



THE EXISTENCE OF EXISTENCE VALUE — A STUDY OF THE ECONOMIC BENEFITS OF AN ENDANGERED SPECIES

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ABSTRACT

This paper offers a theoretical and empirical description of existence value in a wildlife valuation context. The first sections contain a theoretical inquiry into what existence value actually is, how it is defined in the literature, and by economic theory. Here we use the concept of a minimum viable population (MVP) to explore its relation to other non-use and use values. The empirical analysis is based on data from a contingent valuation survey undertaken to estimate the economic benefits of the white-backed woodpecker, a species classified as endangered in Sweden. Willingness to pay (WTP) is found to be positive for preserving the species, while the marginal value of an increased population density is zero or non-positive. In addition, a majority of the respondents also rank "all species have a right to exist" as their first priority among different reasons for preserving the woodpecker. These results are all regarded as evidence of an existence value.

Keywords: Contingent valuation, existence value, minimum viable population, non-use values, wildlife valuation.

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INTRODUCTION

When estimating the economic benefits of wildlife, non-use values are often considered to be a significant part of the total value (Freeman, 1993a and 1993b, Stevens, *et al.* 1991). The concept of a non-use value, sometimes referred to as existence value, was introduced by Krutilla (1967), and has since been a controversial issue in the literature on natural resource valuation. When Krutilla wrote "...There are many persons who obtain satisfaction from mere knowledge that part of wilderness North America remains even though they would be appalled by the prospect of being exposed to it..." he obviously excluded all sorts of use-values from the concept of existence value, leaving the mere "knowledge of the existence" to represent a satisfaction. However, Krutilla

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did not provide an exact definition of this value component, i.e. one that could be used in a resource valuation context. As a result, later economists have tried to couch this satisfaction in monetary terms, using a variety of definitions.

Some researchers equate existence value with all non-use values (Mitchell & Carson, 1989), while others limit the definition to the inherent value of the resource (Brookshire *et al.*, 1986). In the latter case, there must be other non-use values, besides the existence value. Non-use values motivated by, for example, various forms of altruism. Brookshire *et al.* also argue that defining all expressions of existence value as willingness to pay measures are not necessarily consistent with the normative basis of benefit-cost analysis. They define two components of existence value; an economic component consistent with utility maximizing behavior, and an ethical component inconsistent with normative benefit-cost assumptions. This ethical dimension is also emphasized by several researchers dealing with different aspects of environmental ethics, see for example Sagoff (1988) and Booth (1992). However, the Brookshire *et al.* argument has been criticized by Mitchell & Carson (1989) who contend that the contingent valuation (CV) method is also capable of measuring, what they call, "inherent components" of existence value.

In a forthcoming article by Cummings & Harrison they critically review some of the CV literature on non-use values. They identify several problems with the empirical estimations of non-use values that have been made to date, and also question whether such values are measurable and a significant component of the total value.¹

Nevertheless, several valuation studies regarding wildlife and, in particular, endangered species have found non-use values to be important components of the total value (Stoll & Johnson, 1984, Boyle & Bishop, 1987, and, Stevens *et al.*, 1991). Stevens *et al.* found that 79 per cent of the respondents to a survey, valuing Atlantic salmon in New England, agreed with the statement that "*All species of wildlife have a right to exist independent of any benefit or harm to*

¹ Note, however, that none of the studies examined involved endangered species.

people". Furthermore, 70 per cent of the respondents declared this as one of the three most important reasons for the existence of bald eagles, wild turkeys, and coyotes in New England.

This paper focuses on the use, non-use and existence values of wildlife, with special emphasis on the latter. In the next section we start with the total value and from there outline the different value components. We also adopt the notion of a minimum viable population (*MVP*) to demarcate existence value from other non-use values and use values. We then use the compensating and the equivalent variations to derive separate economic measures of the value components for proposed increases, and a proposed decrease, in the population density. Finally, empirical evidence of existence value is presented using data from a contingent valuation survey estimating the economic benefits of an endangered species in Sweden, the white-backed woodpecker.

EXISTENCE VALUE AND WILDLIFE

The total economic value a person, or household, places upon a natural resource can be divided into several different value components. Table 1 summarizes some of the most frequently used terminology found in the literature² (see for example Boyle & Bishop, 1986; Mitchell & Carson, 1989; Stoll & Johnson, 1984; Walsh *et al.*, 1984). One common way to classify these value components is to divide them into *use* and *non-use* classes. Both consumptive and non-consumptive use value imply an on site use of the resource, and it is reasonable to address these as use values. If the resource, subject to valuation, no longer exists (for example, the extinction of an endangered species) such values are no longer present.

The indirect value is also a kind of use value which is derived off site. However, it is not clear whether it should be included in the use, or non-use, class. It also possesses the odd feature of being present even if the resource no

² This list does not claim to be complete. Other definitions, names, and classes may be used elsewhere. For example, on site use values are sometimes referred to as direct use values.

longer exists (cf. What is the economic value of the mammoth?).

Existence and altruistic values are both referred to as non-use values. They share the characteristic that benefits arise independently of any personal direct or indirect use of the resource. For example, I may obtain an altruistic value from the knowledge that some of my friends can use the resource. Since all these non-use values require the present existence of the resource, they are sometimes also referred to as an existence value. However, in a wildlife valuation context such a definition of the term existence value is somewhat misleading. As shown in the next section, a better approach is to link existence value to the minimum viable population (*MVP*) of the resource, while at population densities larger than *MVP* the total non-use value may exceed the existence value.

Option value, which is not a separate value component of the total value, is the difference between an *ex ante* and *ex post* measure of the total value of the resource (Smith, 1987a). Smith (1987b) also points out that the *ex ante* perspective is the appropriate basis for the decomposition of

TABLE 1. POSSIBLE VALUE COMPONENTS OF A NATURAL RESOURCE

VALUE COMPONENT	USE VALUE	NON-USE VALUE
<i>Consumptive use value (on site)</i> : benefit derived from "consumption" (extraction) of a natural resource on site; e.g. hunting, forest harvesting or berry picking.	X	
<i>Non-consumptive use value (on site)</i> : benefit derived from "contact" (on site) with a natural resource without any extracting of it; e.g. bird-watching or hiking.	X	
<i>Indirect value (off site)</i> : benefit derived from an off site contact with a natural resource; e.g. reading a book or watching a TV-program about it.		?
<i>Existence value</i> : benefit derived from the knowledge that a natural resource exists.		X
<i>Altruistic value</i> : benefit derived from the knowledge of others consumption* of the natural resource.		X
<i>Option value</i> : benefit derived from the option of possible future benefits of a natural resource.	X	X

* Here "consumption" implies both use and non-use value.

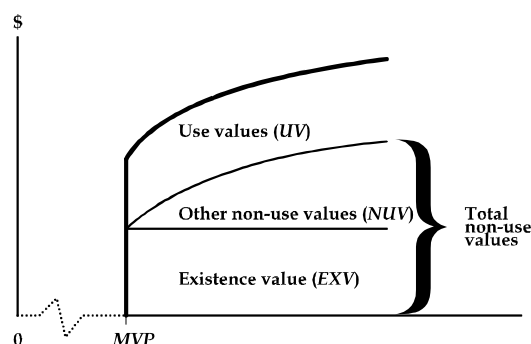


FIGURE 1. VALUE COMPONENTS OF WILDLIFE AS A FUNCTION OF POPULATION DENSITY.

the total value. Since this paper primarily focuses on non-use values in a static world, we will not discuss uncertainty and option value any further here.

In this paper, the hypothesis is that existence value can be defined as a non-use value limited to the existence of the resource. In terms of wildlife valuation, this is best illustrated by the concept of a minimum viable population, *MVP*, as a reference point (Gilpin & Soulé, 1986). Let z denote the population density of an endangered species. For all $z < MVP$ the species will become extinct since the population is too small for survival in the long run. Hence, by definition all $z < MVP$ have no value.³ This is illustrated by the dotted line in Figure 1 above. At $z = MVP$ we have a threshold population, just large enough to secure the continued existence. The non-use value at this population density represents an existence value. This existence value is based upon one or more motives, such as different forms of altruism or an inherent motive, depending on which species we are considering.⁴ As we move toward population densities larger than the *MVP*, we may experience a

³ In the short run, population densities less than *MVP* may have a value. Furthermore, it is possible to read books etc. about species that are below *MVP* or extinct. Obviously, we have to ignore these kind of values in the analysis that follows.

⁴ In Johansson (1987) five altruistic motives for existence value are presented: bequest motives; benevolence toward relatives and friends; sympathy for people and animals; environmental linkages; and environmental responsibility. The inherent (or intrinsic) motive is explained by peoples' concern about the state of the world (environment) regardless of the well-being of others (Madariaga & McConnell, 1987). It is also argued that this motive is closely linked to an environmental ethic.

change in use and non-use values other than existence value such as, for example, altruistic values. However, the size of the existence value is set at the *MVP* and will not change for larger population densities. How the use and "other" non-use values vary with the population density ($z > MVP$) is, of course, dependent on what species we are studying, and Figure 1 is just an outline of the general principle.⁵

THE ECONOMIC MEASURES OF USE, NON-USE, AND EXISTENCE VALUES OF PROPOSED CHANGES IN POPULATION DENSITY

One method commonly used to distinguish between use and non-use values is based upon the notion of weak complementarity (Freeman, 1993a and 1993b; Mäler 1974).⁶ By using this method we are able to show, from a theoretical point of view, the distinction between use, non-use and existence values as they are outlined in the previous section. The concept of weak complementarity implies that there is some market good consumed together with the resource, and the use of the resource is measured by the use (quantity consumed) of the complementary good.

Assume a market good, x with price p , complementary to the resource, z , and that z is an argument in the compensated demand function of x . Two conditions must then be satisfied for the conditions of weak complementarity to hold: (1) there must be some value of $p^*(z)$ at which the compensated demand for x is zero; and (2) at that price, the marginal utility of a change in z is zero. If we can identify a complementary market good, and the conditions for weak complementarity hold, we are able to define use values. If the second condition for weak complementarity does not hold, there is an indication of non-use values as well.

Even using this approach we can not handle the off site indirect values in a satisfactory manner (they will be treated as non-use values). Nevertheless, this method gives

⁵ Also note that use values, and other non-use values, can be negative.

⁶ The alternative method is based on the notion of access, i.e. what happens when the agent for whom we are trying to ascertain maximum *WTP* is personally denied access to use the resource if it is supplied (Mitchell & Carson, 1989). See also Hanemann (1993) for a discussion over different approaches to defining non-use value.

us a tool to define use and non-use values, including existence value, in a way consistent with economic theory.

Assume a household utility function

$$u = u(x, z) \quad (1)$$

where z denotes the population density of an endangered species, that is, an environmental resource provided at no cost, and $x = [x_1, \dots, x_n]$ is a vector of private goods with price $p = [p_1, \dots, p_n]$. The minimum expenditure required to obtain a given level of utility, u , at given prices is then

$$\begin{aligned} \text{Min } & \sum_{i=1}^n p_i x_i \\ \text{s.t. } & u(x, z) = u \end{aligned} \quad (2)$$

The solution to this minimization problem yields a set of compensated or Hicksian demand functions $x_i = x_i^c(p, z, u)$. These demand functions are homogeneous of degree 0 in p and by definition

$$\sum_{i=1}^n p_i x_i^c(\cdot) = e(p, z, u) \quad (3)$$

where $e(\cdot)$ is the minimized expenditure function, that is, the inverse of the indirect utility function (see Boadway & Bruce, 1984 or Johansson, 1987). Using the expenditure function, the total value, TV, of a change in the provision of z can be expressed in terms of the compensating, and equivalent, variation measures respectively;⁷

⁷ For notional simplicity, we only consider the price of the complementary market good, denoted p , and suppress all other prices since z is an argument only in the compensated demand function of x .

$$TV(cv) = e(p, z^1, u^1) - e(p, z^2, u^1) \quad (4)$$

$$TV(ev) = e(p, z^1, u^2) - e(p, z^2, u^2) \quad (5)$$

where z^1 (u^1) is the initial level and z^2 (u^2) is the final level of z (u). Now, let us introduce a number of assumptions regarding the resource, z , and the complementary market good, x , required for the proceeding analysis.

- (1) The use value of z is measured via the demand for some market good, x with price p .
- (2) The conditions for weak complementarity between z and x hold.
- (3) There is a choke price, p^* , at which the demand for x is zero.
- (4) There is a minimum viable population, MVP , of z .
- (5) p^* is an increasing function of z above MVP .
- (6) $x = 0$ below MVP and positive when $z \geq MVP$.

Let us also make the assumption that $0 < MVP = z^1 < z^2$. This tells us that the current population, z^1 , is equal to MVP , which is larger than extinction, $z = 0$, but smaller than some hypothetical population density, z^2 . The current utility level is u^1 , while u^0 and u^2 correspond to $z = 0$ and z^2 , respectively. Under the assumptions 1–6, we are now able to derive separate economic measures (willingness to pay) of the use, non-use, and existence values of proposed changes in z (see Freeman, 1993a).

WTP to Avoid Extinction

Since a decrease in the population density below the MVP implies extinction, the expenditure function is discontinuous at the MVP . The willingness to pay (WTP) for the non-use value to avoid such a change in z , measured as equivalence variation, is the existence value (EXV),

$$EXV = e(p^*, z^1, u^0) - e(p^*, 0, u^0) \quad (6)$$

or

$$EXV = e(p^*, z^1, u^0) - e(p, 0, u^0) \quad (7)$$

since $z = 0$ eliminates all use values. However, a decrease in z from the *MVP* can also imply a loss in use value since a use of the resource may be present at z^1 . In this case, the *WTP* to avoid such a loss, measured as use value (*UV*), is

$$UV = e(p, z^1, u^0) - e(p^*, z^1, u^0) \quad (8)$$

where $p < p^*$. Consequently, the total value of a decrease in z from the *MVP* is equal to

$$\begin{aligned} EXV + UV &= e(p^*, z^1, u^0) - e(p, 0, u^0) \\ &\quad + e(p, z^1, u^0) - e(p^*, z^1, u^0) \\ &= e(p, z^1, u^0) - e(p, 0, u^0) \end{aligned} \quad (9)$$

WTP to Increase the Population Density

Now, assume a change in the provision of z from z^1 to z^2 . The total value of the change can again be separated into use and non-use values, and as pointed out earlier, the non-use value (*NUV*) of this change is different from the existence value. Measured as compensating variation the *WTP* of such a change is

$$NUV = e(p^*, z^1, u^1) - e(p^*, z^2, u^1) \quad (10)$$

For the use values, the corresponding expression is

$$\begin{aligned} UV &= e(p^*, z^2, u^1) - e(p, z^2, u^1) \\ &\quad - e(p^*, z^1, u^1) + e(p, z^1, u^1) \end{aligned} \quad (11)$$

The sum of the non-use and use values for the change in z , from z^1 to z^2 , is then

$$\begin{aligned}
 NUV + UV = & \\
 & e(p^*, z^1, u^1) - e(p^*, z^2, u^1) \\
 & + e(p^*, z^2, u^1) - e(p, z^2, u^1) \\
 & - e(p^*, z^1, u^1) + e(p, z^1, u^1) = \\
 & e(p, z^1, u^1) - e(p, z^2, u^1) \quad (12)
 \end{aligned}$$

We have now shown one method to derive separate economic measures of the use, non-use, and existence values of proposed changes in the population density. Although, we can do so in theory, the methodological difficulties of such a procedure may be substantial. Just consider the difficulty of the identification of a market good complementary to some particular wildlife species, and the problems involved in estimating the demand of that good. One practicable way could be to estimate the use value by a travel cost analysis. The non-use and existence values can, however, only be identified by the CV method.⁸ There is also the ecological challenge of defining the population density equal to *MVP*.

With these methodological difficulties in mind, we shall now proceed to the empirical part of this paper and study the different value components by using data from a CV survey aimed at estimating the economic benefits of the white-backed woodpecker in Sweden. There is an obvious hiatus between this section and the previous theoretical analysis. Partly because of the design of the CV survey, but also as a result of the problems outlined above. Nevertheless, the empirical part of this paper will to some extent confirm the notion of an existence value as it is defined in this, and the previous, sections.

⁸ One serious concern when decomposing the total value into its value components is the "path dependency problem" (Johansson, 1993). Hence, we can in general not sum the benefits (value components) derived from different sources in order to get the total value. We must either proceed sequentially and ask about the *WTP* for the existence value conditional on the *WTP* for the use value etc., or ask for the total *WTP* and then decompose this value into its components.

AN EMPIRICAL ANALYSIS OF USE, NON-USE AND EXISTENCE VALUES

The white-backed woodpecker (*Dendrocopos leucotos*) is classified as endangered in Sweden. During the spring of 1993 a contingent valuation (CV) survey was undertaken to estimate the economic value of this bird species. Questionnaires were distributed by mail to 3360 randomly chosen Swedish citizens, aged between 17 and 74 years. The survey design included a number of subsamples according to the information provided on the current status, the proposed final population density, and the elicitation question format. It was found that the total benefit of preserving the species in Sweden was positive,⁹ while the marginal willingness to pay of an increase in the population density was zero.¹⁰ Furthermore, a majority of the respondents ranked the existence of the white-backed woodpecker as their first priority among different reasons for preserving the species in Sweden. These are findings we will further investigate in this section, and for a more "complete" presentation of the CV survey see Fredman (1994).

For the purpose of this analysis we will only consider three subsamples: Those of the respondents who received information about the Swedish status¹¹ of the woodpecker population and stated their *WTP* for: (1) preserving the current population density; (2) increase the population density to a population classified as "rare"; and (3) increase the population density to a population classified as "common".¹² This reduces the sample size to 1440. The *WTP* was estimated from a discrete choice elicitation question, and two of the question designs are presented below; z^1 refers

⁹ Mean *WTP* was estimated at SEK 406.

¹⁰ Individuals in one of the subsamples of the survey expressed a negative marginal willingness to pay. This is further discussed in the next section.

¹¹ The survey design included two different subsamples regarding the information given about the status of the white-backed woodpecker: (1) national status only; and (2) national status and global status.

¹² The formats "endangered", "rare", and "common" were used instead of actual numbers of individuals because of several reasons: (1) the respondents probably find it easier to understand the implication of these words than some unfamiliar numbers expressing the population density; (2) it is very hard or impossible to give exact numbers of individuals counted in the three classes of threat; and (3) these classes are used by the environmental authorities. Observe that respondents only faced one of the three alternatives "endangered", "rare" and "common" and the response rates were 0.57, 0.63 and 0.63 for the three subsamples.

to the current population density, while z^3 refers to the hypothetical population density classified as common.¹³

z^1 : Suppose that we prevent the extinction of the white-backed woodpecker in Sweden. Measures will be taken in order to maintain the number of white-backed woodpeckers at the same level as today. Would you be willing to pay an "once-for-all" amount of SEK **** as a contribution to these measures? (provided that all adult Swedes pay an equal amount)

(mark with a cross)

☐ Yes ☐ No

z^3 : Suppose that we prevent the extinction of the white-backed woodpecker in Sweden. Measures will be taken in order to increase the number of white-backed woodpeckers, to a level at which it will be classified as common (instead of endangered). Would you be willing to pay an "once-for-all" amount of SEK **** as a contribution to these measures? (provided that all adult Swedes pay an equal amount)

(mark with a cross)

☐ Yes ☐ No

Value Components

Subsequent to the WTP-question, sample members of the CV survey were asked to rank different reasons for preserving the white-backed woodpecker. The aim of this question was not to disaggregate the total WTP, but rather to investigate the significance of the different value components. The question format used was:

One can think of different reasons for preserving the white-backed woodpecker. Some possible reasons are listed below. Rank the reasons; i.e. mark the reason you consider as most important with 1, mark the second most important reason with 2, and so forth

- (1)¹⁴ ☐ My own outdoor experiences of the white-backed woodpecker through, for example, bird watching.
- (2) ☐ My own experiences of the white-backed woodpecker via television, books, newspapers, etc.
- (3) ☐ Other people can experience the white-backed woodpecker.
- (4) ☐ All species have a right to exist.
- (5) ☐ Future human generations can enjoy the white-backed woodpecker.
- (6) ☐ Other reasons, please specify: _____

¹³ The bid vector included SEK 10, 50, 100, 300, 500, and 2000.

¹⁴ The numbers in parenthesis were not printed in the original questionnaire. They are used here simply to facilitate the presentation.

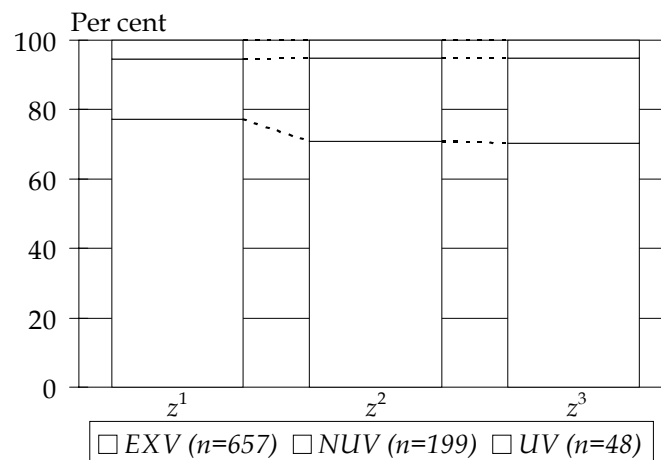


FIGURE 2. REASONS FOR PRESERVING THE WHITE-BACKED WOODPECKER

Distribution of the respondents' first priority (among different reasons) for preserving the white-backed woodpecker in Sweden, presented for the three population densities z^1 , z^2 , and z^3 . n =total number of observations in each category.

Here (1) refers to a use value (on site non-consumptive use), (2) to an indirect value generated off site, (3) to a value generated by altruism, (4) to an existence value, and (5) to a value generated by bequest motives. For simplicity, numbers (2) and (6) are excluded from the subsequent analysis.¹⁵ We are now left with four motives (1), (3), (4), and (5), which are grouped into the three categories; use value (1), non-use value (3) and (5), and existence value (4), in accordance with the reasoning in the previous sections.

Assume z^1 denotes the current population density, classified as endangered;¹⁶ z^2 denotes the hypothetical population classified as rare, and z^3 denotes the hypothetical population classified as common. By definition $z^1 < z^2 < z^3$. In Figure 2 we can study the distribution of the respondents' first priority among the different value components, presented for the three population densities. Here we can draw the

¹⁵ The reasons for this are: 1) it is not possible to objectively categorize these value components into non-use values or use values; and 2) these values were assigned first priority by only two, and four, percent of the respondents respectively. Also note that a majority of the respondents who marked (6) "other reasons" as their number one priority expressed some kind of reason related to existence value.

¹⁶ In the proceeding analysis, the underlying assumption will be that $z^1 \geq MVP$.

general conclusion that almost 70 per cent of the respondents rank "all species have a right to exist" as their number one priority. Obviously, the existence value appears to be an important component of the total value of the white-backed woodpecker. Other non-use values are given first priority by approximately 20 per cent of the respondents, while use values count for some five per cent.

Figure 2 also indicates that individuals in subsamples z^2 and z^3 are more inclined to give non-use values, other than existence value, a higher rank compared to individuals in subsample z^1 . Furthermore, it is not surprising that we find an almost constant, and very small proportion, first priority for use values as a function of population density. As far as woodpeckers (in general) are concerned in the Swedish fauna, use values are not expected to be substantial for any population density of a single species (within reasonable limits, of course).

Marginal Benefits

Marginal willingness to pay was estimated for the two proposed increases in the population density of the white-backed woodpecker. This was done by means of a probit model where Y_i is an index variable for individual i , defined such that $Y_i = 1$ if the willingness to pay, WTP_i , is greater than, or equal to, the bid presented to the individual, bid_i , otherwise $Y_i = 0$. Furthermore, it is assumed that the willingness to pay is log-normally distributed (see Fredman, 1994). The natural logarithm of WTP is then defined as

$$\ln(WTP_i) = \mu + \beta x_i + \varepsilon_i \quad (13)$$

where μ is the mean of the log valuation, x_i is a vector of dummy variables (d) of individual i , and ε_i is a stochastic component with a zero mean and a constant variance. In the case of an "yes" answer to the elicitation question, it follows that $\ln(WTP_i) \geq \ln(bid_i)$, while for a "no" answer $\ln(WTP_i) < \ln(bid_i)$,¹⁷ or using expression (13), $\mu + \beta x_i + \varepsilon_i \geq \ln(bid_i)$ and $\mu + \beta x_i + \varepsilon_i < \ln(bid_i)$, respectively. The discrete

¹⁷ The corresponding probability distribution may then be described by $Pr(Y_i=1) = Pr[\ln(WTP_i) \geq \ln(bid_i)]$ and $Pr(Y_i=0) = Pr[\ln(WTP_i) < \ln(bid_i)]$, respectively.

choice model used in the probit analysis can now be specified as (Cameron, 1988; Gabler *et al.*, 1993)

$$Y_i = 1 \quad \text{if} \quad \left[\frac{\mu + \beta x_i + \varepsilon_i - \ln(\text{bid}_i)}{\sigma_\varepsilon} \geq 0 \right]$$

$$Y_i = 0 \quad \text{otherwise} \quad (14)$$

where Y_i is the binary response variable (1 for a "yes" and 0 for a "no" answer to the bid_i), and $\ln(\text{bid}_i)$ is the natural logarithm of the bid. The x_i vector includes two dummy variables, d_2 and d_3 , defined as follows (Greene, 1993)

$$\begin{aligned} d_2 = d_3 = 0 & \quad \text{if } z = z^1 \\ d_2 = 1, d_3 = 0 & \quad \text{if } z = z^2 \\ d_2 = d_3 = 1 & \quad \text{if } z = z^3 \end{aligned}$$

In expression (13), μ is, by definition, the *WTP* for saving the current population density, z^1 , while the parameter estimates of d_2 (d_3), measure the marginal value of an increase in z from z^1 to z^2 (z^2 to z^3) respectively. By maximizing the log-likelihood function¹⁸ we obtain the parameter estimates.

Separate models were estimated for respondents ranking the use value (*UV*), the non-use value (*NUV*), and the existence value (*EXV*) as their first priority. Table 2 below features the regression output, while Table 3 presents a likelihood ratio test which simply reinforces the result of the former.

From Table 2 we can see that the parameter estimates of all dummy variables, except d_3 in the *EXV* model, indicate non-significant changes in willingness to pay as z increases. Hence, a zero marginal willingness to pay as a function of population density is suggested. The significant negative parameter value of d_3 indicates a negative marginal willingness to pay for an increase in the population density, from being classified as "rare" to classified as "common",

¹⁸ $Ln(L) = \sum_i Y_i \cdot \ln \left[1 - \Phi \left[\frac{\ln(\text{bid}_i) - \mu - \beta x_i}{\sigma_\varepsilon} \right] \right] + \sum_i (1 - Y_i) \cdot \ln \Phi \left[\frac{\ln(\text{bid}_i) - \mu - \beta x_i}{\sigma_\varepsilon} \right]$, where Y_i

is an indicator variable and Φ is the cumulative distribution function of the standard normal variable.

TABLE 2. MARGINAL VALUE ESTIMATIONS

Estimates of marginal values of proposed increases in the population density of the white-backed woodpecker.

FIRST PRIORITY	VARIABLE	PARAMETER ESTIMATE	STD. ERR.	CHI SQUARE	Pr>CHI-SQUARE
UV:	Constant	3.010	1.115	7.287	0.0069
	$\ln(bid)$	-0.445	0.170	6.817	0.0090
	d_2	-0.417	0.552	0.569	0.4506
	d_3	-0.238	0.504	0.223	0.6370
NUV:	Constant	2.816	0.460	37.46	0.0001
	$\ln(bid)$	-0.502	0.076	44.24	0.0001
	d_2	0.244	0.286	0.725	0.3945
	d_3	0.020	0.266	0.006	0.9411
EXV:	Constant	2.687	0.234	131.2	0.0001
	$\ln(bid)$	-0.410	0.039	112.3	0.0001
	d_2	-0.017	0.148	0.014	0.9076
	d_3	-0.409	0.146	7.897	0.0050

Model fit: UV: $n = 41$, log likelihood for normal = -23.000; NUV: $n = 167$, log likelihood for normal = -80.479; EXV: $n = 562$, log likelihood for normal = -292.87.

for those of the respondents who ranked "all species have a right to exist" as their first priority.

The likelihood ratio test will test which of the parameter estimates of expression (14) that are equal to zero, and hence, indicate a zero marginal value. Let $L(\beta_R)$ denote the value of the restricted maximized log likelihood function under the null hypothesis that β_2 and/or β_3 is zero, while

TABLE 3. ESTIMATED CHI-SQUARES IN THE LIKELIHOOD RATIO TEST

The critical chi-squared table values at a 95% significance level are 3.84 ($m=1$) and 5.99 ($m=2$)

FIRST PRIORITY	H_0		
	$\beta_2 = 0$	$\beta_3 = 0$	$\beta_2 = \beta_3 = 0$
UV:	0.58	1.30	1.32
NUV:	0.72	0.84	1.00
EXV:	0.06	8.66	11.06

$L(\beta_{UR})$ is the value of the unrestricted function (Pindyck & Rubinfeld, 1991). The test statistic is

$$-2[L(\beta_R) - L(\beta_{UR})] \sim \chi_m^2 \quad (15)$$

where χ_m^2 is the chi-square distribution and m the number of parameter restrictions. A comparison between the estimated chi-square values and the critical values of relevant significance levels in a chi-square distribution table will give us the test results. Thus, if the estimated χ_m^2 values of Table 3 are larger than the corresponding critical values we can reject the null hypothesis. Obviously, this is the case only for those of the respondents who give existence value their first priority and are faced with a large increase (z^2 to z^3) in the population density. This finding verify the results presented in Table 2.

CONCLUDING REMARKS

Does existence value have any real existence? The unambiguous answer to that question must be yes, it has. The obscure characteristics of the existence value do, however, cause some obvious difficulties when dealing with wildlife valuation. In this study, we are not able to derive a monetary measure of existence value, but we can, with some confidence, conclude that it is an important component in wildlife valuation. This should be true, particularly for species that represent a non-significant use value to humans, such as the endangered white-backed woodpecker.

Existence value, as it can be characterized in wildlife valuation, is identified for a population equal to the minimum viable one. The willingness to pay to avoid extinction of this population density is equal to the existence value. This was illustrated by the discrete jump (dotted line) of Figure 1, and in the theoretical analysis, where the expenditure function was found to be discontinuous at the MVP. For species only representing an existence value, i.e. no use or other non-use values are involved, the marginal willingness to pay, as a function of the population density, should be zero above MVP.

In this study, the criteria above are met for most of the respondents valuing the white-backed woodpecker. There is however, somewhat surprisingly, one category among the respondents that is found to have a negative marginal willingness to pay as a function of population density. People in this category consider as their first priority that *all species have a right to exist*, and are faced with an increase in the population to a density classified as "common". One explanation to this result could be that people in this category are negatively disposed to large populations of the white-backed woodpecker. People primarily "holding" an existence value may be more inclined to distribute their total willingness to pay amount among additional species, or public amenities, when the proposed population density is large and the species is not considered as threatened any longer. Consequently, their willingness to pay should decline as they are asked to contribute to a large population.

We may also consider the case of a positive marginal willingness to pay as a function of population density. This was, for example, found in a study by Mattsson (1990) who studied the relation between the total hunting value and the moose population density in Sweden. However, in this case the moose, in contrast to the white-backed woodpecker, does represent an obvious use value.

Thus, the major point in this study is the empirical evidence of a positive willingness to pay in order to save this particular wildlife species, and the non-positive marginal willingness to pay for an increased population density above the minimum viable. This finding, and the fact that a majority of the respondents assign first priority to *the right of all species to exist*, confirm Figure 1 and our notion of an existence value.

As a final remark, it is important to stress that all data in this study are valid only for this particular species. In the analysis, it was also assumed that a population density equal to the minimum viable was identifiable. Since the MVP is a relative concept, not easy to define in terms of population size, there are some obvious ecological problems present. One should also not forget that all species play a more or less important role in the ecosystem in which they exist, and the ecological, as well as the economical,

consequences of species extinction are not always known. To save a single endangered species will, in many cases, involve saving a whole ecosystem. The existence value of an endangered species may therefore be highly integrated with the existence value of an ecosystem.

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