WESTERN REGIONAL RESEARCH PUBLICATION W-133

BENEFITS & COSTS IN NATURAL RESOURCES PLANNING

INTERIM REPORT

COMPILED BY

John B. Loomis
University of California, Davis
Davis, CA 95616

Under the procedure of cooperative publication, this regional report becomes, in effect, an identical publication of each of the participating experiment stations and agencies and is mailed under the indicia of each.

1 August 1988

VOLUNTEER TIME AS A COMPENSATION VEHICLE IN CONTINGENT VALUATION STUDIES OF ENDANGERED SPECIES[1]

KARL C. SAMPLES
JAMES R. HOLLYER

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS
210 BILGER HALL
UNIVERSITY OF HAWAII
HONOLULU, HI 96822

INTRODUCTION

Transfer of money income is the typical compensation mechanism used in Valuing public goods with the contingent valuation method (CVM). However, recent theoretical work by Bockstael and Strand, and Cory suggests that alternative welfare measures, other than those based solely on money transactions, deserve more consideration in non-market valuation research. Compensation in the form of discretionary time payments is discussed as one such alternative. Their work demonstrates that reliance on money transfers alone may have clear distributional implications favoring individuals with relatively higher income endowments. Such reliance may also lead to understatements of underlying social values of individuals who, because of their relative endowments of income and discretionary time, prefer that at least a portion of their compensation be in the form of a time commitment.

The inclusion of time as a CVM payment option raises two fundamental issues. First, can time payments be feasibly implemented in a manner that is both acceptable to respondents and conducive to unbiased valuation estimates? Second, what monetary cost should be ascribed to time compensation made or received? The CVM literature provides almost no insight into the first question, except perhaps to warn that use of an unpopular payment vehicle can lead to downward-biased value estimates, along with refusals to cooperate in valuation exercises (Cummings et al.). Practical experience, however, suggests that donation of discretionary time without pay is a relatively popular contribution mechanism, at least in the United States. By Hodgkinson and Weitzman's estimates, 52 percent of all adult Americans contributed volunteer time in 1981 to secure provision of public goods. Over half of these volunteers contributed more than two hours per week.

With respect to the second question, there are no studies to our knowledge that estimate the monetary value of individuals' time contributions. Somewhat parallel studies, however, exist in the outdoor recreation demand analysis literature where several attempts have been made to convert travel and on-site time into a money metric. For example, Mcconnell and Strand proposed estimating the value of travel time as a constant fraction of participants' wage rates. Smith et al., estimated hedonic prices for travel and on-site time on an individual observation basis. Time values were derived using data on each respondent's personal, job and residential site characteristics. Notwithstanding these developments, no clear consensus has yet been reached about appropriate methods to value time spent in recreational pursuits. This is troublesome because as Bishop and Heberlein have shown, final benefit estimates appear to be extremely sensitive to time cost assumptions. Similar difficulties could likely arise if time payment options are adopted in CVM applications.

In this paper we propose a simple welfare model that illustrates the theoretical basis for including time payments to estimate economic surpluses. This general framework is then applied to value the preservation of two endangered marine mammals. A dichotomous choice valuation technique is used that incorporates both time and money payment options. Implicit values of time contributions are estimated from sample data. We show that the contribution of discretionary time is a popular payment option in this specific valuation context. Due to this popularity, however, time contributions have low estimated implicit values which are far below opportunity wage rates. This outcome is significant because preservation values estimated using our approach are acutely sensitive, and directly related, to the value placed on time donations.

WILLINGNESS TO PAY AND WILLINGNESS TO VOLUNTEER TIME

Consider a representative individual with a utility function,

(1) $U = U(s,x)$

where s represents the exogenously determined population size of a particular endangered species; and x is a vector of all other private goods and services weakly separable from s.

Faced with limitations on available income from all wage and non-wage sources (Y), and on available discretionary time after income-producing activities (T), the individual's constrained choice problem is to

(2) $\max_{x} L = U(s,x) + \lambda(Y-px) + \Psi(T-tx)$

where p and t are the price and time input requirement vectors associated with x, respectively. Both income and time have separate utility shadow values given by λ and Ψ, respectively.[2] The ratio of shadow values (Ψ/λ) can be interpreted as the marginal rate of substitution between time and income. The solution to the problem in the two-constraint case yields the indirect utility function,

(3) $U = V(p,t,Y,T,s)$.

Consider now an exogenous decrease in the population level of the endangered species from s′ to s′′, holding p, and t constant, and assuming U(s′) > U(s"). Presumably the individual would be willing to forgo income, leisure time, or both, to avoid having this population decrement occur.[3] The maximum time and income amounts that the individual would forgo, and still maintain utility at the subsequent level (given by V′′) is

(4) $V''(p,t,Y,T,s'') = V''(p,t,Y\text{-}WTP,T\text{-}WTVT,s')$

where WTP is maximum willingness to pay in terms of dollars, and WTVT is maximum willingness to contribute volunteer time towards preservation efforts.

As pointed out by Cory, various combinations of WTP and WTVT exist that solve equation (4). Let the entire set of feasible combinations be written as

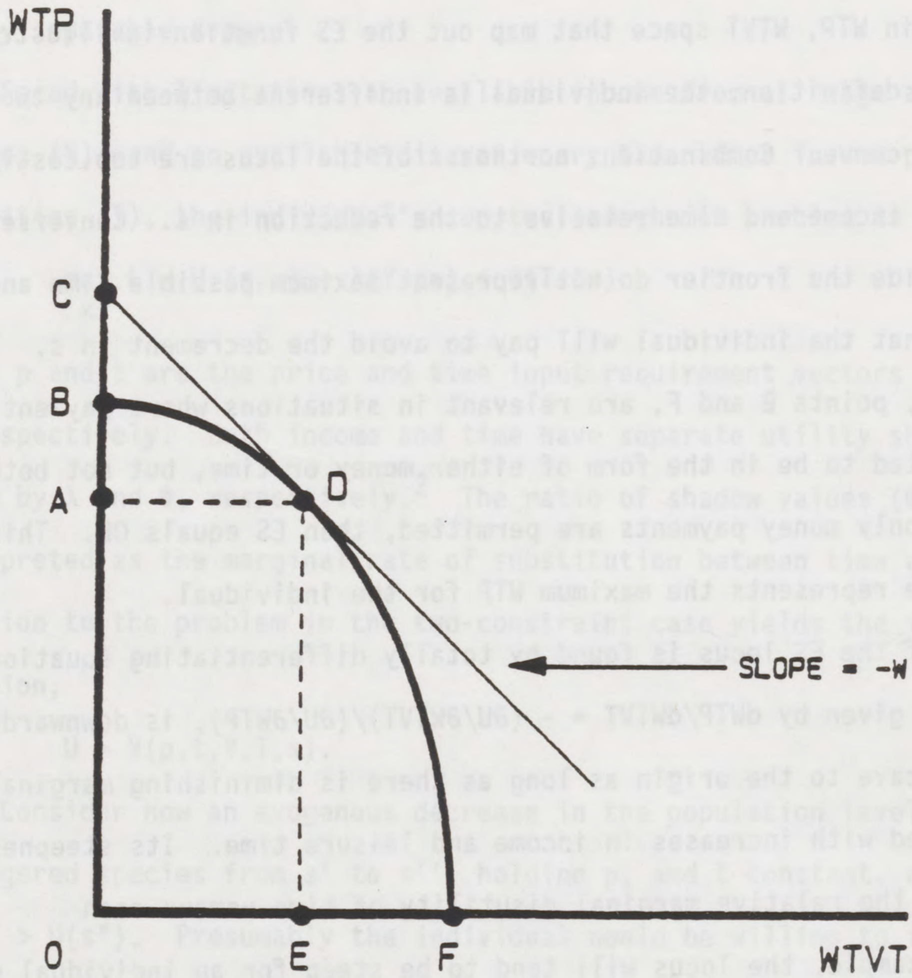
(5) ES = (WTP,WTVT)

where ES signifies that this is an equivalent surplus measure of a welfare loss arising from an exogenous decrement in the quantity of s available.[4] The locus of points in WTP, WTVT space that map out the ES function is illustrated in Figure 1. By definition, the individual is indifferent between any two points along the curve. Combinations northeast of the locus are too costly in terms of forgone income and time relative to the reduction in s. Conversely, combinations inside the frontier do not represent maximum possible time and money payments that the individual will pay to avoid the decrement in s. The corner solutions, points B and F, are relevant in situations where payment options are limited to be in the form of either money or time, but not both. For example, if only money payments are permitted, then ES equals OB. This vertical distance represents the maximum WTP for the individual.

The shape of the ES locus is found by totally differentiating equation (4). The slope, given by $dWTP/dWTVT = -(\partial U/\partial WTVT)/(\partial U/\partial WTP)$, is downward. The locus is concave to the origin as long as there is diminishing marginal utility associated with increases in income and leisure time. Its steepness is determined by the relative marginal <u>disutility</u> of time versus cash payments. For example, the locus will tend to be steep for an individual with scarce discretionary time relative to income such that the disultility of time payments far outweighs monetary outlays. Conversely, it will tend to be more flat for a person who has a generous leisure time endowment relative to income.

FIGURE 1

TRADEOFFS BETWEEN WILLINGNESS TO PAY (WTP) AND WILLINGNESS TO CONTRIBUTE VOLUNTEER TIME (WTVT)



A more shallow sloped ES locus would also characterize a person who, by contributing volunteer time, realizes some utility gain which to some extent offsets the disutility of a reduction in leisure time. Cesario, Wilman and others have interpreted this utility gain as arising from the "commodity value of time," or the utilitarian value of time spent in a particular manner. If volunteering to save an endangered species yields satisfaction to an individual, then the commodity value of time is positive. A utility maximizing individual will tend to adjust the scarcity value of time downward to account for this positive commodity value of time. A reduced perceived opportunity cost of discretionary time translates into a more shallow sloped ES curve.

Cory has noted that although the individual is indifferent concerning the various payment combinations given by the ES locus, a public agency seeking to maximize the total value of preservation contributions has clear preferences in this matter. For example, suppose that the change from s′ to s″ can only be forestalled using purchased inputs of materials and labor. Money payments (WTP) obtained from individuals can be used to acquire materials. Similarly, contributions of volunteer time (WTVT) can be used to substitute for labor inputs that would have to otherwise be hired at some market-determined wage rate. From the perspective of the public agency, therefore, the maximum market value of preservation contributions (PC) that can be extracted from an individual is found by

(6) $$\max_{WTP,WTVT} PC = WTP + w * WTVT$$

subject to U = V″ as defined in equation (4). The term w is a constant market wage rate for hired labor used in the preservation effort. The solution to equation (6) implies that the optimal combination of time and money contributions to extract from an individual is defined where dWTP/dWTVC = - w, or where the slope of the individual's ES locus equals the negative market wage rate for hired preservation labor inputs. In Figure 1, this equality occurs at point D, where OE units of volunteer time are obtained, along with OA dollars in monetary contributions.

PC in this instance equals OC, if time contributions are valued at w per unit. Notice that PC exceeds the individual's maximum WTP (equal to OB) by the amount BC. This means that if only money compensation was permitted, then the maximum dollar contributions forthcoming from the individual would be less than monetary value of the individual's maximum combined time and money contributions.

The divergence between PC and maximum WTP serves to illustrate the importance of appraising discretionary time payments. The difference is attributable entirely to how the individual's time compensation is valued. From the perspective of a public agency engaged in preservation projects, time contributions are appropriately valued at the market wage rate paid for hired labor. This is because each unit of volunteer time generates an average labor cost savings equal to W. From the volunteer's perspective, however, the relative scarcity value of forgone discretionary time is governed by the shape of the ES locus. If the locus is concave, this value declines as money payments are substituted for time payments. Consequently, although the marginal value of time contributions indeed equals w at point D in Figure 1, the marginal value is less than w for all inframarginal units of donated time. The monetary equivalent of all inframarginal units (OE) is given by the vertical distance AB. This amount, except perhaps by chance, has little correlation with some external wage rate paid by the public agency for hired labor. Moreover, as Wilman points out in the case of valuing discretionary recreation travel time, this amount is not always directly proportional to the individual's average wage rate. The link between time value-and average wage rates is weakest when the individual cannot readily transform discretionary time into wages, and when time donations yield direct utilitarian benefits to the volunteer.

AN EMPIRICAL EVALUATION

The feasibility of including time payment options in CVM was explored in the context of a recent study of endangered species preservation in Hawaii. Two marine mammals were targeted for valuation: the Hawaiian monk seal (Monachus schauinslandi) and the humpback whale (Megaptera novaeangliea). The empirical analysis centered on measuring Hawaii residents' willingness to sacrifice time and income to ensure the continued existence of these seals and whales at their existing population levels. Several different versions of a standard survey instrument were developed to value monk seals and humpback whales individually and jointly. The order in which the mammals were valued varied across survey versions. The effects of sequencing has been discussed elsewhere by Samples and Hollyer and will not be treated here.

The following fabricated contingent market situation provided the basis for valuation. Depending on the questionnaire version, respondents were asked to imagine themselves learning the next morning that a rare disease had killed either two seals or two whales. Respondents were further informed that the disease would rapidly destroy the entire remaining population unless expensive medical attention was provided. They were told that medical care, if provided in sufficient quantities, would absolutely guarantee the short-run survival of the remainder of the affected population from this particular disease. However, no guarantees were made about long-term survival in the face of other maladies. In short, respondents were presented with a dramatic and urgent situation requiring a discrete input of resources to ensure preservation over the short-run.

After describing this hypothetical scenario, valuation assessment was conducted in two stages. During the first stage, respondents were asked if they would contribute to preserving the threatened resource at hand. It was explained that contributions could be made in the form of money (payable over the next 12 months), or in the form of volunteer time (to be delivered over the next 12 months at home or a central location preparing medical supplies), or both. Respondents were further given the option of not making a contribution at all. The percentage of selecting the zero donation alternative ranged from 18 to 31 percent depending on survey version. Individuals in this group were automatically assigned a zero valuation for preserving the resource at hand. Motives of non-contributors were not further probed, although less than 1 percent of respondents refused to participate in the valuation exercise altogether.

Selected payment methods did not vary significantly (at the 95 percent level of significance) across survey versions and across species (Table 1). The most commonly selected contribution option was payment of "money only," which was selected by 34 to 45 percent of respondents, depending on survey version. Nearly an equal proportion of individuals, however, expressed willingness to contribute "time only," or some combination of time and money. Therefore, of those respondents willing to make some form of contribution, nearly half expressed a desire to make a time contribution.

Hypothesized relationships between preferred payment option and respondent total annual household income (a categorical variable) were explored using contingency table tests. Modes of payments differed across all survey versions (at the 95 percent significance level) depending on whether household income was greater than or less than $20,000 (approximately the Hawaii 1985 median household income). Respondents in the higher household

TABLE 1

RESPONDENT CHOICE OF PAYMENT OPTION FOR

PRESERVING MONK SEALS AND HUMPBACK WHALES

PERCENTAGE OF RESPONDENTS

PAYMENT OPTION	Survey Version I (a) (N=88) Seals	Survey Version I (a) (N=88) Whales	Survey Version II(b) (N=77) Seals	Survey Version II(b) (N=77) Whales
Time Only	23%	24%	16%	19%
Money Only	36	34	43	45
Time & Money	16	16	10	17
Neither Time Nor Money	24	25	31	18
Refusal	1	1	0	0
Total	100%	100%	100%	99% (c)

Notes: (a) Seals valued first, then whales

(b) Whales valued first, then seals

(c) Deviation from 100% due to rounding error

income bracket generally preferred making money rather than time payments. Presumably, this reflects their high scarcity value of discretionary time relative to income.

In the second stage of the valuation exercise, respondents who expressed a willingness to make some form of contribution were then asked if they would contribute at least X dollars or Y hours, or both, depending on the contribution method they selected. This presented a relatively simple dichotomous choice situation with the acceptable responses being either "Yes" or "No." Fixed amounts for X and Y were independently and randomly assigned. Requested time contributions ranged from 1 to 136 hours. Money payments were on the average three times larger, and ranged from $3 to $213.

Assigned time amounts translated into assigned money amounts using a $3.00 "wage" conversion factor. This meant that for respondents who valued their discretionary time at a rate greater than $3.00 per hour, assigned time payments were more costly on the average compared with assigned money payments. Nevertheless, payments of time were generally more acceptable to respondents compared with money payments. Out of 179 persons presented with fixed requested money contribution amounts, 57 percent said "yes" to contributing the amount specified. By comparison, 85 percent of 117 respondents responded affirmatively that they would contribute specified time amounts.

For each survey version and particular resource, data on the binary response ("Yes" or "No") and fixed contribution amounts were used to fit a logistic probability function (see Bishop and Heberlein, Hanemann and Sellar et al., for discussion of this procedure). The basic estimation model used to accommodate inclusion of volunteer time payments was specified as

(7) $P(Yi) = 1/[1 + \exp-(B_0 + B_1 * Ci)]$.

where P(Yi) is the probability that the ith respondent will answer affirmatively to a given total time and money contribution amount Ci. B_0 and B_1 are parameters to be estimated. A linear specification of the exponential term was adopted following Hanemann who showed that this form is consistent with utility theory.[5]

The contribution amount (Ci) was formulated as a linear combination of the fixed money (Mi) and time (Ti) amounts proposed to the ith respondent, $Ci = (Mi + w*Ti)$.[6] The time variable was expressed in monetary terms using a constant hourly "wage" rate (w). Two approaches were followed to define w. The first was to set w arbitrarily at the 1986 U.S. minimum wage rate ($3.35). This approach is admittedly problematic because of the ambiguous relationship between an individual's marginal valuation of volunteer time contributions and an exogenous wage rate. Given this uncertainty, a wage rate of $1.00 was also used to test for the sensitivity of preservation value estimates to changes in assigned volunteer time "wages."

A second approach was to let sample data determine w as a prior step to estimating equation (7). By first estimating the logistic probability function as:

(8) $P(Yi) = 1/ [1 + \exp-(B_2 + B_3{*}Mi + B_4{*}Ti)]$

an estimate of w was obtained as B_4/B_3.[7] This ratio reveals respondents' overall average willingness to trade money for time contributions. Specifically it gives the dollar value of one unit of volunteer time and is constant for all sample observations regardless of occupation and income. McConnell and Strand used an analogous approach to estimate the implicit value of the opportunity cost of time spent in recreational travel.

Maximum likelihood estimates of equation (8) coefficients for seals and whales, based on data from two different survey versions, are given in Table 2. Statistical tests indicate that the estimated models have relatively high predictive power as measured by the percentage of correct forecasts which ranged between 73 and 82 percent. The money donation variables were consistently significant with negative signs as expected. The time variables were consistently insignificant and took on positive signs in both whale models.

TABLE 2

MAXIMUM LIKELIHOOD ESTIMATES FOR LOGIT MODELS

TO ESTIMATE IMPLICIT VALUES OF VOLUNTEER TIME CONTRIBUTIONS

SURVEY VERSION	RESOURCE	INTERCEPT	MONEY	TIME	PERCENT OF CORRECT FORECASTS(a)	IMPLICIT TIME VALUES
I (b)	Seal	1.832 (0.457)	-0.018 (0.005)	-0.001 (0.009)	82	$0.05
	Whale	1.264 (0.438)	-0.011 (0.004)	0.007 (0.009)	75	-0.60
II(c)	Seal	0.830 (0.477)	-0.016 (0.006)	-0.006 (0.008)	73	0.38
	Whale	2 .246 (0.552)	-0.018 (0.005)	0.003 (0.013)	79	-0.16

Notes: Estimated standard errors of coefficients in parentheses.

(a) Fraction of observations where predicted response is the same as observed response

(b) Seals valued first, then whales

(c) Whales valued first, then seals

Implicit time values which were calculated from the estimated time and money coefficients are given in Table 2. The implicit values were consistently low, and were negative in the case of whales. We interpret these results to mean that individuals perceived essentially zero opportunity costs associated with contributing volunteer time, at least within the range of time commitments we set forth. At least two factors may have contributed to this outcome, the first of which is the fact that volunteer time contributions could be made at home preparing supplies, thereby eliminating conflict with many other at-home leisure pursuits. Given this payment alternative, respondents may have percieved little opportunity cost associated with donating large quanitities of time. The second factor is that individuals may have expected to receive some private benefit by volunteering that would offset the opportunity costs of forgone discretionary time. Stated in terms of the model given above, the typical respondent's perceived commodity value of time spent in preservation activities apparently equals (for seals) or exceeds (for whales) his or her scarcity value of time.

Estimated imputed wage values, along with the two arbitrarily selected exogenous wage values ($1.00 and $3.35) were used to fit final logistic models [equation (7)] via maximum likelihood estimation. Not surprisingly, best fits were obtained in those models where estimated implicit values of volunteer time were used instead of arbitrary wage rates. Statistical tests indicate that the estimated models have relatively high predictive power as measured by the percentage of correct forecasts between 65 and 90 percent. Estimated coefficients on the Ci variables were significantly different from zero at the 90 percent significance level across all equations.

Willingness to provide time and money (hereinafter called total willingness to pay, or TWTP) for seal or whale preservation was computed in two steps. First, expected willingness to pay was derived by integrating each estimated logistic probability equation from zero to infinity using the formula $E(WTP)=(-B_0/B_1)+\ln[1/\{1+\exp-(B_0)\}]/B_1$. Evaluating this definite integral is analogous to integrating the area above the cumulative distribution function (CDF) for willingness to pay. By definition the area above a CDF of a random variable equals its expected value. The second step was to weight the resulting integral to reflect the proportion of respondents who were unwilling to commit time or money to the particular preservation effort. For example, if 20 percent of respondents would contribute neither time nor money, the value of the integral was multiplied by 0.8 to arrive at a final weighted expected value.

Resulting weighted expected TWTP estimates to preserve seals or whales for two survey versions and three alternative values assigned to time are given in Table 3. Calculated expected TWTP ranged between $52 and $266 for seals and between $101 and $1,050 for whales. These amounts may seem inordinately high compared with typical values in the range of $5 to $15 reported elsewhere in the other wildlife valuation studies (see for example Brookshire et al.; Boyle and Bishop). However, it is important to bear in mind that the values reported in Table 3 represent lump- sum TWTP amounts rather than annual WTP annuities as are more commonly reported. These disparities are greatly reduced by either capitalizing the annual values reported elsewhere to arrive at a lump-sum amount, or by amortizing the lump-sum values given in Table 3 to estimate annual values; in both cases using a discount rate in the range of 7 percent. For example, the annuity equivalent of a $266 lump-sum payment is approximately $19.

TABLE 3

ESTIMATED TOTAL WILLINGNESS TO PAY FOR MONK SEAL AND HUMPBACK WHALE PRESERVATION UNDER ALTERNATIVF- ASSUMPTIONS ABOUT VALUE ASSIGNED TO CONTRIBUTIONS OF VOLUNTEER TIME

	ESTIMATED TOTAL WILLINGNESS TO PAY			
	Survey Version I(a) (N=88)		Survey Version II(b) (N=77)	
VALUE ASSIGNED PER UNIT HOUR OF TIME DONATED	Seals	Whales	Seals	Whales
$1.00	$103	$ 142	$ 62	$125
3.35	266	1050	178	244
Imputed	82	101	52	109

Notes: (a) Seals valued first, then whales

(b) Whales valued first, then seals

Estimated TWTP was significantly affected by the value assigned to volunteer time. The lowest estimates were consistently associated with the imputed wage models. These estimates differed by as much as an order of magnitude from TWTP estimates based on a $3.35 wage rate. On the average, estimates based on a $3.35 hourly time value were 220 percent higher compared with those based on a $1.00 assigned wage.

The relatively low TWTP values derived using imputed wages presents an apparent paradox: a high willingness to sacrifice discretionary time to save the resource leads to low estimated preservation values. According to the received knowledge about time valuation, this outcome, albeit curious, makes perfect sense and is explained as follows. Imputed values of volunteer time are low because sampled individuals are overwhelmingly willing to provide volunteer effort to preserve seals and whales. Low imputed wage values in turn imply that the opportunity cost of time, as perceived by respondents, is also low relative to average wage rates. When time payments are converted to monetary flows using low time opportunity costs, TWTP is therefore accordingly lower than what would otherwise be the case if opportunity wage rates were used to value time payments. Clearly whether one accepts this argument or not depends on the premise that it is acceptable to deduct the commodity value of volunteer time from its scarcity value. If this premise is rejected, then the method used here is problematic. This is because our procedure entails measuring the combined commodity and scarcity components of the opportunity cost of time as a single imputed value. Identification of individual time value components is therefore not possible.

CONCLUSIONS

Welfare theory suggests that individuals may be willing to forgo income, discretionary time, or both in order to secure provision of a public good such as endangered species preservation. However, valuation research using CVM has largely ignored compensation options that take the form of time payments or receipts. Results of this study show that many individuals are willing to make donations of volunteer time, and some individuals prefer this option exclusively. The preference for time payments appears to be inversely related to household income.

We interpret the generous response to requested time payments as a clear indication of a high degree of respondent acceptance of a time payment vehicle. However, the popularity of time payments in this study also gives cause to question respondent's motives and perceived payoffs underlying their willingness to make significant donations of volunteer time. This concern comes directly into play when trying to estimate the value of time contributions in a simple manner, as we have done here.

It appears unavoidable that the inclusion of time payments in CVM requires that a value be placed on this time, assuming that CVM estimates are to be expressed in monetary terms. Selection of an appropriate value for time appears to be critical, as evidenced by the sensitivity of estimated seal and whale preservation values to time value assumptions.

Assigning an arbitrary constant "wage" value to volunteer time for the sample is certainly convenient but it does not satisfactorily address the relationship between discretionary time value and average wage rates. Alternatively, time values can be imputed using cross-sectional data on time-money tradeoffs. In this study, calculated shadow values for contributions of volunteer time were found to be low relative to U.S. minimum wage levels. This in turn results in lower preservation value estimates that would be the case if only the scarcity value of discretionary time is used to monetize time contributions. We hypothesize that this outcome reflects positive personal benefits associated with volunteer action that tend to balance reductions in wage-earning potential. Nevertheless, the same result could conceivably arise due to respondents' lack of familiarity with making volunteer time contributions and a consequent overstatement of actual willingness to contribute. Further research is needed to better understand motives for making time payments, and how these should be appropriately valued on an individual observation as well as a sample-wide basis.

REFERENCES

Bishop, R.C. and T.A. Heberlein. 1979. "Measuring Values of Extramarket Goods: Are Indirect Measures Biased?" American Journal of Agricultural Economics 61:926-30.

Bockstael, N. and I.E. Strand. 1985. "Distributional Issues and Nonmarket Benefit Measurement." Western Journal of Agricultural Economics 10:162-69.

Boyle, K.J. and R.C. Bishop. forthcoming. "The Economic Valuation of Endangered Species of Wildlife." Water Resources Research.

Brookshire, D.S., L.S. Eubanks and A. Randall. 1983. "Estimating Option Prices and Existence Values for Wildlife Resources." Land Economics 59:1-15.

Cesario, F.J. 1976. "Value of Time in Recreational Benefit Studies," Land Economics 52:32-41.

Cory, D.C. 1985. "Income-Time Endowments, Distributive Equity, and The Valuation of Natural Environments." Western Journal of Agricultural Economics 10:183-86.

Cummings, R.G., D.S. Brookshire and W.D. Schulze. 1986. Valuing Environmental Goods: An Assessment of the Contingent Valuation Method, Towata, New Jersey, Rowman and Allanhead.

Hanemann, W.M. 1984. "Welfare Evaluations in Contingent Valuation Experiments With Discrete Responses." American Journal of Agricultural Economics 66:332-41.

Hodgkinson, V. and M. Weitzman. 1984. "Dimensions of the Independent Sector." Washington, D.C.:Independent Sector.

McConnell, K.E., and I.E. Strand. 1981. "Measuring the Costs of Time in Recreation Demand Analysis: An Application to Sport Fishing." American Journal of Agricultural Economics 63:153-56.

Samples, K.C. and J.R. Hollyer. forthcoming. "Contingent Valuation of Wildlife Resources in the Presence of Substitutes and Complements" in G.V. Johnson and R.L. Johnson, eds., Economic Valuation of Natural Resources: Issues, Theory and Applications, Boulder, Colorado, Westview Press.

Sellar, C., J.R. Stoll, and J.P. Chavas. 1985. "Validation of Empirical Measures of Welfare Change: A Comparison of Nonmarket Techniques." Land Economics 61:156-75.

Smith, V.K., W.H. Desvousges, and M.P. McGivney. 1983. "The Opportunity Cost of Travel Time in Recreation Demand Models." Land Economics 59:259-78.

Wilman, E. 1980. "The Value of Time in Recreation Benefit Studies." Journal of Environmental Economics and Management 7:272-86.

FOOTNOTES

1. This paper is the result of research (project PP/R-9, "Economic Benefits and Costs of Marine Mammal Preservation in Hawaii") sponsored in part by the University of Hawaii sea Grant College Program under an Institutional Grant No. NA85AA-D-SG082 from NOAA, Office of Sea Grant, U.S. Department of Commerce.

2. This two-constraint formulation assumes that discretionary time cannot be readily converted into income. If, however, leisure time and income are perfectly substitutable, then the two constraints on time and income collapse to a single constraint on "full income" which is normally defined as actual and potential income from all sources.

3. The choice of income and time payments rather than receipts is purely expositional. The model presented here (except for minor changes in signs) applies equally when compensation is received rather than given. Similarly, it is straightforward to consider quantity increments, along with changes in the reference utility level from a posteriori to a priori.

4. ES is formulated here as a multi-dimensional welfare measure indicator that includes both time and money compensation components without any explict conversion between the two. However, for purposes of interpersonal comparisons and aggregation it is useful to express ES in dollar terms by appropriately converting the WTVT term.

5. Respondent household income was included as an explanatory variable in preliminary model testing phases. Income was expressed as a series of four dummy variables because that income data were collected in a categorical format. The income dummy variables were jointly insignificant at the 90 percent significance level on a consistent basis and occasionally had incorrect signs. This result, as Hanemann points out, follows directly from our specification of the logit model which essentially eliminates income effects. The income variable was dropped in all final estimation models.

6. Mi was set to zero for respondents who chose the "time only" payment option. Similarly, Ti was set to zero for those who chose the "money only" option.

7. This can be seen by first rewriting the exponential term in Equation (7) to reflect the definition of Ci (that is, $B_0 + B_1(Mi + w*Ti)$). Next, expand it to form $B_0 + B_1*Mi + B_1*w*Ti$. Now, by allowing B_0 to equal B_2 in Equation (8), and similarly $B_1=B_3$ and $B_1*w=B_4$, then w is recovered by the ratio $B_4/B_3=(B_1*w)/B_1$.