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Exploring Existence Value

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The notion that individuals value the preservation of water resources independent of their own use of these resources is discussed. Issues in defining this value, termed "existence value," are explored. Economic models are employed to assess the role of existence value in benefit-cost analysis. The motives underlying existence value are shown to matter to contingent valuation measurement of existence benefits. A stylized contingent valuation experiment is used to study nonusers' attitudes regarding projects to improve water quality in the Chesapeake Bay. Survey results indicate that altruism is one of the motives underlying existence value and that goods other than environmental and natural resources may provide existence benefits.

Introduction

The history of the application of benefit-cost analysis records increasingly broad attempts to include intangibles in benefits or costs. *Eckstein* [1958, p. 41], writing in the 1950s, demonstrates how to calculate the costs and benefits of activities such as navigation and flood control which have market prices, but concludes that "purposes such as recreation must ... be judged on other criteria." But a decade and a half later, *Howe* [1971] discusses how to measure the benefits of water recreation for purposes of benefit-cost analysis. As economists have refined their methods of estimating recreational benefits, a new criticism has arisen. What about the benefits to people who value the development of a water resource project, or an improvement in water quality, but who cannot be immediately identified as members of a particular user group?

Economists have responded to this criticism by constructing two kinds of measures of the benefits of water resource development: measures connected with the uncertainty of future returns and measures associated with the existence but not the use of the resource. Both notions of benefits have their origin in *Krutilla*'s [1967] essay, "Conservation Reconsidered" and stem from his experience in applying benefit-cost analysis to water resource projects. Research on existence value is part of the evolution of benefit-cost analysis of water resource projects, representing an attempt to include previously unmeasured intangible benefits.

Below we give a more precise definition of existence value, but for now simply define it as an individual's willingness to pay for a change (or to avoid a change) in the provision of a resource with no prospects or no intention of enjoying in situ services from the resource. Existence value as a component of benefit-cost analysis merits some thought because it harbors the potential for quite large benefits of water resource projects and because those benefits are less susceptible to disproof than benefits from the direct use of the resource. The conclusion that every household in the United States would pay $1.00/year to attain swimmable water in the Chesapeake Bay yields not just a large number but a number which is hard to refute. When dealing with existence value, more than other sources of value, we need to concern ourselves with the question, "What are we measuring?" rather than "What is the measurement?".

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While formal studies of existence value are limited, empirical evidence of existence value has been of two sorts. First, we have indirect evidence based on people's willingness to join organizations such as Save the Bay groups, the Sierra Club, Audubon Society, etc., organizations which are active in resource conservation. Such activity, not always based on use, seems to be an underutilized source of revealed preferences implying existence value. Second, many of the more formal inquiries using contingent valuation are ably summarized by *Fisher and Raucher* [1984]. They give evidence that nonuse benefits of improvements in water quality (which include option value as well as existence value) tend to be some fraction of the use value of resource changes. Other research [e.g., *Walsh et al.*, 1985; *Schulze et al.*, 1983] shows that existence value is greater than use value, and in the *Schulze et al.* [1983] case, is substantially greater.

The measurement of nonuse benefits such as existence value has been of particular interest to researchers concerned with the preservation of water resources. Several water resource valuation studies have addressed the problem of estimating such benefits. Studies by *Mitchell and Carson* ([1981]; U.S. surface water resources) and *Cronin* ([1982]; Potomac River) have employed contingent valuation to estimate intrinsic values associated with water quality. Studies by *Desvouges et al.* ([1983]; Monongahela River), *Walsh et al.* ([1978]; South Platte River), and *Walsh et al.* ([1985]; wild and scenic Colorado rivers) obtained explicit estimates of existence value for water quality via contingent valuation.

While economists have accepted existence value as something worth measuring, they have not reached a consensus on the models which underlie the measurement. We pose several questions whose answers are ambiguous in current thinking. Our questions relate primarily to definitions of existence value. Should existence value be distinguished from off-site use values? Does the nature of the resource matter when establishing measures of existence and use value? Do the motives which give rise to existence value matter? Is existence value limited to natural resources, i.e., the "biological and geomorphological variety" of which *Krutilla* [1967] speaks? Attempting to answer these questions will help our understanding of the role of existence value in benefit-cost analysis.

The Accounting Definition of Existence Value

We begin by deriving the definition of existence value from the minimum cost function. Details about the following summary can be found in the works by *McConnell* [1983] or

Smith et al. [1985]. Let the preference function by $U(x, R)$, where x is an n-dimensional vector of commodities purchased at the price vector p, and R is a resource, such as water quality, water levels, or water releases, whose existence may be valued. The minimal cost of obtaining utility level u is given by the standard cost function

$$C(p, R, u) = \min\,[xp \mid U(x, R) = u] \qquad (1)$$

Let x be partitioned such that $x = (x^*, x^0)$, where x^* is a vector of commodities complementary to R. For example, for $x^* = (x_1, x_2)$ x_1 could be recreational visits to a river and x_2 purchases of a magazine which features news about the river. Let p^* be the price vector that sets the Hicksian demands for x^* to zero. Then the existence value E of a change in the resource from R_1 to R_2 is the change in the cost of obtaining utility u at prices p^*

$$E = C(p^*, R_1, u) - C(p^*, R_2, u) \qquad (2)$$

The change in use value from the change in the resource is the sum of the change in the areas under the Hicksian demand curves for x^* at the appropriately defined limit prices. At R_1, the sum of the areas under the Hicksian demand curves is given by $C(p^*, R_1, u) - C(p, R_1, u)$. The change in this value, which we call S for site or use value for a resource change, is given by

$$S = C(p^*, R_2, u) - C(p, R_2, u) - \{C(p^*, R_1, u) - C(p, R_1, u)\} \qquad (3)$$

By adding existence and site value we obtain the accounting identity of total value

$$T = C(p, R_1, u) - C(p, R_2, u) = E + S \qquad (4)$$

We use these definitions in measuring and using existence value.

Issues in Defining Existence and Use Value

The first issue we discuss concerns the precise definition of existence value. How are existence and use values to be distinguished? At one extreme is the notion that any complementarity between the resource and market commodities connotes use. For example, when one reads a magazine article about Yellowstone, is one gaining use value from the resource? This view of existence value is found in the work by *Randall and Stoll* [1983]. The other perspective (see, for example, *Smith et al.* [1985]), would equate existence value to any use of the resource which does not utilize in situ services. One may also find this view in the work by *Krutilla and Fisher* [1975, p. 124].

Does it matter whether we define existence value as any off-site enjoyment of the resource service flows, or require it to be enjoyment of the resource not complementary to any marketed good? The answer is part pragmatic and part substantive; the pragmatic part concerns measurement. If we define existence value in its most broad sense, then we hold out the hope that we can measure at least part of the existence value from a resource change as changes in the areas under the demand curves for commodities not connected with in situ use. For example, in principle, we measure existence value by estimating the demand for books and articles about a lake and show how these demands changed with the change in the

This discussion of the possible motivations for pure existence alue is inconclusive .... Definitions can be considered in part as matter of taste. A set of definitions can be considered useful if it urthers the research objective and leads to useful answers to neaningful questions and if the definitions are based on operationally meaningful distinctions.

agree in general with these comments, but will argue for erationally meaningful distinctions in the section Do Mo- es Matter?.

THE NATURE OF THE RESOURCES

Does the nature of R affect measures of existence and use ue? We find many different measures of R, even in the ntext of measuring existence value. For example, it can be index of visibility [*Schultze et al.*, 1983], grizzly bears, and horn sheep [*Brookshire et al.*, 1983], an index of water ality [*Desvousges et al.*, 1983], or the availability of wild l scenic rivers [*Walsh et al.*, 1985]. But there are two views measures of resources in the context of weak complemen- ity and existence value. Each view helps to understand the ure of a resource change. To maintain simplicity, assume t R is weakly complementary to x_1 only, and that there are off-site uses. When x_1 is zero, the only benefit from a nge in R is pure existence value.

First, we can conceive of R as simply an index of quality, as s most frequently used. In that case, R simply enters the ference function and is not part of any explicit or implicit duction process; it merely enhances the enjoyment of use. cond, R can be viewed as part of a production process. en R is part of a process, minimum levels of R could be ential for x_1. This view of R in the preference function kes the link between x_1 and R a technical link. Denote the ical minimum level of R as R_m, the level of the resource ich reduces use to zero, and suppose that R_0 is less than

We are interested in changes in welfare induced by in- asing the resource from its minimum level at R_0 to some l R_1. This approach is similar in spirit to work by *Smith et* [1985]. In effect, we introduce a kind of symmetry in the ference function. Weak complementary would give

$$\partial U(0, x_2, \cdots, x_n, R)/\partial R = 0$$

le having R at R_0 implies

$$x_1 = x_1(p, R_0)$$
$$= 0$$

$$U(x, R_0) = U(0, x_2, \cdots, x_n, R_0)$$

symmetry exists because when R is below some critical imum R_0, changes in x_1 bring no net increases in utility. t is, when $R = R_0$,

$$\partial U(x, R_0)/\partial x_1 = 0 \tag{7}$$

s symmetry also extends to the expenditure function. he classic result of *Mäler* [1974] concerning weak comp- entarity simply states that when the price vector reaches the expenditure function is stable with regard to the re- rce level. Specifying R as an implicit but essential input s us another condition in the absence of existence value. resource levels less than R_m, changes in the price of x_1 e no impact on the expenditure function when there is no tence value, broadly defined:

$$C(p_1^0, p_2 \cdots p_n, R_0, u) - C(p, R_0, u) = 0$$

Does this additional link between R and x_1 provide any additional information? It suggests looking for existence value in two ways. First, when individuals do not use a resource because they are priced out, we can look for existence value. Second, when the resource level is so low that the technical link involves no direct use, existence motives, that is, care about the resource for reasons other than its direct use, will induce existence value:

$$E = C(p, R_0, u) - C(p, R_1, u) \tag{8}$$

where R_0 and R_1 are less than the critical minimum.

Does this distinction matter? Changes in R influence the choke price for x_1, so that reductions in R can bring x_1 to zero without technical or implicit production links. That is, the p_1^* that satisfies $x_1(p_1^*) = 0$ depends on R, so that with enough reductions in R and the right complementarity between R and x_1, p_1^* will fall. The case of the technical link differs. When the link between x_1 and R is purely technical and R falls below the critical minimum or essential level, then no other levels of $(p_1 \cdots p_n)$ will induce a positive level of x_1 to be chosen. Thus the technical link influences behavior independent of the utility function and the budget constraint.

However, defining the resource as essential does not destroy the definitions of existence and use value. While it is possible that resource levels may constrain use just as the level of use may constrain enjoyment of the resource, accounting for this phenomenon with the expenditure function appears to present no special problems (an example is given in the appendix).

DO MOTIVES MATTER?

Economists are leery of analyzing motives, since typically motives don't matter. Because existence value cannot practically be linked with behavior, its estimation requires the techniques of contingent valuation. Understanding the motives that underlie contingent value responses can help design and interpret contingent valuation experiments. Further, understanding motives may alter the role of existence value in benefit-cost analysis.

The analysis of motives must regretably begin with taxonomy. For our purposes, two broad motives may be discerned: altruistic and intrinsic. We will be concerned in the analysis below with altruism, but first a word about intrinsic motives.

Existence value which stems from intrinsic motives reveals a concern about the state of the world. People may care about animals, and they may care about preservation and development of natural areas, without regard to the well-being of others. Care about the order of things may cause some people to be worse off when they read about pollution events such as toxic waste spills, regardless of whether such spills have long-run consequences, because such events may violate a sense of how the world should be ordered. The environmental ethic is closely linked with the intrinsic motive.

Despite the potential importance of intrinsic motives, we concentrate on altruism. We have no basis for judging which motives are operative except to ask individuals. Both the presence of environmental groups and the observed positive responses to questions eliciting existence value can be explained by altruism toward others, intrinsic motives, or indirect-use values. It is instructive simply to recognize that intrinsic motives may exist and to note that these motives may also be

relevant to the proper design and interpretation of contingent valuation experiments.

Two kinds of altruism are plausible. People have individualistic altruism when they gain value from the enhanced well-being of others, without regard to the manner in which the gains of others were achieved. Paternalistic altruism motivates people who gain value from the use of a particular good or resource by others. Whether individualistic or paternalistic altruism (or neither) underlies preferences is an empirical question. Our purpose is merely to suggest that both kinds of altruism are possible.

Individualistic altruism can be directed toward heirs or others of current or future generations. For simplicity, consider a two-person world where person A is a nonuser and person B is a user of a water resource R. (The principle results of this section have been generalized in the work by *Madariaga and McConnell* [1984].) Assume that existence value accrues to person A from the provision of R. If the underlying motive is individualistic altruism, then we could envision person A and B with preferences:

$$U^A = U^A(Y_A, U_B(Y_B, R)) \tag{9}$$

$$U^B = U^B(Y_B, R) \tag{10}$$

where U^i and Y_i are the utility and income levels, respectively, for person $i = A, B$. A unit increase in R yields existence value to person A when

$$(\partial U^A/\partial U^B)(\partial U^B/\partial R) > 0$$

Any good that yields value to person B, whether public or private, would yield existence value to person A.

Suppose the motive behind existence value is paternalistic altruism. If A is paternalistic solely toward B's use of R, then (9) would be rewritten simply as

$$U^A = U^A(Y_A, R) \tag{11}$$

so that

$$\partial U^A/\partial R > 0 \qquad \partial U^A/\partial Y_B = 0$$

We now show that motives are important because they can determine whether existence value influences benefit-cost outcomes. Consider a proposed project that would tax A and B in order to pay for an increase in water quality from R_1 to R_2. Suppose we ask A the following stylized contingent valuation question, Q^*: How much would you be willing to pay to have water quality increased from R_1 to R_2? We would expect A's response to be positive if he is motivated by either kind of altruism. Since A is not a user of the resource, the standard procedure would be to interpret this response as his existence value for the increase in water quality. However, depending on A's motives, this interpretation may be misleading.

Suppose person A's existence value stems, at least in part, from individualistic altruism. Since he is not told the value of goods that must be sacrificed (other than his own contribution) for the resource enhancement, he is not given the opportunity to compute the change in well-being of person B. Hence there is no opportunity for a negative response. Suppose Q^* is rephrased as follows, Q^{**}: How much would you be willing to pay to have a project undertaken (positive dollars) or stop a project from being undertaken (negative dollars) that would tax person B and increase water quality from R_1 to R_2? The response to Q^{**}, even if still positive, may be lower than when no opportunity cost is presented to A. It may even vary depending on the type of goods to be sacrificed by B if A is motivated partly by paternalistic altruism. That is, A's response may depend on whether B pays in higher taxes or reduced services of some other public good. At some level of opportunity cost, A will become willing to pay some amount to prevent the resource change. Thus if existence value bids are at least partially based on individualistic or paternalistic altruism, efforts to use contingent valuation to estimate existence value must give respondents information about the size and form of the costs that others must pay when a resource enhancement project is undertaken.

We can make these results explicit. Consider a project that increases water quality from R_1 to R_2, and costs C, to be paid by B, the user. B's surplus from the change (S_B) is given implicitly by

$$U^B(Y_B - S_B, R_2) = U^B(Y_B, R_1) \tag{12}$$

Suppose that $C > S_B$; i.e., user benefits are less than costs. Then benefit-cost analysis may not give the correct decision if it ignores benefits to nonusers. Under the payment scheme when B pays, how much surplus does A get from the project when he is motivated by individualistic altruism? A's surplus is given implicitly by

$$U^A(Y_A - S_A, U^B(Y_B - C, R_2)) = U^A(Y_A, U^B(Y_B, R_1)) \tag{13}$$

Since $U^B(Y_B - C, R_2) < U^B(Y_B, R_1) = U^B(Y_B - S_B, R_2)$, A must be compensated for the move, and hence S_A (existence value) is negative. Thus the aggregate benefits remain less than costs after the inclusion of existence value

$$S_A + S_B < C \tag{14}$$

because $C > S_B$ and $S_A < 0$. When individualistic altruism prevails and the user pays all costs, adding in the surplus from existence value from the nonuser does not change the benefit-cost outcome. (This result may not hold in the case of N users if the nonuser is more altruistic toward one group of users than another group. See the discussion in the work by *Madariage and McConnell* [1984, p. 11].)

A change in the distribution of costs cannot make benefits exceed costs. If A is altruistic toward B, won't he help share costs? Rewrite (13), letting w be A's share of costs and $(1 - w)$ B's share

$$U^A(Y_A - S_A - wC, U^B(Y_B - (1 - w)C, R_2))$$
$$= U^A(Y_A, U_B(Y_B, R_1)) \tag{15}$$

Expressions (13) has $w = 0$. Differentiating with respect to w and observing how S_A changes gives us

$$\partial S_A/\partial w = [U_1{}^B U_2{}^A/U_1{}^A - 1]C \tag{16}$$

where subscripts on U indicate partial derivatives with respect to arguments. If $\partial S_A/\partial w$ is less than zero, changing the cost share cannot influence the benefit-cost outcome. When S_B and C do not change and S_A goes down, the inequality (14) will be preserved.

The algebraic result above confirms intuition. A's willingness to pay for the project will increase if he gets more utility by giving B a dollar ($U_2{}^A U_1{}^B$ is the rate of A's utility change from B's income increase) then he gets from having a dollar himself $(U_1{}^A)$. While such a result cannot be discarded completely, it seems extreme. Thus if the users cannot pay for the project when $w = 0$, then including individualistic altruism when nonusers share the cost will not increase the benefits.

TABLE 1. Summary Results of Contingent Valuation Experiment

Scenario Number	Proportion of Yes Responses, Users	Standard Error of Difference*	Proportion of Yes Responses, Nonusers	Standard Error of Difference
1	0.96		0.83	
2	0.70	0.032	0.69	0.088
3	0.71	0.032	0.67	0.088
4	0.49	0.035	0.37	0.091

The number of users and nonusers is 236 and 46, respectively.
*This number is the standard error of the difference between the proportion in scenario 1 and the proportion of the given scenario.

The question of whether there are restrictions on the types of resource good, action, risk, or regulation which provide or deprive an individual of existence value bears directly on the issue of motives. *Krutilla* [1967] observed that historical and cultural features and perhaps rare works of art can also provide service flows to those who do not use them. This same conclusion is argued by *Randall and Stoll* [1983], who suggest that many different kinds of goods and services have potentially significant existence value. Nevertheless, one view is that there is something special about natural and environmental resources that makes existence value from these resources more significant than existence value from most or all other types of goods. This view may be based on the intuition that existence value is likely to be most important for assets that are unique, irreplaceable, and long-lived.

There is no easy answer to the question of the extent of existence value. The answer lies with the unobserved motives that give rise to existence value. For example, if the only motive underlying an individual's existence value is individualistic altruism, then all kinds of goods consumed by others would provide existence value to the individual based on the extent of use values provided by each good. Characteristics of natural assets such as uniqueness, irreplaceability, and longevity may account for large existence value, but only in as much as these characteristics increase the potential for use value from natural assest. In contrast, if the source of existence value is paternalistic altruism or an intrinsic concern for the resource, then existence value may be greater from natural versus man-made assets.

To summarize, motives for existence value matter. The application of benefit-cost analysis is incorrect only when existence value is of sufficient magnitude to change the sign of benefits less costs. When individual altruism is the prevailing motive, the measurement of existence value cannot alter the outcome of benefit-cost analysis. This conclusion suggests that research on the nature of motives is a useful part of contingent valuation surveys.

SOME EMPIRICAL EVIDENCE

This section presents some results of a stylized contingent valuation experiment designed to provide information about the motives behind existence value. The study population was defined as adult (age 18 or over) residents of the Washington, D. C., and Baltimore Standard Metropolitan Statistical Areas. A Random Digit Dialing Telephone Survey was used to contact 1057 individuals in the study area. Of those contacted, 741 agreed to fill out and return a brief mail questionnaire regarding water quality in the Chesapeake Bay, and of these 741, 282 actually returned the questionnaires. The 282 respondents were grouped as users or nonusers. Users were defined as all respondents who thought they might use the Bay. Respondents who felt certain that they would not use the Bay for recreation at any time in the future were defined as nonusers; nonusers accounted for 16.3% of the respondents.

Becasue only about 70% of those contacted agreed to receive the mail questionnaire and because only 38% of those who agreed actually returned these questionnaires, these results should not be taken as representative of the population sampled. Further, the counterfactual nature of the questions raises some doubt about the validity of the responses. But we use the contingent valuation framework to gain insights into motives, not to compute aggregate benefits and costs.

Respondents were asked to consider a series of situations concerning public beaches surrounding the Chesapeake Bay. They were asked to assume that water quality at these beaches had fallen below a level acceptable for swimming. They were told that a cleanup project could be undertaken that would clean the beaches so that a water quality level acceptable for swimming was achieved and maintained. Then respondents were asked the question, "Would you prefer that the cleanup project be undertaken?" under four different scenarios: (1) no additional information; (2) access to the beaches by the public is permanently denied so that even if clean, the beaches will not be used; (3) if the project is undertaken, taxes would be raised so much that nearly everyone prefers that the project not be undertaken (these taxes would be paid by individuals other than the respondent); and (4) if the project is not undertaken, funds would instead be used to improve hospital services in selected communities surrounding the Bay. The respondent would never need to visit any of the improved hospitals, and of all the people who care, half want the beaches cleaned and half want improved hospital services. The proportion of yes responses for users and nonusers under each scenario is given in Table 1.

Responses to the question under scenario 1 are used as a control to be compared with responses under scenarios 2 through 4. As was expected, most respondents preferred that the project be undertaken under scenario 1. Nonuser responses of yes indicate positive existence value. The relatively high number of nonusers exhibiting positive existence value is consistent with the results of previous studies that have estimated existence value. Note, however, that scenario 1 is purposely ambiguous about project costs.

With access to beaches denied under scenario 2, the number of yes responses to the question predictably declined. Since the number of nonuser responses of yes declined when access was denied, it appears that existence value, to at least some individuals, is related to others' use. Thus altruism may be one motive that underlies existence value. However, even with access denied, most respondents preferred that the project be undertaken. This may reflect the presence of intrinsic motives. Finally, note the closeness of user and nonuser group responses under scenario 2. Since with access denied there can be no users, yes responses from the user group will also indicate positive existence value. Thus the proportion of users and nonusers exhibiting existence value was nearly identical.

Scenario 3 differs from scenario 1 only in that respondents were told that others would need to pay taxes to have the project undertaken. The reduced number of yes responses under scenario 3 indicates an underlying concern regarding the income or well-being of others, i.e., individualistic altruism. Hence the conceptual results of the previous section appear to have practical significance.

Under scenario 4 the number of yes responses fell dramatically compared with the responses under scenario 1. Since less than one half of the nonusers preferred that the cleanup project be undertaken, it appears that existence value from improved hospital services is at least as great as existence value from clean water in the Bay. Preferences for the cleanup project or improved hospital services should not be interpreted as stemming from individualistic altruism, since respondents were told that an equal number of people preferred each project. Nonuser preferences for one project or the other could be based on paternalistic altruism or intrinsic motives. This result is consistent with the hypothesis that existence value is not confined to natural assets, even if the underlying motive for existence value is not individualistic altruism.

The empirical results are consistent with the idea that individualistic altruism is one of the motives underlying existence value and that existence value accrues from at least some man-made goods, even if individualistic altruism is ignored. Interpretation of this experiment must be made with some caution given the highly hypothetical nature of the questions posed. Nevertheless, experiments such as this one may be our only means to provide information regarding the motives underlying existence value.

CONCLUSION

Motives can matter. In some cases, existence value which stems from individualistic altruism may have no impact on the qualitative outcome of benefit-cost analysis. Further, underlying motives matter to the proper design and interpretation of contingent valuation experiments for eliciting existence value. Existence value may be derived from goods other than natural and environmental resources. Its omission from benefit-cost analysis may mean lower costs as well as lower benefits. Without some knowledge of the setting, the resources, and the issues, there is not a good case that omission of existence value from benefits will result in too little conservation.

Existence value which stems from intrinsic motives, that is, concern over the resource itself, rather than someone else's use of it, has an unambiguous effect on the measurement of benefits. A useful line of research would appear to be discovering how to use contingent valuation methods to estimate existence value which flows from the environmental ethic, the concern for economic order, and other motives which pertain to existence of resources. Making existence value contingent on altruism attempts to incorporate a component of benefits in benefit-cost analysis with a faulty structure.

APPENDIX: MEASURING EXISTENCE AND USE VALUE FROM AN ESSENTIAL RESOURCE: AN EXAMPLE

Suppose utility is given by

$$U(x_1, x_2, R) = ax_1 + \ln x_2 + b \qquad \text{(A1)}$$

where a and b are functions of R such that $\partial a/\partial R > 0$ and $\partial b/\partial R > 0$. Suppose that $a(R_m) = 0$, where R_m is the critical minimum level of the resource. This is a weakly complementary link. Thus when $R = R_m$, $x_1 = 0$. The Hicksian demand for x_1 is given by

$$x_1 = [u - b - \ln(p_1/ap_2)]/a$$

and the Hicksian choke price is

$$p_1{}^* = ap_2 \exp(u - b) \qquad \text{(A2)}$$

use value component of (A5), based on the definition in
is the increase in use value (area under the Hicksian
and curve) created by a change from R_m to R_2. Since use
e is zero at R_m (because x_1 is zero at R_m), this change in
value is simply the area under the Hicksian demand curve
$_2$:

$$\begin{aligned} U &= C(p_1^*, p_2, R_2, u) - C(p, R_2, u) \\ &= p_2 \exp(u - b(R_2)) \\ &\quad - \frac{p_1}{a(R_2)}\left[u - b(R_2) + 1 - \ln\left(\frac{p_1}{a(R_2)p_2}\right)\right] \end{aligned} \qquad (A7)$$

ressions (A7) and (A6) add up to total value, as given in
, so that in principal at least, the case where the resource
sential causes no difficulty in the decomposition of total
e into use and existence value.

his discussion of decomposing use and existence value for
source change has been based on the fact that when $R =$
purchases of x_1 bring no utility and hence any positive
l of x_1 is a waste of money. What about the case where R_m
ices x_1 to zero by a technical link, and not through the
ty function? We will get the same answer as we have
ve. With $R \le R_m$, the expenditure function is independent
$_1$, and the welfare analysis of changes in R measures exis-
e value only. When the change is from R_1 to R_2, where
$< R_m < R_2$ (case 2), we can proceed as we have in the
nple above.

Ve can summarize this result with another example. Sup-
e that R is the depth of water in a lake in feet. Let x_1 be
nming and $R_m = 3$; i.e., when the depth is less than 3 feet,
nming is impossible. Existence value is attached to R be-
se greater R means greater biological diversity. A change
R from 2 to 4 feet can be decomposed as follows. We have
existence value of the change from 2 to 3 feet. We have
stence and use value from 3 to 4 feet.

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Valuing Wildlife in Benefit-Cost Analyses: A Case Study Involving Endangered Species

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The focus of the research presented in this paper is to ask what types of values are relevant in the valuation of wildlife species for benefit-cost analyses of projects that may affect wildlife or its habitat. First, the components of value for wildlife resources are discussed, with emphasis on those particularly relevant to the valuation of endangered species. A simple model is then proposed and results from an application to valuing two of Wisconsin's endangered species of wildlife are presented. The empirical results indicate that significant values may be associated with endangered species of wildlife above and beyond those that arise from viewing these species in the wild. We conclude that to overlook values for wildlife species that go beyond common use values may result in a misleading project or policy decision.

Introduction

A major issue in environmental benefit-cost analysis is how to conceptualize and estimate the total value of wildlife resources in a consistent and usable manner. This issue is particularly relevant for benefit-cost analyses relating to water resource projects. Such projects often have direct or indirect effects on wildlife. For example, some types of water resource projects affect fishery resources. Other types of wildlife, such as waterfowl and nongame birds, can be affected because water resources constitute a critical portion of their habitats. However, both theoretical and empirical problems confound the monetary valuation of such effects.

Benefit-cost theorists are tending to agree that natural resource values, including wildlife values, can be roughly grouped under the general headings of "use" and "intrinsic" values [*Desvousges et al.*, 1983; *Fisher and Raucher*, 1984]. Use values are associated with the current uses of a resource. Intrinsic values comprise a catch-all category of values that are not associated with current use. However, considerable confusion still exists regarding the exact theoretical distinctions between these categories and the relationships among their components. In addition, the components of the intrinsic value category have not always been clearly defined in a way that is internally consistent.

Partly because of these conceptual problems, empirical research on wildlife values has often focused only on consumptive uses such as hunting and fishing. Nonconsumptive uses like viewing wildlife are rarely studied, and values associated with the pure existence of wildlife resources have been almost completely ignored. (Notable exceptions to this statement are the recent studies by *Brookshire et al.* [1983] and *Stoll and Johnson* [1984].) A classic example of the latter issue is the case of the snail darter and the Tellico Project. Proponents of the Dam asked whether this relatively obscure fish, for which there was no current known use, was worth preserving. The existence value argument would imply that some people in the current generation may place a positive monetary value on the preservation of the snail darter even though they never plan on having any personal use for it. Still, questions remain about whether people do hold such existence values and how these values can be quantified.

The objectives of the research reported in this paper were to develop a conceptual framework for examining the total value of a wildlife resource and to use this framework to estimate the values that Wisconsin residents place on the preservation of two of Wisconsin's endangered species of wildlife, the bald eagle and the striped shiner. Although the bald eagle is classified as an endangered species in Wisconsin, its status has been upgraded to a threatened species at the federal level. The striped shiner is a minnow whose primary habitat is in sections of the Milwaukee River and it is not classified as a federally threatened or endangered species. While the survival of these species in Wisconsin does not appear to be affected by an impending development project, they do provide an opportunity to examine some of the types of wildlife values that are relevant to benefit-cost calculations for water resources projects.

This paper is organized in the following manner. A conceptualization of the components of the total value of a wildlife resource is briefly discussed in the following section. A theoretical model of total value, with the valuation of bald eagles as a case example, is presented in the third section. The estimation of values is discussed in the fourth section. Actual value estimates are presented in the penultimate section and the final section contains some concluding comments.

The Problem Setting

Early valuation studies focused on the use benefits associated with environmental assets. However, only a subset of use values were actually considered for empirical valuation. This was especially true in regard to the valuation of wildlife resources [*Brown and Nawas*, 1973; *Davis*, 1964; *Gum and Martin*, 1975]. Only "consumptive use values" such as those associated with hunting and fishing were typically estimated. These so-called consumptive use values comprise an impor-

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