity of an environmental public good (whale populations) is tested along three lines. First, we test whether WTP for 50% and 100% increases in whale populations are statistically different from zero. Second, we ask whether the incremental WTP from a 50% increase to a 100% increase is statistically significant. Finally, we test whether there is diminishing marginal valuation of the second 50% increment in gray whale populations. The paired t-tests on open-ended WTP responses supported all three sets of hypotheses. Both visitors and households provided WTP responses that were statistically different from zero and increased (but in a diminishing fashion) for the second increment in WTP. In this survey both visitors and households provided estimates of total economic value (including non-use or existence values) for large changes in wildlife/fishery resources that were consistent with consumer theory.*

Keywords Existence value, contingent valuation, gray whale, California, willingness to pay.

Introduction

It is generally recognized that direct viewing of wildlife provides an economic value to the participant. However, preservation of the species for viewing is a joint product for the "users" and also may provide value to non-viewers, from the continued existence of the species for both themselves and (in many cases) for others in the future. That continued preservation of a species provides joint pro-

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duction of viewing, existence and bequest values was first formalized by Randall and Stoll (1983) as "total economic value." Most economists recognize that existence of a species is a public good and, like any other public good, its total economic value should be included when calculating benefits and costs of proposed policies (Randall and Stoll, 1983; Kopp, 1992). Given this, two key questions arise. First, how is one to measure the total economic value? Second, is the marginal or incremental total economic value for changes in abundance of a particular species significantly different from zero? That is, once a minimum viable population is provided, does increased abundance beyond that add to society's well being?[1] In answering this latter question, we focus on whether the pattern of incremental valuation of gray whale populations is consistent with first principles of consumer demand theory. What we learn about the *patterns of an individual's valuation* of gray whales is useful for understanding how valuations of other marine mammals such as elephant seals, sea otters and dolphins would also change with their population levels. Such information may be helpful in dealing with a wide variety of policy decisions such as what magnitude of incidental take of marine mammals to allow in commercial fishing operations.

With respect to the first question, at present, the Contingent Valuation Method (CVM) appears to be the only way to measure total economic value, although Larson (1993) has proposed a revealed preference approach. While the reliability of CVM to measure existence values has been subject to much debate over the years, the journal literature provides several examples of the reliability (Loomis, 1989, 1990; Reiling, *et al.*, Kealy, *et al.*,) and validity (Brookshire, *et al.*, 1982; Welsh, 1986) of CVM derived benefit estimates. Nonetheless, the high stakes in natural resource damage assessment has brought renewed interest in CVM by a broad spectrum of economists. Concerns about inconsistency of CVM with economic theory appears to have been one of the reasons why the National Oceanic and Atmospheric Administration (NOAA) commissioned a "blue ribbon" panel to advise NOAA on the use of CVM for measuring non-use values (Augustyniak, Jones and Meade, 1992). After reviewing the available research, "The Panel concludes that CV studies can produce estimates reliable enough to be the starting point for a judicial or administrative determination of natural resource damages—including lost passive-use value." (Arrow, *et al.*, 1993), as long as certain sampling and survey design guidelines are adhered to. Since these guidelines were released about a year *after* our survey administration, we will only make reference to areas of consistency and inconsistency with these new guidelines.

This paper contributes to improving our understanding of the properties of individual's CVM responses as measures of total economic value, including non-use value. Specifically, we ask whether CVM-derived estimates of an individual's incremental total economic value for increases in wildlife populations are significantly different from zero, and whether they are consistent with expectations based on economic theory. These questions are also of practical importance to policy analyses aimed at increasing wildlife populations beyond their legally required minimum viable population. While numerous previous studies have found statistically significant marginal *use* values for consumptive users (Brookshire,

[1] This simplistic discussion assumes that once society is above the minimum viable population that risk of extinction is zero. In addition, a decidedly anthropocentric viewpoint is represented here.

Randall and Stoll 1980; Loomis and Cooper, 1990), and for bird viewing (Cooper and Loomis, 1991), few studies have attempted to measure incremental values for *total economic values* of wildlife.

Hypotheses About Marginal Values of Increases in Public Goods

Utility and consumer theory is primarily a theory about individual behavior. First principles of consumer theory require only that increases in quantities of economic goods provide non-negative values to individuals. It seems plausible that increases in populations of many native fish and wildlife species could have positive values given their currently low populations. For a given individual, the principle of diminishing marginal returns suggests that if the first increment has a positive value, the value of the second increment would normally have a lower marginal value than the first, *i.e.*, one would expect diminishing marginal value for greater and greater additions to the stock of the public good.

The first hypothesis to be tested is whether stated WTP for a given increase of size **n** in a population of a particular species is statistically different from zero. Specifically the null hypothesis is:

$$H_o\text{: } WTP_n \leqslant 0 \qquad (1)$$

against the alternative that $WTP_n > 0$. If the dollar amount of stated WTP is obtained from responses to open-ended CVM questions, then WTP is measured as a ratio level variable. Therefore (1) can be tested using parametric tests such as a one-tailed Student's t-test.

A second and related hypothesis test is whether WTP for a larger increase in the public good (WTP_{n+m}), where $m > 0$, is statistically different from WTP for a smaller increase (WPT_n). Formally,

$$H_o\text{: } WTP_{n+m} - WTP_n \leqslant 0 \qquad (2)$$

against the alternative that $WTP_{n+m} - WTP_n > 0$. This is a one-tailed *paired* t-test since it is a test of the consistency of an individual's behavior, a more direct test of consumer theory then comparing consistency of aggregate behavior.

If we obtain positive incremental values for $WTP_{n+m} - WTP_n$, and accept the alternative to the second hypothesis, then one would expect a diminishing incremental valuation. Specifically if both increments are of the same size $\mathbf{n} = \mathbf{m}$, then a diminishing marginal value implies that

$$H_o\text{: } WTP_{2n} - WTP_n < WTP_n \qquad (3)$$

This will also be tested as a paired t-test with the null hypothesis that

$$H_o\text{: } WTP_{2n} - WTP_n \geqslant WTP_n \qquad (4)$$

Case Study

The gray whales that migrate from their summer home in Alaska down the west coast past California to Baja were until recently a threatened species under the

Endangered Species Act. Whales are also a species with documented nonconsumptive use and strong evidence of existence/bequest values. Many conservation organizations such as Greenpeace and the Oceanic Society are maintained by contributions from people, many of whom rarely, if ever, see whales.

Our sample frame is comprised of two populations: (1) persons who went to the coast during the gray whale migration usually, although not exclusively, to view whales; and (2) California households. We include both current users and the general population of California households (some of whom may be past users) for two reasons. First, current viewers will have more first-hand experience "trading money for opportunities to view whales" and better information on whale abundance. These individuals generally meet the "Reference Operating Conditions" for CVM suggested by Cummings, *et al.* (1986). Hence CVM estimates of WTP should be more reliable for this group. In addition, we would expect that if any group would have significant total economic values, it should be this group. This user group contrasts with general households who may have never gone whale watching, possibly do not care about marine mammals, and have less experience with trading money for whales. However, it is this group for which even small estimates of total economic value per household often expand into large aggregate estimates, due to the sheer size of this group. Thus we are also interested to see whether this less-experienced and less-interested group also expresses statistically significant marginal values for successive increases in whale populations.

There have been two CVM studies to date attempting to measure the total economic value of whales. Hagemann (1985) used a payment card to elicit WTP for gray whales and blue whales as well as three other marine mammals. Hagemann's mail survey was of general households in California. Samples and Hollyer (1990) have applied CVM to value humpback whales in Hawaii. They asked individuals their WTP to provide one-time emergency assistance to protect whales in Hawaii. A dichotomous choice CVM format was used with in-person interviews of the general population.

While these studies both represent pioneering efforts in valuation of whales and presented interesting methodological comparisons, they generally involved either small sample sizes or low response rates. We informally compare our dollar values with these two studies in the results section. Formal comparisons are not possible since our survey evaluates large increases in number of whales while the two past studies involved WTP to avoid large reductions in whale populations.

Format of Whale Questionnaire

A major focus of the survey was questions regarding the total value for two increases in gray whale populations. First the respondents were told the current population of gray whales was 20,000. Then respondents were informed that the population could be increased by reducing coastal pollution and restricting commercial and industrial activities along the coast, particularly in calving habitat. The payment vehicle was payment into a Gray Whale Protection Fund. The survey stated that *"Legally the money could only be used to clean up coastal waters of pollution and drift nets, purchase additional calving habitat areas, etc."* Respondents were asked to state their WTP for a 50% and 100% increase in gray whale populations and corresponding increase in sightings of gray whales along the California coast. Specifically the question read *"What is the maximum you* *would pay each year into the Gray Whale Protection Fund to increase gray whale populations and your sightings by 50%?"* Respondents were asked to assume that a 50% increase in whale populations would translate into equal percentage increase in whale sightings. This WTP question format was open-ended and was followed by questions to help determine whether persons stating zero WTP were protesting some feature of the CVM market. On the adjacent page, the 100% increase in whale program was presented as follows: *"Program Two: This alternative program is a more comprehensive gray whale protection that would increase by 100% or double gray whale populations and your sightings along the California coast. This second program is illustrated in the graph below."* Respondents were then asked to state their WTP for Program #2 if it were the only program offered.

Thus, individuals were first asked to pay for a 50% increase, and then asked to consider an alternative second WTP question for a 100% increase. Reliance on a series of WTP questions has both methodological advantages and disadvantages. First, having the same individual give their WTP for both population levels provides a more efficient statistical control for estimating the value of the population change. In this setting, the difference in WTP by the same individual is related only to the change in whale population. The alternative questioning approach, of having different individuals answer one question for one of the two population levels would be statistically inefficient since the research would have to be able to completely control for differences among individuals before they could conclude if the differences in valuation related to differences in whale populations or differences in individual respondents. If separate samples were each asked one of the two questions, the required sample would need to be far greater than simply twice the current sample. Asking more than one quality level of the same respondent has been a standard CVM procedure for deriving Bradford bid curves (Bradford, 1970) for decades (Daubert and Young, 1981; Walsh, *et al.*, 1984) and continues to be used today (Hoehn, 1990; Hoehn and Loomis, 1993). Loosely speaking, this question format is like a panel design and has the same statistical advantages.[2] One methodological concern relates to possible order effects. Since everyone answered the 50% increase before the 100% increase this may create a conditional path in the WTP values, even though individuals were told that the 100% increase program was an alternative program. However, *if* there are sequencing effects such that the program valued second is worth less than the one valued first, this will tend to bias our hypothesis test #2 ($WTP_{50\%} < WTP_{100\%}$) against us because it would raise the WTP for the 50% increase and lower the WTP for 100% increase, thereby shrinking the differences.

A draft of the survey instrument was pretested using individuals who had gone whale watching in the previous year. A survey was given or mailed to them and they were asked to fill it out and make additional comments on it. The pretest indicated respondents had difficulty understanding what a 50% and 100% increase in whale populations represented. Therefore, two sets of bar charts were added to illustrate what a 50% and 100% increase in gray whale populations represented relative to the current situation (which was the no action or default level if they did not pay). The first bar chart showed the 50% increase next to the current popu-

[2] As a reviewer points out such a practice may not be an acceptable way to test for the presence of embedding. See Arrow, *et al.*, 1993 on this point.

lation, while the second chart showed the 100% increase next to the current population. We believe these bar charts significantly aided respondent understanding of the scope of the programs. However, we did not perform formal one-on-one debriefing or use verbal protocols on the revised survey instrument to verify this. Lastly, demographic information including attitudes toward the marine environment, work status, wage rates and household income was asked. The overall survey was a booklet.

Data Sources

Visitor Sample Frame

The visitor sample frame is defined by both time and space. We sampled over the months of the gray whale migration along the California coast. Whales start arriving in northern California in late December and migrate south to San Diego and Baja California during January. In February whales begin to migrate back north, passing through northern California by late March. Many people taking trips to the coast during these months are out to view whales rather than for traditional summer ocean activities. For cost effectiveness in sampling, we sampled weekends and holidays at the locations described below. The choice of whether to sample on Saturday or Sunday was random, but did allow for a balance of Saturdays and Sundays over the season. The interviewers were present from 10am until dark.

The visitor survey took place at four locations along the California coast: San Diego (Point Loma National Seashore), Monterey, Half Moon Bay (south of San Francisco) and Point Reyes National Seashore (north of San Francisco). At both Point Loma and Point Reyes people view whales from the shore. At both Monterey and Half Moon Bay, people took short boat trips being run at that time specifically for gray whale viewing by commercial operators in the area.

Visitor Data Collection Procedures

The survey was administered as follows. Every nth adult (age 16 or older) visitor (where $n = 5$ for boat trips and $n = 10$ for onshore viewers) was contacted by a trained interviewer as they returned from the viewing area or boat. The interviewer asked each sampled visitor to take a survey packet home and then recorded the visitor's name and address in case follow-up mailings were required. The interviewers explained that the survey was being done by the University of California, which is viewed as a non-advocacy, research-oriented organization by most Californians. This message was reinforced by official jackets and name tags worn by the interviewers. The survey packet include a cover letter, the questionnaire and a postage-paid return envelope.

We chose this survey approach because it combined the best of personal interview and mail questionnaires. The personal contact allowed the interviewer to stress the importance of the respondent to the study and obtain a "good faith" commitment to return the survey (Mitchell and Carson, 1989:110). The interviewer was able to answer any concerns the visitor had about the survey or how they were selected. However, we did not want to conduct the interview at the site itself, for several reasons. First, weather at the coast in the winter is not always conducive to lengthy outdoor interviews and weatherproof shelter was very limited at most of these interview sites. Second, some passengers coming off the boats (particularly at Half Moon Bay) were not in physical or mental condition to answer detailed questions about their trip and thought-provoking CVM questions. By giving the visitor the survey to take home, they could devote adequate thought to answering the CVM questions at their own pace (Bailey, 1987:148).

In total, 1,402 surveys were handed out at the four intercept locations. We obtained 1,003 back for an overall response rate of 71.3%. The response rate was reasonably similar across the four locations, varying from a low of 65.2% at Point Loma in San Diego to a high of 80.3% at Half Moon Bay. On-site refusals were not a problem. For example, at Point Reyes only 10 people out of roughly 600 refused to take a survey (about 1.5%).

Household Survey Design and Data Collection Procedures

The CVM questions in the household survey were identical to those asked of visitors. However, less information was requested on whale viewing trips.

A stratified sample of California households was purchased from Survey Sampling Inc. The sample was stratified between persons living in counties adjacent to the California coast and those living in inland counties. Given that the California population distribution is heavily centered along the coast, a simple random sample would not have given us an adequate representation of non-coastal residents who are more likely to be nonusers. The foundation for the sample drawn by Survey Sampling Inc. is telephone listings. To partially overcome the omission of unlisted numbers, Survey Sampling Inc. supplements the initial list with drivers license and utility records. Since our purpose here is to compare households to whale viewers rather than generalize our WTP results to give aggregate values, we feel this is an adequate sampling scheme to obtain non-users.

A total of 2,000 names and addresses were obtained. Following Dillman's repeat contact approach, a personally-addressed cover letter (with original signature) and postage-paid return envelope accompanied the questionnaire. We also attached a dollar bill to the survey as a token of appreciation. This first mailing was followed up with a reminder postcard one week later. Then a second mailing was carried out (without the dollar bill). Finally, a random sample of non-respondents was phoned. The purpose of the phone call was to encourage non-respondents to complete the survey or to find out the reasons why they would not complete a survey. We also noted any English language difficulty (which to our surprise was not a problem). We asked persons refusing to accept another survey whether they had ever been whale viewing and their education level for comparison purposes. As expected, non-responding households were less likely to have been whale watching and had slightly lower education levels.

Of the 2,000 household surveys, 301 were undeliverables, 41 were deceased and 16 turned out to be businesses or government agencies. Of the eligible sample of 1642, 890 questionnaires were returned after all three contacts. The overall response rate was 54% of deliverable questionnaires, slightly above the average for other mail CVM surveys in California (Loomis, 1987). In the household sample, 56% of the respondents had *never* gone whale watching, 35% had gone at some time in the past and only 9% had gone whale watching this year. This compares to the visitor survey where 100% had gone whale watching this year.

Table 1
Visitor and Household WTP for Increases in Whale Populations

	Visitor Sample		Household Sample	
	Mean	Std Error	Mean	Std Error
50% Increase in Population	$25.00	1.16	$16.18	1.07
100% Increase in Population	$29.73	1.39	$18.14	1.16
n =	672		519	

Thus the household sample is dominated by pure non-users or those with only past whale viewing activity.

Survey Results

WTP Estimates

Before calculation of WTP two steps are typically performed in most CVM studies. First, individuals stating a zero WTP and indicating it was a "protest" response (*e.g.*, it is unfair to ask people to pay for greater protection of gray whales, *etc.*) are dropped. This was only about 10% of the visitor sample and about 20% of the household sample. We offer two reasons why visitors were more willing to accept the trust fund scenario. First, visitors had experience trading money for whale viewing opportunities, so thinking about whales in dollars was not alien to them. Second, nearly half of the visitors were members of environmental organizations (more than double the rate in the household sample). Hence visitors were most used to seeing real appeals for money to protect particular species or natural areas.

Once protests are accounted for, the next step, which is especially important with an open-ended response format, is to check for outliers. There was only one bid in the visitor sample that would be considered an outlier: an annual WTP of $500 per year, where the next highest amount was $300.[3] In the household survey the highest WTP was $180. Both of the remaining upper dollar amounts are well within the household's payment capacity, as the sample average *household* income was $50,000.[4]

Table 1 presents the mean WTP and standard error of the mean for the visitor and household samples. Each sample was asked their WTP for both a 50% and a 100% increase in whale populations. As would be expected, the average WTP values for general households are lower than for current visitors. In both cases the WTP estimates are measured fairly precisely, with the coefficients of variation for mean WTP (standard error/mean) being 6 or 7% of the means in the household survey and about 4% in the visitor survey. These standard errors are generally

[3] The $500 WTP response was dropped from the empirical analysis that follows. However, none of the results of the hypothesis tests reported below for visitors were changed by inclusion of this $500 WTP amount.

[4] While by U.S. standards this average household income may seem high, it is fairly close to the average California household income of $48,100 in 1991 (based on updating the 1990 Census estimate for California).

smaller than what others (Walsh *et al.*, 1984; Desvousges, *et al.*, 1992; Loomis, *et al.*, 1993) have found in other open-ended CVM surveys. Table 2 presents the WTP distribution of visitors and households for the two increases in whale populations.

Table 3 presents the results of the hypothesis tests concerning mean WTP for increments n = 50% and 2n = 100% above current gray whale populations. With respect to whether the incremental valuations are statistically different from zero, we can reject the hypothesis of equality with zero for both the 50% and 100% changes in gray whale populations for both visitors and general households. The t statistics are all significant at well below the 1% level.

Since each individual surveyed provided WTP for the 50% and 100% increment, the second hypothesis test involves a paired t-test. Thus we test whether their *difference* in expressed WTP for the 50% and 100% increments is different from zero. That is, by forming the WTP difference $D = WTP_{100} - WTP_{50}$ we test whether $D \leq 0$. The t statistics reported in Table 3 are significant at the 1% level, indicating the incremental valuation from a 50% to a 100% increase is statistically different from zero.

While the incremental valuations are statistically different from zero, the third consistency test requires that the second increment (D) to be of less value than the first increment (WTP_{50}). Rearranging and collecting like terms allows us to use a paired t-test of $2(WTP_{50}) - WTP_{100} > 0$. The test statistics reported in Table 3 are statistically significant, indicating the marginal value of the public good in our study is decreasing. That is, we reject the null hypothesis that the valuation for the second 50% increase is greater than or equal to the value of the first 50% increase for both the visitor and household samples.

Thus results from our case study suggest that for substantial increases in wildlife populations that are above current (and minimum viable) levels, there appears to be a statistically significant positive but diminishing marginal valuation for individuals. This pattern of results was found for both current gray whale

Table 2
Distribution of WTP of Visitors and Households

	Number of Visitors		Number of Households	
WTP	50% change	100% change	50% change	100% change
$0	107	121	195	216
$10	201	145	145	115
$20	127	121	79	63
$30	119	117	60	65
$40	15	38	15	24
$50	71	74	29	34
$60	6	10	2	2
$80	10	10	3	5
$100	39	48	18	25
$150	7	15	3	4
$200	1	2	1	1
$250	0	1	0	0
$300	1	2	0	0

Table 3
Hypothesis Tests Concerning WTP for Increases in Whale Populations

Null Hypothesis	Visitor Sample		Household Sample	
50% Increase				
$WTP_{50} = 0$	Reject	t = 21.45	Reject	t = 15.15
100% Increase				
$WTP_{100} = 0$	Reject	t = 21.31	Reject	t = 15.65
$WTP_{50} = WTP_{100}$	Reject	t = 9.14	Reject	t = 4.60
WTP 1st 50% gain = WTP 2nd 50% gain	Reject	t = 17.78	Reject	t = 12.47

viewers and for a sample of households, the majority of which were non-users and is consistent with expectations from basic principles of consumer demand theory.

There are of course several qualifiers to our results. First, we tested our hypotheses by comparing responses by the same individuals to the two increases in whale populations. Had we asked one sample their WTP for 50% increase and another sample their WTP for a 100% increase, the results of the hypothesis tests might have been different. In addition, our WTP values for the 100% increase in population may be conditioned on the responses given to the 50% increase. Since only one survey treatment for each population was performed, we do not have the ability to test for the significance of order effects. These are important methodological issues that should be evaluated in future research.

Comparison of Results to Previous Studies

Samples and Hoyller (1990) used in-person interviews of Hawaii residents and a dichotomous choice format. A one-time payment to prevent a loss of Humpback whales in Hawaii was elicited from two relatively small (n = 65 to 72) samples. They obtained values for general households ranging from $125 to $142, depending on the survey treatment. Annualized at 10% and updated for inflation, this value is somewhat higher than our annual estimates. In part this may be due to being asked study about their WTP to avoid a complete loss of humpback whales (Samples and Hoyller, 1990:183). Hagemann's mail survey of California households has some similarity to ours in terms of sample frame and evaluation of large changes in whale populations. Using a payment card, Hagemann (1985:72) obtained an annual value of $27 for gray whales in 1984 dollars or $36 in 1992 dollars to avoid a reduction in whales from their 1984 population of 16,000 to 1,300. However, there are some differences that may partially explain why she obtained higher values for the general population that we did. First, she asked WTP to avoid a 90% reduction in gray whale populations, rather than an increase in populations as we did. She also had a relatively low response rate (21%) which may imply only very interested respondents with correspondingly higher values. Compared to both studies, our value estimates for general households are relatively low, but similar in magnitude, and the differences may well be ascribed to the relative magnitudes and direction of changes in whale populations between the three studies.

Our annual values for doubling whale populations are lower than what Olsen, *et al.* found for doubling anadromous fish runs in the Columbia River basin. His non-users had values averaging $27 while users had values of $74. Of course his users, were consumptive users (*e.g.*, anglers) while our users where viewers. This comparison suggests that CVM studies of different marine resources do obtain values that seem to vary with the intensity of interest the public and users have in the resource.

Conclusions

At the level of the individual respondent, this research found that non-marginal increases in whale populations above current and minimum viable levels resulted in a statistically significant positive and diminishing marginal valuation. This pattern was found in samples of both current users (whale viewers during winter 1991-92) and of general households in California, which consists mainly of nonusers. The results suggest that carefully-performed CVM studies can obtain results consistent with principles of consumer demand theory for reasonably large changes in the quantity of a public good. Thus this study provides evidence that CVM can provide useful information on societal benefits from maintaining and increasing wildlife populations. The robustness of our conclusions should be tested in future research for order effects and use of independent samples for each increment, however.

In addition, the results suggest that citizens do derive a benefit from having a larger stock of whales, but from the standpoint of marine policy the costs (especially opportunity costs) of increasing whale populations would need to be considered before concluding that expanding populations beyond current levels is warranted on the grounds of economic efficiency.

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