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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 seotion. 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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tant component of many valuation studies. However, it is necessary to look beyond this type of value if one is to fully consider the total value of a wildlife species. This is particularly true for studies examining endangered species of wildlife, since current consumptive uses do not exist. Thus before developing a formal model of total value, it will be helpful to examine the various types of values an individual might hold for a species of wildlife.

We will argue that there are three basic groupings of use values. The first, consumptive use value, arise from the consumptive use of a wildlife resource; i.e., the animal is extracted from its habitat via hunting, fishing, or trapping. Going beyond this traditional concept of value, a second type of use value arises when an individual comes in contact with wildlife in its natural habitat, but the animals are not taken from the wild. For example, people visit National Parks and wildlife sanctuaries with the intent of viewing wildlife. Bird watching is also an activity that many people enjoy. Some people in the Northwest may go out to watch the salmon runs, even if they never plan to fish for salmon. We will refer to this second category of use value as "nonconsumptive use value." The third type of use is not associated with direct contact with wildlife. Many people never come in contact with wildlife in its natural habitat, but they do derive satisfaction from it. Among other activities, they enjoy reading about wildlife, viewing pictures of wildlife, watching television specials about wildlife, and visiting zoos. Another form of indirect consumption arises from some types of wildlife research, e.g., research on birds that signaled rapid accumulations of pesticides. We will refer to values that arise from indirect contact with a wildlife resource as "indirect use values." In contrast, we will sometimes refer to consumptive and nonconsumptive use values, together, as "direct use values."

Turning to intrinsic values, we shall distinguish two different types of values, "existence values" and "option values." Existence values were first suggested by *Krutilla* [1967], who reasoned that people may value an environmental asset even though they are sure that they will never personally use the resource in question. Several authors have argued or assumed that the basis for existence value is altruism [*Boyle*, 1985; *McConnell*, 1983; *Randall and Stoll*, 1983]. For example, a person may hold existence values because of a desire to bequeath a wildlife resource to future generations, out of a desire to be benevolent to friends and relatives who are users, from a feeling of sympathy for animals themselves, or other motivations of an altruistic nature. V. K. Smith (unpublished manuscript, 1985), on the other hand, has suggested that altruism may not be the only motivation for existence values and appears to include indirect use as an additional motivation. We would argue that the term existence value should be restricted to nonuse values that arise solely from altruistic motives including bequest motives.

Option values, first introduced by *Weisbrod* [1964], have subsequently been refined and clarified [*Bishop*, 1982; *Freeman*, 1982, 1985; *Graham*, 1981; *Schmalensee*, 1972; *Smith*, 1983]. Option values arise when peopled are uncertain about the future. For example, an individual might be uncertain as to the future availability of a favored hunting or fishing opportunity. Alternatively, this person might have a variety of future activities to choose among, only one of which involves wildlife, and is currently uncertain as to which activity he or she will actually choose to participate in. In addition, future income levels or other economic parameters may be uncertain. Option values are an adjustment to resource values to reflect uncertainty. From a theoretical perspective, the sign of this adjustment is not clear: taking on positive or negative values. In our theoretical model of total value, uncertainty is ignored because the modeling of option values can be quite complex and developing our model to reflect various sources of uncertainty would not generate any substantial new insights.

Any given individual can hold more than one of the above values for a specific wildlife resource. Thus it is necessary to develop a formal theoretical model of individual preferences to examine the relationships among these component values and to determine how they fit together to define the total value an individual holds for the wildlife resource in question.

A SIMPLE MODEL OF TOTAL VALUE

In this section, we develope a model of total value which specifically incorporates nonconsumptive use, indirect use, and existence as arguments in an individual's choice set. Within this model we formally define each of the values discussed in the preceeding section, with the exception of option value, and examine how the components fit together to develop a formal definition of total value. We also define existence value using a precise definition of the existence argument in an individuals choice set.

The standard approach economists use to formalize individuals' preference structures is to define a "utility function" which expresses the satisfaction an individual would derive from the consumption of goods and services, and participating in various activities. A utility function is generally assumed to have several desirable properties such as being twice differentiable, quasi concave, etc. [see *Varian*, 1978]. Such utility functions are maximized subject to a budget constraint and other types of constraints on an individuals choices. This type of formal specification of a choice set facilitates the development of definitions of value, testing for internal consistency of concepts, analyzing incentives for choices, and developing empirically testable hypotheses.

Using the valuation of bald eagles as an example, the choice problem used to define values under conditions of certainty is

$$\max_{e_i z} U(e_1, e_2, Z, \gamma) \tag{1}$$

subject to

$$P_e e + P_z Z \leq Y \tag{2}$$

$$e_i \leq g_i(\gamma) \qquad \forall\ i \tag{3}$$

$$\gamma = \bar{\gamma} \tag{4}$$

$$e \geq 0 \tag{5}$$

$$Z \geq 0 \tag{6}$$

where $u(\ )$ is a utility function; e_1 is nonconsumptive use (viewing, photographing, etc.); e_2 is indirect use (reading about, watching TV specials on, etc.); Z is a vector of market goods and services; γ is the bald eagle population level (existence argument); and $\bar{\gamma}$ is the current population of bald eagles. There is no consumptive use argument due to the bald eagles designation as an endangered species. The symbols P_e and e are price and quantity vectors that reflect the two categories of use, P_z is a vector of market prices, and Y is annual income.

The constraint on the use arguments $[g_i(\ )]$ could take the form

$$e_i \leq g_i(\gamma) = [I_i(\gamma)]\ C \tag{7}$$

$$\begin{aligned} I_i(\gamma) &= 1 \qquad \text{if } \gamma \geq \alpha_i \\ I_i(\gamma) &= 0 \qquad \text{otherwise} \end{aligned} \tag{8}$$

where $I_i(\ )$ is an indicator function; C is an arbitrarily large constant; and α_i is a constant that varies across use arguments. If the population (γ) falls below α_i, there are insufficient eagles to support the ith category of use.

A specific individual may participate in any one, or combination of, the uses of bald eagles (e_1 and e_2) and may have existence motivations as well. All three are included for theoretical and expository purposes. That is, each of the wildlife related arguments may need to be specifically considered for a variety of reasons. First, each of these arguments may be quantified in a different unit of measurement and each may have a different set of parameters associated with it in an individuals utility function, and in their choice set in general. Alternatively, these arguments may have complementary or substitute relations among themselves, or with the other arguments in the utility function. An example of a complementary relationship may be that a fall in the price of viewing wildlife may lead a person to read more about wildlife and vice versa. Thus it is important to consider all of the various types of values an individual might hold for a species of wildlife simultaneously, rather than treating each of the components values as separate entities.

We will assume that the marginal utility of existence $(\partial U/\partial \gamma)$ is positive and is increasing at a decreasing rate as did *McConnell* [1983]. However, it is possible that the marginal utility of certain resources may be negative for some people, thereby leading to negative existence values. Consider the case of coyotes in the western United States. Some people may not like coyotes even though they will never come in contact with one. An increase in the population of coyotes may irk these people, thereby leading to a reduction in their level of utility. Alternatively, there may be people who have relatives who are ranchers that are adversely affected by coyotes. In this case, these people may be willing to pay a positive amount just to know that their relatives (the ranchers) will not be bothered by coyotes. In such cases, existence values would be negative.

In economic terms existence is a pure public good. This means that an individual must make his or her choices given the existing population of bald eagles. More specifically, the existence argument is not a choice variable in the individual's maximization problem. Modeling existence in this manner helps to distinguish existence values from the other types of values an individual might hold for a wildlife resource. This is due to the notion of weak complementarity [*Freeman*, 1979; *Mäler*, 1974]. Weak complementarity implies that people who do not demand a market good that is dependent on an environmental asset being valued will not be willing to pay any positive amount for the asset. There is no market good that is related to altruistic motivations so that methods of valuation that are based on weak complementarity cannot be used to measure existence values. Weak complementarity does apply to each of the use categories which implies that at an empirical level there is a strong distinction between the various types of use values and existence value.

The solution to the maximization problem specified in (1) thru (6) can be stated as

$$V(P_e, P_z, \bar{y}, Y) = U(e_1^*, e_2^*, Z^*, \bar{y}) = \bar{U} \tag{9}$$

where $V(\ )$ is an "indirect utility function" (defined in terms of the parameters of the maximization problem); an asterisk denotes the optimal level of a choice variable; and $\bar{U}$ is the reference level of utility. A definition of the total value for bald eagles can now be defined implicitly by

$$V(P_e, P_z, \bar{y}, Y - BETV) = V(P_e^m, P_z, 0, Y) \tag{10}$$

where the price vector P_e^m is a vector of prices that are high enough that both use categories are zero. In technical terms, $BETV$ is an "equivalent variation" measure of value. This is the maximum an individual would pay to avoid the extinction of bald eagles.

It will be assumed that "choke" prices exist that are high enough so that an individual would not participate in any of the various use activities. In general, $P_e^m \neq [P_{e_1}^m, P_{e_2}^m]$. That is, the choke price which forces any single use demand to be zero depends on the status quo of the other use price due to the potential for substitute and complementary relations. As a consequence, the choke prices that force both categories of use to be zero simultaneously are generally not the same as those which separately force each category of use to be zero. In addition, there is no reason to expect that the vector of prices P_e^m is unique.

The total use value of bald eagles is defined as follows:

$$V(P_e, P_z, \bar{y}, Y - BETUV) = V(P_e^m, P_z, \bar{y}, Y) \tag{11}$$

Likewise, the component use values can be defined for the present model:

$$V(P_e, P_z, \bar{y}, Y - BENUV) = V(P_{e_1}^m, P_{e_2}, P_z, \bar{y}, Y) \tag{12}$$

$$V(P_e, P_z, \bar{y}, Y - BEIUV) = V(P_{e_1}, P_{e_2}^m, P_z, \bar{y}, Y) \tag{13}$$

Nonconsumptive use value is $BENUV$ and indirect use value is $BEIUV$; both are equivalent variation measures of value. There is no a priori reason to believe that the sum of the component use values is equal to total use value. More precisely, complementary or substitutionary relationships between uses implies that $BETUV$ may be different from the sum of $BENUV$ and $BEIUV$.

Total existence value is not easily defined when a person is both a user of a resource and also has existence motivations. This problem can be portrayed in the context of the current example. That is, when constraint (3) is binding the following condition holds:

$$\frac{dU}{d\gamma} = \sum_{i=1}^{2} \frac{\partial U}{\partial e_i} \frac{\partial e_i}{\partial \gamma} + \frac{\partial U}{\partial \gamma} \tag{14}$$

It appears that this result holds, regardless of the manner in which existence motivations are modeled as it is impossible to use a resource when it does not exist. Thus driving the population of a species to zero is tantamount to forcing the prices for the various types of uses to infinity.

The above result is not a severe limitation if a researcher only desires to measure marginal changes in existence values or total value as may be the case for applied policy research. An alternative, to test for the presence of existence values, is to measure a conditional existence value. This value is defined implicitly by

$$V(P_e^m, P_z, \bar{y}, Y - BEEV_{e=0}) = V(P_e^m, P_z, 0, Y) \tag{15}$$

where prices are such that all categories of use are zero. This conditional existence value is an equivalent value definition indicating the maximum an individual would pay to secure the preservation of bald eagles even if there was not an opportunity for any type of use.

It is important to understand that the valuation question is even more complicated than presented here. Each of the three components of value have various features. Nonconsumptive use may involve going out with the intent of viewing bald eagles or incidentally seeing a bald eagle while driving or hiking. We have already discussed the various types of indirect use and the altruistic motivations for existence values. Thus for empirical applications it may be necessary to consider more refined definitions of the components of value. However, these three crude groupings of value components are used to represent the complexity of the valuation question. In addition, unless there is empirical justification to conclude that all consumers do participate in nonconsumptive and indirect uses and do not not have altruistic motives, only valuing consumptive uses of a wildlife resource will, in general, result in an underestimate of total value.

Finally, the model presented here was developed under conditions of certainty. There are, however, many potential sources of uncertainty, each of which could give rise to option values. For any single source, or multiple sources, of uncertainty the above model can be appropriately modified giving rise to specific definitions of option value.

Empirical Implications

The theoretical model of total value has important implications for the empirical valuation of wildlife resources. It should be recognized at the outset that wildlife valuation is usually hampered by a lack of market data. Nevertheless, over the past 30 years, economists have developed an impressive arsenal for valuing nonmarketed environmental assets, including wildlife. These methods are surveyed by *Freeman* [1979] and *Anderson and Bishop* [1986]. The method of special interest here is contingent valuation. Contingent valuation employs survey research to ask people about the values they would place on a nonmarket resource if a market or other means of payment were created. All transactions are purely hypothetical. For some categories of value, particularly direct use values, other valuation techniques may be used. For example, the travel cost method uses travel costs and other expenditures as proxies for market prices and has been widely applied to estimate hunting and fishing values.

The choice of a valuation method is predicated to some extent on a prior decision of whether the components of value should be estimated separately and then aggregated to obtain a measure of total value or whether total value is to be estimated directly. That is, the more emphasis there is on measuring total values in general, and intrinsic values in particular, the more dependent the researcher is on contingent valuation.

From the perspective of an analyst who is striving to incorporate wildlife values in a benefit-cost study, the desired "end result" is total value. In calculating the present value of benefits or costs, it matters little whether a dollar is an existence value or a nonconsumptive use value or, for that matter, whether it is associated with any of the specific components of total value. The analyst's main concern is the accuracy of the value estimates being used.

Research to investigate the accuracy of wildlife values, in contrast, may benefit from the measurement of specific components. Separate estimates of the components can facilitate the testing of hypotheses regarding the relative magnitude of the various components. For example, where existence values can be isolated, their relationships to other components of value and their relationships to altruistic motives can be investigated. In addition, from a practical perspective, if indirect use, existence, and option values can be shown to be insignificant, they can be ignored in empirical valuation studies. This will simplify the tasks of benefit-cost practioners and will allow them more leeway in the choice of a valuation method. On the other hand, if these more esoteric values turn out to be substantial, they they will have to be explicitly incorporated in the empirical valuation framework to avoid serious errors in the valuation of wildlife resources and contingent valuation will have to be used extensively.

Given that it may be desirable to estimate the components of value separately for validation research, we would argue that the measurement of total value should be the starting point for this type of research. The alternative of estimating the components separately presents some serious problems. First, the taxonomic distinctions used to formulate theories of total value help to organize a researchers thoughts and to rigorously test for gaps and inconsistencies in the development formal models, but it would be a mistake to assume that all of the theoretical distinctions are clear in the minds of real people. For example, difficulties may arise when people are asked, in a contingent-valuation exercise, to state their direct use values, indirect use values, and intrinsic values in an internally consistent way. It seems more promising, to us, to ask people first about their total values and then about the components.

Building analyses of value on expressions of total value also avoids some potential problems highlighted by our theoretical model. One clear conclusion from theory is that even if it is possible to estimate each of the components separately, the resulting estimates generally are not additive. That is, the potential exists for both complementary and substitutionary relationships in demand among the wildlife arguments in an individuals' utility function, and a pure existence value may not be definable for individuals who are users of a wildlife resource and also have existence motivations. These theoretical concerns emphasize the importance of building analyses of value or expressions of total value and then working backward to test hypotheses about the various components.

Admittedly, the estimation of total values directly has the disadvantage of requiring total reliance on the contingent-valuation method to elicit values. A long debate has centered on the validity of the value estimates derived from contingent-valuation studies [*Cummings et al.*, 1986]. Recent validation research has been encouraging. For willingness-to-pay measures of value, contingent valuation has been shown to perform fairly well in field and laboratory experiments [*Coursey et al.*, 1984; *Heberlein and Bishop*, 1985; *Welsh*, 1986]. However, it must be hastily added that all of these experiments involved direct use values. Only further research will determine if these favorable results can be generalized to indirect use and intrinsic values. In the meantime, contingent valuation is the only procedure capable of measuring these other components. As a result, the application of contingent valuation to the measurement total values is consistent with the current state of the art for valuing nonmarketed environmental assets.

For all of these reasons, we believe that valuation studies, whether focused on a research agenda or a practical policy application, should use contingent-valuation estimates of total value as a basis to develop appropriate and useful analyses. Given this conclusion, our analysis of bald eagle and striped shiner values, reported in the following section, started with estimates of total value.

RESULTS FROM AN APPLICATION

We used the contingent-valuation method to estimate the value Wisconsin taxpayers place on the preservation the bald eagle and the striped shiner in Wisconsin. These two species are interesting case examples because the bald eagle represents a well-known species with potentially large nonconsumptive and indirect use values, while the striped shiner represents a relatively obscure species that does not have any type of use associated with it in Wisconsin. As was previously noted, much of the empirical work on the valuation of wildlife resources has focused on consumptive uses such as hunting and fishing for fairly well-known species. This type of narrow valuation framework would overlook the monetary values that members of society might place on the preservation of endangered species. In addition, most endangered species of wildlife are relatively obscure like the striped shiner. Thus the objective of our study was to test whether there are significant values that are not derived from direct contact with these wildlife resources. To facilitate this test, three types of values were estimated: a total value for bald eagles $BETV$, a conditional total value for bald eagles $BETV_{e_1=0}$, and a total value for striped shiners $SSEV$.

The values to be estimated can be defined in a manner similar to the definitions developed in the fourth section. The definitions are

$$V(P_e, P_x, \bar{y}, \bar{\rho}, Y - BETV) = V(P_e^m, P_x, 0, \bar{\rho}, Y) \quad (16)$$

$$V(P_{e_1}^m, P_{e_2}, P_x, \bar{y}, \bar{\rho}, Y - BETV_{e_1=0}) = V(P_e^m, P_x, 0, \bar{\rho}, Y) \quad (17)$$

$$V(P_e, P_x, \bar{y}, \bar{\rho}, Y - SSEV) = V(P_e, P_x, \bar{y}, 0, Y) \quad (18)$$

where $\bar{\rho}$ is the current population of striped shiners, and all other arguments are as previously defined. The distinction between $BETV$ and $BETV_{e_1=0}$ is that the former is a total value for bald eagles given the current population of eagles, while the latter is the total value individuals would place on the existing population of bald eagles if nonconsumptive use became too expensive to be feasible. Since there is not any current or anticipated use associated with striped shiners in Wisconsin, their total value is a pure existence value.

Survey Procedures

The contingent valuation questions for the present study were included in a mail survey conducted by the Wisconsin Department of Natural Resources (DNR). The purpose of the DNR's survey was to determine why Wisconsin residents do or do not contribute to the State's Endangered Resources Donation (ERD) program. Questionnaires were mailed to samples of individuals from two mutually exclusive groups of Wisconsin taxpapers: (1) contributors to the ERD program in 1984 and (2) noncontributors to the ERD program in 1984. Thus any individual who paid taxes in Wisconsin for 1984 was eligible for selection in the sample.

One half of the individuals in each of the two samples were asked a bald eagle total value question ($BETV$) and the other half were asked a conditional bald eagle total value question ($BETV_{e_1=0}$). All respondents were administered the striped shiner total value question. Given the finding of *Randall et al.* [1981] that contingent values for an item may vary depending on the placement of the respective valuation question in the valuation process, it would have been desirable to alternate the order of the valuation questions in the questionnaires. This was not possible due to certain research limitations. In turn, the valuation question for striped shiners was preceded by a valuation question for bald eagles in all questionnaires.

The payment vehicle for eliciting these valuation responses was a memership to a private foundation that would conduct the necessary activities to preserve the species in question in the State. This is similar to the payment vehicle used by *Stoll and Johnson* [1984] in their study of whooping cranes at the Aransas National Wildlife Refuge in Texas.

The dichotomous-choice technique of contingent valuation, which has been used in several contingent-valuation studies, was used to elicit values [*Bishop et al.*, 1983; *Boyle and Bishop*, 1984; *Sellar et al.*, 1985; *Welsh*, 1986]. Respondents were asked to accept or reject fixed membership fees to join the foundation. Offers were even dollar amounts that were randomly selected within fixed intervals on the range \$1 to \$100. The following excerpt from the questionnaire is an example of the valuation question used to elicit bald eagle total values from contributors and noncontributors.

> We would like you to *pretend* that *all funding* to preserve bald eagles in Wisconsin is *terminated. Assume* that without funding, there will not be an organized effort to preserve bald eagles in Wisconsin and bald eagles will become *extinct* in our *state.* Suppose that an independent private foundation is formed to preserve bald eagles in Wisconsin and to prevent the possibility of extinction. The activities of the foundation will include maintaining and restoring bald eagle habitats. Please assume that the foundation *will be able* to save the bald eagle.
>
> *Pretend* that the foundation is to be funded by selling supporting memberships. All members will be provided with information, at no cost, on how to conveniently view bald eagles in Wisconsin. Members who do not wish to view eagles will have the satisfaction of knowing that they helped preserve the bald eagle in Wisconsin. These people may have various reasons for wanting to preserve bald eagles. Some of these reasons might be: a gift to future generations, a sense of responsibility for the environment, sympathy for animals, and generosity towards friends and relatives.
>
> If a supporting membership cost \$ *per year*, would you become a member and help to make sure that bald eagles will not become extinct in Wisconsin? annual
>
> ____ yes—I would become a supporting member at this amount.
>
> ____ no—I would not become a supporting member at this amount.

The blank in the valuation question is where the randomly selected memership fee was entered. Responses to this question formed the basis for estimating the bald eagle total values $BETV$. Similar questions were used to elicit the conditional bald eagle total values $BETV_{e_1=0}$ and the striped shiner values $SSEV$. For example, for $BETV_{e_1=0}$ we asked respondents to assume that the foundation would be able to maintain bald eagles in Wisconsin, but that the birds habitat would be in remote parts of the State where viewing was not possible.

Survey Results

A total of 1000 questionnaires were mailed to individuals in the samples. Five hundred questionnaires were mailed to contributors to the ERD program and an additional 500 were mailed to noncontributors. The overall response rate was 81%. The within group response rates were 89% for contributors and 73% for noncontributors.

Value Estimates

A dichotomous-choice estimate of value is derived by analyzing respondents "yes" and "no" answered to the dollar offers in the valuation question and socioeconomic characteristics of respondents. This is done by estimating a logit function which describes the relationship beteen respondents answers to the valuation question and variables that explain respondents answers, such as the dollar offer in the valuation question. The general form of the logit model for the present study is

$$Pr(\text{YES}) = [1 + \exp(-\beta X)]^{-1} \quad (19)$$

where Pr(YES) is the probability of a yes response to the valuation question; β is a vector of parameters; and X is a vector of variables that includes the membership fee. It should be noted that $[1 - Pr(\text{YES})]$ is a cumulative distribution function. Thus the estimated logit equation can be used to calculate the mathematical expectation of the value that respondents place on the item being valued.

Hanemann [1984] has shown that the functional specification of the βX term in (19) can be derived from utility theory. In this context, each of the three values defined in (16) through (18) would lead to a slightly different specification of the βX term. Following Hanemann, the βX term associated with each of these three values can be derived by specifying a functional form for the indirect utility function, replacing the true value in each equation with a selected membership fee, and taking the difference between the left-hand side and right-hand side of each equation. This type of utility consistent specification was not possible for the present study because it was impossible to collect data on the implicit bald eagle price vectors (P_e and P_e^m) and the DNR chose not to ask respondents to report their incomes on the questionnaires. One might also specify an indirect utility function which is conditional on various socioeconomic characteristics of respondents, and these terms would show up in the exponent of the logit equation. In our preliminary statistical analysis none of these characteristics produced significant coefficients in the logit equations.

The specification of the βX term in (19) took the following form:

$$\beta X = \beta_0 - \beta_1 \ln(MF) \quad (20)$$

where the β_i are parameters, and MF is the membership fee from the valuation question. Although this specification is not consistent with utility theory, empirical applications have shown that specifications like equation (20) may provide the best statistical fit to the data [*Bishop et al.*, 1983; *Boyle and Bishop*, 1984]. This conclusion seems to be supported in the present study in that the specification of the βX term in (20) fit the data better than a linear in the variables specification that is consistent with a linear specification of the indirect utility function; i.e., the income argument cancels out when the two utility levels are differenced. A specification of the indirect utility function that is linear in its arguments would result in the income argument cancelling out when the two utility levels are differenced to derive the βX term in (19). Thus this type of specification was possible even though the DNR did not ask respondents to report their income in the survey.

TABLE 1. Estimated Logit Coefficients

Equation	β_0	β_1	χ^2 Statistic	N
Contributors				
(1) *BETV*, viewer	2.054* (0.795)	−0.641* (0.233)	9.118†	99
(2) *BETV*, nonviewer	2.988* (0.810)	−1.149* (0.256)	28.821†	123
(3) $BETV_{e_1=0}$, viewer	4.060* (1.260)	−1.297* (0.359)	21.939†	86
(4) $BETV_{e_1=0}$, nonviewer	2.532* (0.741)	−0.885* (0.216)	21.146†	130
(5) *SSEV*		−0.613* (0.049)	245.360†	435
Noncontributors				
(6) *BETV*, viewer	1.257 (1.082)	−0.511 (0.338)	2.503	35
(7) *BETV*, nonviewer	2.153* (0.700)	−1.150* (0.234)	33.351†	147
(8) $BETV_{e_1=0}$, viewer	6.699* (2.599)	−2.161* (0.755)	16.994†	43
(9) $BETV_{e_1=0}$, nonviewer	1.500‡ (0.785)	−0.942* (0.254)	15.210†	133
(10) *SSEV*		−0.833* (0.073)	274.540†	355

Numbers in parentheses are asymptotic standard errors.
*Significance at the 1% level.
†Significance at the 1% level.
‡Significance at the 10% level.

It is a common practice to examine contingent-valuation data sets for valuation responses that are deemed to be outliers, and zero bids are also evaluated to determine whether respondents truly place a zero value on the item in question. These evaluations have been typically applied to data sets where the valuation responses are continuous, rather than qualitative as with responses to dichotomous-choice questions. For the current study, we asked respondents who answered no to the valuation questions why they said no. However, we chose not to remove any of the "no respondents" from the data set based on their responses to these questions. Thus the equations, reported here, were estimated using the data from all respondents who answered the valuation questions. Only four respondents refused to answer the bald eagle total valuation question and four different respondents did not answer the bald eagle conditional total value question. Fourteen respondents did not answer the striped shiner total valuation question.

The estimated logit equations are presented in Table 1. Note that separate logit equations were estimated for each type of value and for four different groups of respondents. The bald eagle equations in Table 1 are classified as to whether respondents were viewers or nonviewers of eagles. This split was made on the basis of whether respondents reported, as part of their survey responses, having ever made a trip where one of their intentions was to view bald eagles. All of the coefficients (β_i's) in Table 1, except those for (6), are statistically significant. The problem with (6) may be due, at last in part, to the small sample size for this subgroup of respondents.

TABLE 2. Estimated Values for the Bald Eagle and the Striped Shiner in Wisconsin

Type of Value	Contributors Mean	Contributors Median	Noncontributors Mean	Noncontributors Median
BETV, viewer	75.31	24.63		
BETV, nonviewer	18.02	13.47	11.84	6.50
$BETV_{e_1=0}$, viewer	28.38	22.88	25.97	22.20
$BETV_{e_1=0}$, nonviewer	30.78	17.46	10.62	4.92
SSEV	5.66	1.00	4.16	1.00

Values are given in dollars.

The β_0 coefficients were not significant in (5) and (10). Thus equations were estimated for the striped shiner that do not include a constant term. This type of specification, without a constant term in the exponent, implies that the median response is $1.

The expected values derived from the estimated logit functions are presented in Table 2. These are annual values for Wisconsin taxpayers and they show some obvious patterns when one looks across the rows and down the columns. A *BETV* value is not reported for noncontributors who are viewers because of the insignificance of (6) in Table 1. The values reported here are computed by truncating the range of integration of the estimated logit models. This is a procedure that has been used in several contingent valuation studies to cope with the large tails that can occur with estimated logit models [*Bishop et al.*, 1983; *Boyle and Bishop*, 1984; *Sellar et al.*, 1985]. A simple rule of thumb, discussed by *Boyle and Bishop* [1984], was used to choose the point of truncation. This is, the range of integration was truncated at the 90th percentile or the highest offer in the sample ($100) here, whichever was larger. The truncated models were normalized so that the areas under the probability density function equaled one.

We hypothesized that *BETV* would equal $BETV_{e_1=0}$ for nonviewers. This null hypothesis could not be rejected at a 90% level of confidence for either contributors or noncontributors. The intuition behind this hypothesis is straightforward. Since the data for this study is from a stratified random sample, nonviewers' valuation responses should not have varied with question format as the only difference in the two valuation questions dealt with the opportunity to view eagles in the wild. On the other hand, if there are significant values associated with viewing bald eagles, then *BETV* would be significantly larger than $BETV_{e_1=0}$ for viewers. The null hypothesis that these two values are equal could be rejected for contributors. This test was not performed for noncontributors because of the small sample size for this group of respondents.

We also expanded the estimated values, as is often done in valuation studies, to obtain aggregate estimates of value for the population of Wisconsin taxpayers. Aggregate total values for bald eagles and striped shiners are reported in Table 3. At first glance these numbers may appear to be amazingly large, but once they are put into perspective, the magnitudes seem quite plausible. Considering that there are about 3 million taxpayers in Wisconsin, an average willingness to pay of just a few dollars per person will add up to a sizeable total. In addition, a substantial aggregate willingness to pay for bald eagles is reasonable due to the symbolism that is associated

TABLE 3. Aggregate Value Estimates for All Wisconsin Taxpayers ($1,000)

Type of Value	Contributor	Noncontributor
BETV, viewer	1,486.5	
BETV, nonviewer	487.2	26,179.1
SSEV	264.7	11,762.2

with these birds. In turn, these results are indicative that members of the current generations of Wisconsin taxpayers do place a significant aggregate monetary value on the preservation of two of the State's endangered species of wildlife.

CONCLUDING COMMENTS

Can values, such as the estimates presented in this paper, be taken as clear evidence that values for endangered species of wildlife, other than those arising from nonconsumptive use, are positive? At a conceptual level, altruistic motives leading to positive utility from the existence of a wildlife resource are quite compatible with economoic theory. Furthermore, the reported valuation results for both a well-known and an obscure species indicate a substantial willingness to pay that is not associated with direct contact. Still, caution is warranted. More research is needed to determine whether contingent valuation can provide accurate estimates of total values and components such as existence values.

All the same, the estimated values reported here do seem plausible when they are considered in the appropraite context. The bald eagle is our national symbol and it is also an aesthetically pleasing species to view. In addition, Wisconsin recently initiated a fund raising program entitled "Adopt an Eagle Nest." The essence of this program is that for $100 an individual or group can adopt an eagle nest for one year. The $100 contribution is used to identify nests, protect and manage the birds and their habitat, conduct research on bald eagles, and provide participants with some basic information about the nest which they adopted. That is participants are told that their $100 contribution will be used to (1) locate the nests by surveying from an airplane; (2) check on the eaglets to see how many eggs hatched and how the young birds are doing; (3) rescue and rehabilitate any eaglets which are injured or orphaned; (4) test any unhatched eggs to determine why they didn't hatch; (5) put numbered bands on the youngster's legs to help identify the birds if they are trapped, injured or killed, and to learn more about their populations and migration patterns; (6) and work with landowners to properly protect and manage nest trees. In addition, participants will receive (1) a package containing an adoption certificate stating that you or your group adopted an eagle nest, a copy of the booklet "Wisconsin's Birds of Prey," and information on Wisconsin's bald eagles; (2) a status report of what happened with your nest, and a general report on the eagle management program; and (3) a photograph of young eagles in a nest.

In 1985, the first year of the program, there were 103 nests adopted for a total contribution of $10,300. The number of contributors has grown to 217 in 1986 with contributions totaling $21,700. These results, given limited advertising of the program, indicate that some Wisconsin residents really are willing to contribute money to save bald eagles in Wisconsin. In addition, none of the participants in this program are told the location of the nest they adopt so there is no direct opportunity for nonconsumptive use (viewing) associated with these contributions, although a larger bald eagle population may provide more general opportunities for viewing eagles in Wisconsin.

For the striped shiner, a relatively obscure species, the average value is only about $4.00, a very small amount for an average taxpayer to spend. Also note that our results indicate that half of Wisconsin's taxpayers place a value of less than $1.00 on the striped shiners. Thus there is no implication that all or even a majority of citizens have a large willingness to pay. On the other hand, one need only consider the celebrated case of the snail darter versus the Tellico Dam to realize that some people do care about these more obscure species.

Finally, this paper has some important implications for analysts who conduct benefit-cost analyses of water resource projects. Any benefit-cost analysis of a project that affects wildlife should, at least at a conceptual level, explicitly allow for all of the types of values individuals might place on the wildlife resources in question. This is true regardless of whether the affected species are endangered or not. That is, the values that arise from nonconsumptive use or existence motivations, as well as the other components discussed in the preceeding sections, may apply to nonendangered species as well. At an empirical level, these types of benefit-cost analyses should be focused on obtaining the best estimate of value associated with the resulting change in the status of a wildlife species.

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