(revised 7/26/85)

# THE TOTAL VALUE OF WILDLIFE: A CASE STUDY INVOLVING ENDANGERED SPECIES*

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* Selected paper, joint meetings of the American Agricultural Economics Association and the Association of Environmental and Resource Economists, Iowa State University, August 4-7, 1985. Kevin Boyle is a Research Assistant and Richard Bishop is a Professor of Agricultural Economics, University of Wisconsin-Madison. This research was supported by the College of Agriculture and Life Sciences, University of Wisconsin-Madison; the Rocky Mountain Forest and Range Experiment Station, U.S. Forest Service; and the Bureau of Research, Wisconsin Department of Natural Resources. This paper is an abridged version of a more extensive report on this research, a copy of which can be obtained from the authors.

# ABSTRACT

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The components of value for a wildlife resource are discussed, with emphasis on existence value. A simple model is proposed and preliminary results of an application to valuing endangered species of wildlife are presented. The empirical results indicate that significant nonuse values may be associated with endangered species of wildlife.

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## I. INTRODUCTION

A major issue in environmental cost-benefit analysis is how to conceptualize and estimate the total value of wildlife resources in a consistent and usable manner. This is especially true with cost-benefit calculations for many water resource projects which often have a direct or an indirect effect on wildlife. For example, nearly all water resource projects will have some type of effect on fishery resources. Other types of wildlife, such as waterfowl and nongame birds, can be affected because they depend on water resources as a critical portion of their habitats.

Some practitioners seem to agree that natural resource values, including wildlife values, can be roughly grouped under the general headings of "use" and "intrinsic" values (see Desvousges, Smith and McGivney; and Fisher and Raucher). Use values are associated with the actual use of a resource. Intrinsic values comprise a catch-all category for nonuse values such as option values, existence benefits and bequest values. However, considerable confusion exists regarding the exact distinction between these categories. 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, the valuation of wildlife resources often focuses on consumptive uses such as hunting and fishing. Nonconsumptive uses like viewing wildlife are rarely studied and existence

values have been almost completely ignored.[1/] A classic example of the latter issue is the case of the snail darter and the Tellico Project (Davis 1979). An important consideration was 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 how such existence values fit into cost-benefit analyses and whether they 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 (bald eagles and striped shiners). 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 neither of these species would be affected by an impending development project, they do provide an excellent opportunity to examine the types of wildlife values that are relevant to cost-benefit calculations for water resources projects. These two species of wildlife are of interest here because bald eagles represent a well known species for which there is no consumptive use and striped shiners represent a relatively obscure species. That is, much of the empirical work on the valuation of wildlife resources has focused on uses such as hunting and

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[1/] Recent studies by Brookshire, Eubanks and Randall, Stoll and Johnson, and Walsh, Loomis and Gillman are exceptions to this statement.

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 and snail darter. Thus, values of particular interest are those which are not derived from direct contact with the wildlife species in question.

As was alluded in the preceding paragraph, bald eagles cannot be hunted and striped shiners cannot be fished in Wisconsin due to their status as endangered species. Yet, it would appear that some people derive satisfaction from seeing bald eagles soaring overhead and diving for fish. The striped shiner, in contrast, does not support any current or anticipated uses in Wisconsin. People may still feel that it is important to preserve this fish for various reasons such as a belief that genetic diversity is important, a feeling of responsibility toward the environment, or a desire to make a bequest to future generations. These types of motives give rise to economic values that are commonly referred to as existence values. Residents of Wisconsin may also be concerned with the preservation of bald eagles in the State, regardless of whether they will ever see one in the wild. These various types of concerns about wildlife motivate the values that were estimated as part of the research reported in this paper.

This paper is organized in the following manner. A conceptual framework for examining the total value of a wildlife resource is briefly discussed in the following section and will be followed by a short overview of existence value literature in the third section of this paper.[2/] A simple model of total value, with the valuation of bald eagles as a case example, is presented

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2/ For an extensive discussion of the conceptual framework and the existence value literature, see Boyle and Bishop (1985).

in the fourth section. Actual value estimates are presented in the following section and the final section contains a discussion of how the estimated values can be incorporated in cost-benefit calculations and subsequently used in policy applications.

## II. COMPONENTS OF TOTAL VALUE

Early cost-benefit analyses focused merely on the user benefits associated with environmental assets. Later theoretical analyses incorporated the concept of option value. First introduced by Weisbrod, the option value concept was subsequently refined and clarified (Bishop 1982; Freeman 1984 and 1985; Hanemann 1985; and Smith 1983 and 1984). Option value is an adjustment to the monetary measure of welfare to reflect the uncertainty consumers face when future states of the world are unknown. Recent developments indicate that option value may be either positive or negative. Thus, the traditional notion of the maximum that an individual would be willing to pay now to insure that an environmental asset will be available in the future is the sum of option value and the expected value of consumer surplus. This sum is option price.

While early cost-benefit analyses focused on use benefits, only a subset of such benefits were actually considered for empirical valuation. This was especially true in regard to the valuation of wildlife resources (Brown and Nawas; Gum and Martin; and Davis 1964). Only consumptive use values such as hunting and fishing were typically estimated. There are also nonconsumptive use values associated with wildlife. For example, people visit National Parks and wildlife sanctuaries with the intent of viewing wildlife. Bird watching

is also an activity that some people enjoy. Some people in the Northwest may go out to watch the salmon runs, even if they never plan to fish for salmon.

There is also a hazy area of use that 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.

These other uses may need to be specifically considered as they may be measured in different units than consumptive use or may have different per unit prices, and they may also have different parameters in individuals choice functions. These other uses may also have complementary or substitute relations to consumptive use.

As an outgrowth of the option value discussion, Krutilla suggested that people may value an environmental asset even though they are sure that they will never personally use the resource in question. This is in direct contrast to use values. Krutilla proposed two types of values that could arise under conditions where an individual's use demand for a resource is certain to be zero. The first is bequest value and is motivated by a desire to provide some of a resource for future generations. The second category is existence value and arises from the knowledge that a resource merely exists. That is, many people might be willing to pay some positive amount to know that a resource exists, even though they are sure that they will never personally use it. It is also conceivable that users and potential users of environmental assets may possess existence or bequest values. If this is the

case, the expected value of consumer surplus is not merely comprised of use values.

Notions of option price and option value can be developed with respect to each of the three use arguments (consumptive use, nonconsumptive use and indirect use). For example, uncertainty could arise with respect to the price corresponding to any one of the use arguments. Option price and option value concepts can also be developed with respect to the existence argument if for instance individuals are uncertain as to whether they have existence motivations for a resource or if the population level of the resource is uncertain. Thus, it is necessary to evaluate the source of the uncertainty. In turn, option value is not merely a concept related to the potential for consumptive use of a resource, but rather is the result of uncertainty wherever it occurs in the consumers choice problem.

## III. EXISTENCE VALUE

Recent theoretical discussions have treated bequests and pure existence as motivations for nonuse values and have referred to the entire category of nonuse values as existence value (Bishop and Heberlein; Fisher and Raucher; McConnell; and Randall). A recent empirical study attempted to differentiate between bequest values and pure existence values (Walsh, Loomis and Gillman).

Individuals who place a value on an environmental asset and are sure that they will never use this resource must be motivated by altruistic feelings.[3/] Bequest values reflect altruism toward future generations. The desire to know

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3/ Randall and Stoll have identified three types of altruism that could motivate existence values: interpersonal altruism, intergenerational altruism and Q-altruism.

that a natural environment merely exists reflects altruism towards nature. Several authors have argued or assumed that the basis for existence value is altruism (Boyle and Bishop 1985; McConnell; Randall; and Randall and Stoll). In contrast, Smith (1985) has suggested that altruism may not be the only motivation for existence values and includes indirect use as an additional motivation.

We would like to argue that the term existence value should be restricted to nonuse values that arise solely from altruistic motives. Thus, existence is a pure public good. Values that arise from indirect contact with a resource will be referred to as indirect use values. We advocate these definitions due to their intuitive and practical appeal. The names provide some insight into the characteristics of the categories. More importantly, there is a theoretical distinction that helps to clarify this definition of existence value. This is the notion of weak complementarity (Freeman 1979; and Mäler). Weak complementarity implies that people who do not demand a market good that is dependent on the environmental asset being valued will not be willing to pay any positive amount for the environment 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. As an alternative, the only tool available for estimating existence values is the contingent valuation method. Weak complementarity does apply to each of the use categories which implies that at a conceptual level these other components of value could be measured with one of the various indirect methods of valuation.

All of the preceding discussion has contained the implicit assumption that the marginal existence value of a resource is positive, as have other

authors (see McConnell). It is possible that for some people the marginal existence value of certain resources may be negative. Consider the case of parents who have children who enjoy back-country hiking in Glacier National Park. The parents may be willing to pay some positive amount to know that grizzly bears do not exist in the hiking area and pose a threat to their children.

## IV. A SIMPLE MODEL OF TOTAL VALUE

The model developed in this section specifically incorporates nonconsumptive use, indirect use and existence as arguments in an individual's utility function. This model is somewhat similar to a model developed by Smith (1985). Our model is different from Smith's in that we acknowledge more than one category of use, give a more precise definition of our existence argument and discuss an oversight in Smith's development of existence value. Using the valuation of bald eagles as an example, the choice problem is

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

$$\text{s.t.} \quad P_e e + P_z Z \leq Y \tag{2}$$

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

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

where $e_1$ is nonconsumptive use (viewing, photographing, etc.), $e_2$ is indirect (reading about, watching TV specials on, etc.), Z is a vector of market goods

and services, $\gamma$ is the bald eagle population level (existence argument) and $\bar{\gamma}$ is the current population of bald eagles.[4/] There is not a 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 and $P_z$ is a vector of market prices. The constraint on the use arguments $[g_i(\cdot)]$ could take the form

$$e_i \leq g_i(\gamma) = [I_i(\gamma)]\ C \tag{5}$$

and

$$I_i(\gamma) = \begin{cases} 1 \text{ if } \gamma \geq \alpha_i \\ 0 \text{ otherwise} \end{cases} \tag{6}$$

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

We will assume that the marginal utility of existence ($\gamma$) is positive and is increasing at a decreasing rate. Existence is treated as a pure public good. A specific individual may have any one, or combination of, these uses or may have existence motivations. All three are included for expository

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[4/] The important consideration is that people do derive satisfaction from bald eagles regardless of the units of measure. Thus, we are not overly concerned with the units in which the use arguments are measured in the present discussion. A similar approach was used by Schulze, Brookshire and Thayer to model existence motivations for visibility in National Parks. See Boyle and Bishop (1985) for a discussion of why the existence argument is modeled in this manner.

purposes. Consumptive use is not included as an argument since bald eagles are a nongame species.

The compensating variation definition of the total value (BETV) of bald eagles in this model is

$$V(P_e, P_z, \bar{Y}, Y\text{-BETV}) = V(P_e^m, P_z, 0, Y) \tag{7}$$

where $V(\cdot)$ is an indirect utility function and the price vector ($P_e^m$) is a vector of lowest possible prices that are high enough that both use categories are zero.[5/]

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

$$V(P_e, P_z, \bar{Y}, Y\text{-BETUV}) = V(P_e^m, P_z, \bar{Y}, Y). \tag{8}$$

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

$$V(P_e, P_z, \bar{Y}, Y\text{-BENUV}) = V(P_{e_1}^m, P_{e_2}, P_z, \bar{Y}, Y) \tag{9}$$

$$V(P_e, P_z, \bar{Y}, Y\text{-BEIUV}) = V(P_{e_1}, P_{e_2}^m, P_z, \bar{Y}, Y) \tag{10}$$

Nonconsumptive use value is BENUV and indirect use value is BEIUV; both are compensating 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.

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[5/] It is important to realize that the following condition generally holds:

$$P_e^m \neq [P_{e_1}^m, P_{e_2}^m].$$

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:

$$\frac{dU}{d\gamma} = \sum_{i=1}^{2} \frac{\partial U}{\partial e_i} \frac{\partial e_i}{\partial \gamma} + \frac{\partial U}{\partial \gamma} . \qquad (11)$$

As a result it is extremely difficult to determine pure existence value in this case. 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, an issue that Smith (1985) overlooked in his definition of existence value.

This is not a severe limitation if the researcher only desires to measure marginal changes in existence values or total value as may be the case for applied policy research. An alternative is to measure a conditional existence value. This value is

$$V(P_e^m, P_z, \bar{\gamma}, Y\text{-}BEEV_{e=0}) = V(P_e^m, P_z, 0, Y) \qquad (12)$$

where prices are such that all categories of use are zero. In Smith's (1985) model, existence value turns out to be merely total value minus total use value. This simple adding-up result does not hold for the current model due to the constraint specified in equation (3).

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 you are driving or hiking. We have already discussed the various types of indirect use and various types of altruism. 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 not have altruistic motives, only valuing consumptive uses of a wildlife resource will in general result in an underestimate of total value.

## V. PRELIMINARY RESULTS FROM AN APPLICATION

In a recent study we used the contingent valuation method to estimate the value of preserving two species of wildlife that are endangered in Wisconsin, bald eagles and striped shiners. The objective of this 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). Striped shiner total value is existence value as there is not any current or anticipated use associated with these fish in Wisconsin.

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

$$V(P_e, P_z, \bar{\gamma}, \bar{\rho}, Y\text{-BETV}) = V(P_e^m, P_z, 0, \bar{\rho}, Y) \tag{13}$$

$$V(P_{e_1}^m, P_{e_2}, P_z, \bar{\gamma}, \bar{\rho}, Y\text{-}BETV_{e_1=0}) = V(P_e^m, P_z, 0, \bar{\rho}, Y) \tag{14}$$

$$V(P_e, P_z, \bar{\gamma}, \bar{\rho}, Y\text{-}SSEV) = V(P_e, P_z, \bar{\gamma}, 0, Y) \qquad (15)$$

where $\bar{\rho}$ is the current population of striped shiners and all other arguments are as previously defined.

A. 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 subpopulations of Wisconsin taxpayers: (1) contributors to the ERD program in 1984, and (2) noncontributors to the ERD program in 1984.

One half of the individuals in each sample 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.[6/] The payment vehicle for eliciting these valuation responses was a membership to a private foundation that would conduct the necessary activities to preserve the species in question. This is similar to the payment vehicle used by Stoll and Johnson in their study of whooping cranes at the Aransas National Wildlife Refuge in Texas.

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6/ Given the finding of Randall, Hoehn and Tolley 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 striped shiner valuation question was preceded by a bald eagle valuation question in all questionnaires.

The dichotomous choice technique of contingent valuation, which has been used in several contingent valuation studies (Bishop, Heberlein and Kealy; Boyle and Bishop 1984; and Sellar, Chavas and Stoll), was used to elicit values. Respondents were asked to accept or reject fixed membership fees to the foundation to preserve the species in question. Offers were even dollar amounts that were randomly selected within fixed intervals on the range $1 to $100. The following excerpt is an example of the dichotomous choice valuation question that was 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?
>
> ___ 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 membership fee was entered. A similar type of question format was used to elicit the

conditional bald eagle total values ($BETV_{e_1=0}$) and the striped shiner values (SSEV).

B. SURVEY RESULTS

A total of 1,000 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 percent. The within group response rates were 89 percent for contributors and 73 percent for noncontributors.

C. VALUE ESTIMATES

A dichotomous choice estimate of value is derived by computing the area under an estimated logit function. Conceptually, this procedure is the equivalent of taking a weighted average. The general form of the logit model for the present study is

$$(1-\pi) = (1 + \exp(-\beta X))^{-1} \qquad (16)$$

where $(1-\pi)$ is the probability of a yes response to the membership fee question, $\beta$ is a vector of parameters and X is a vector of explanatory variables that includes the membership fee. It should be noted that $\pi$ is a cummulative distribution function.

Hanemann (1984) has shown that the functional specification of the $\beta X$ term in equation (16) can be derived from utility theory. In this context,