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ECONOMIC VALUES OF THREATENED MAMMALS IN BRITAIN: A CASE STUDY OF THE OTTER *Lutra lutra* AND THE WATER VOLE *Arvicola terrestris*

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Abstract

We investigated the relative economic values of the otter Lutra lutra *and the water vole* Arvicola terrestris, *two species that occupy similar habitats and face common threats of habitat change, habitat fragmentation and pollution. Willingness to pay for conservation was estimated using the contingent valuation method. Data were collected by a telephone survey using a referendum based on willingness to pay a specified amount as a single addition to tax. The most influential variables in determining respondents' willingness to pay were their age, the specified tax amount, whether they were aware of the threats to that specific species, whether they were a member of a conservation organisation and whether they walked frequently in the countryside. Mean willingness to pay values obtained were £11·91 for the otter, £7·44 for the water vole, and £10·92 for both species together. Aggregated over the survey population of North Yorkshire, these results equate to £6·4 million, £4·0 million and £5·8 million, respectively. These figures are well in excess of the calculated present values for the UK action plans for the otter and the water vole (£0·8 million and £1·0 million, respectively). The results demonstrate strong public support for mammal conservation, in particular for high profile 'flagship' species, and suggest that public profile may be as important as rarity or the degree of threat in determining a species' relative economic value. © 1997 Published by Elsevier Science Ltd*

Keywords: economic value, willingness to pay, contingent valuation, otter, water vole.

INTRODUCTION

Environmental valuation has received, and will continue to receive, increasing emphasis, in both policy-making and research (Department of the Environment, 1991, 1994; Hanley & Spash, 1993; Turner, 1993; Hanley, 1995; Willis & Corkindale, 1995; Bjoernstad & Kahn, 1996). For ecological resources such as species and habitats, relative values have traditionally been formulated in a number of ways, such as by ranking a species according to the degree of overall threat or decline, or according to its status in one particular area relative to a wider area, whether on a regional or national scale. These types of data currently provide the main basis for the allocation of scarce financial resources for conservation. However, this traditional approach is limited in scope and applicability. In particular, it takes no account of broader values associated with ecological resources (their 'total economic value'), and the currencies of measurement used cannot be easily incorporated within an economic cost–benefit analysis. In the comparative assessment of different conservation options or in analysing conflicts between development and conservation, a 'total economic' approach therefore may be of considerable benefit.

The total economic value of an ecological resource incorporates both use (direct, indirect and option-use values) and non-use (bequest and existence) values (Krutilla, 1967; Dixon & Sherman, 1990; Swanson & Barbier, 1992; Pearce & Moran, 1994). Direct-use values are outputs that are directly consumable, such as food and recreation, indirect-use values are functional benefits such as nutrient cycling, and option-use values refer to the benefits of retaining a resource so that it may be used at some time in the future. The bequest value for a resource is the value of knowing that others might benefit from it in some way at some time in the future, and the existence value relates to the value of knowing that it continues to exist. Whilst direct and, to a lesser extent, indirect-use values may have well-defined monetary components, option-use values and non-use values are typically far more difficult to define with respect to existing markets. Nevertheless, these broader social benefits of ecological resources may be considerable (Perrings, 1995). Therefore, although derived values for non-market benefits may be controversial, more effort should be made to assess them and incorporate them into the decision-making process.

The aim of this work was to investigate the relative total economic values of different threatened mammal

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species by evaluating public willingness to pay towards their conservation. The opportunity costs to society from species and habitat conservation may be significant in terms of having to forego benefits from alternative uses that might have yielded actual market economic benefits. Measuring non-market benefits using public willingness to pay is therefore an appropriate measure (Just *et al.*, 1982), and has been used in previous studies to give meaningful estimates of the anthropocentric benefits of conserving rare and endangered species (Loomis & White, 1996). Furthermore, economic values expressed for these species also may incorporate an implicit valuation for underlying ecosystem functions and processes (Loomis & White, 1996).

The UK biodiversity action plans

The work was carried out within the context of the UK biodiversity steering group report (Anon, 1995*a*,*b*). This report included costed action plans for the conservation of 116 species, including nine mammals, and 16 habitats within the UK. The costings given were indicative rather than definitive, but nevertheless represented the first attempt to price potential conservation efforts in the UK on a national scale. This report therefore provides a unique framework within which to consider the relative economic values of different species and habitats, and the consequences of this for conservation.

Among the nine mammal species included in the costed UK biodiversity action plans were the otter *Lutra lutra* and the water vole *Arvicola terrestris*. These were chosen as the two species to be investigated in this study because they occupy similar habitats and face common threats of habitat change, habitat fragmentation and pollution. In addition, they provide contrasting scenarios in terms of their recognition and status. The otter is a high-profile conservation species, whereas the water vole is less well known by the general public.

The action plan objectives and targets set out by the Biodiversity Steering Group (Anon, 1995*b*) for these two mammal species were as follows. For the otter, the objectives were to maintain and expand existing otter populations and, by 2010, to restore breeding otters to all catchments and coastal areas in which they had been recorded since 1960. For the water vole, the objectives were to maintain the current distribution and abundance of the species in the UK and to ensure that water voles are present throughout their 1970s range by 2010, considering habitat management and possible translocation of populations to areas from which they have been lost.

The costs for the action plans were presented as indicative per annum costs for the years 1997, 2000 and 2010. For the otter action plan, indicative per annum costs were £105 000 for 1997, £90 000 for 2000 and £70 000 for 2010. For the water vole action plan, indicative per annum costs were £150 000 for 1997, £110 000 for 2000 and £105 000 for 2010 (Anon, 1995*a*). The total indicative per annum costs for all 116 species action plans were £3·8 million for 1997, £2·9 million for 2000 and £2·4 million for 2010 (Anon, 1995*a*).

Status of the otter and water vole in Britain

The otter in Britain is largely confined to riparian and coastal habitats in Scotland, Wales and Ireland. Otter populations were relatively high until at least the mid-18th century, but from the late 18th to the early 20th centuries otters were increasingly persecuted for fishery protection and sport (Harris *et al.*, 1995). From 1957 to 1958, the otter population declined dramatically over England, southern Scotland and Wales (Harris *et al.*, 1995). This decline has been attributed to a variety of factors including pollution (Jefferies, 1989; Mason, 1989; Mason & Macdonald, 1993), persecution (Foster-Turley *et al.*, 1990), habitat loss and fragmentation (Kruuk, 1995) and reduced or limited prey availability (Kruuk & Conroy, 1991; Kruuk, 1995). The British pre-breeding otter population probably stood at around 7350 in the mid-1980s, of which 90% were in Scotland (Harris *et al.*, 1995). No more recent reliable estimates are available. However, the otter population is currently thought to be stable or slightly increasing (Jefferies, 1989; Anon, 1995*b*; Harris *et al.*, 1995).

The water vole is widely distributed across Britain but mainly confined to lowland areas near water (Corbet & Harris, 1991). At the start of the 20th century, water voles were abundant in all suitable habitats throughout Britain. However, since then, there has been a steady long-term decline in the population, with two periods of accelerated loss, the first in the 1940s and 1950s, and the second in the last 20 years (Harris *et al.*, 1995). The main factors that have been suggested as contributory to this decline are habitat change and fragmentation, pollution and predation by American mink *Mustela vison* (Nature Conservancy Council, 1986; Jefferies *et al.*, 1989; Strachan & Jefferies, 1993; Harris *et al.*, 1995). The British pre-breeding water vole population is estimated to be around 1 169 000, of which 65% are in England (Harris *et al.*, 1995). There has been a decline in numbers or range of at least 25–49% over the last 25 years (Anon, 1995*b*), and this decline is continuing. Strachan and Jefferies (1993) estimated that by the end of this century, 94% of formerly occupied sites may be lost, with an even greater reduction in population size. This would make it the most dramatic population decline of any British mammal this century (Harris *et al.*, 1995).

METHODS

Economic values of the otter and the water vole

The relative economic values of the otter and the water vole were estimated using contingent valuation. This is the only valuation method that can elicit non-use values directly (Mitchell & Carson, 1989), and these are likely to be the most important components of total economic value for many threatened species. Contingent valuation uses direct consumer sampling to estimate the economic values of non-market commodities, such as ecological resources, where there is no corroborating market behaviour that would allow reliable measurement of the same values by revealed preference methods (Cameron, 1988; Mitchell & Carson, 1989; Mattsson, 1994; Hanemann, 1995). It does this by setting up a hypothetical market where people are asked to state their bids for various goods based upon the information provided to them.

Data were collected by a telephone survey using a referendum based on willingness to pay a specified amount as a single addition to tax towards the implementation of the action plans. The survey was undertaken during the period February–March 1996. The target population of the survey was households in North Yorkshire. A random number generating programme was used to define the potential interviewees, by producing reference numbers for the page, column and row of a current regional telephone directory. This method produced a random sample of households having (non ex-directory) telephones. Respondents were interviewed between the hours 1800 and 2030 to minimise bias towards any sex or age category of each respondent.

Three questionnaires were designed. The first and second questionnaires dealt with the proposed action plans for the otter and water vole individually. The third questionnaire dealt with the action plans for both species together. These questionnaires were identical to each other in all aspects, apart from the information specific to a particular species (see Appendix).

There were seven questions per questionnaire, split into four sections. The first section (question 1) was designed to introduce the study and make an initial assessment of the respondent's knowledge of the problem. The second section then introduced the biodiversity action plans in general terms, before making some more specific statements about the status of one or both species and the threats facing them. The respondent was then asked whether he/she was aware of these specific threats to the species concerned (question 2). The third section went into more detail concerning the status of the species concerned. The summary information provided included the estimated population size, the degree of threat and some quantification of population change. The aim of the action plan for the species was then stated.

Following this, the concept of payment towards the action plans was introduced. The payment vehicle chosen was a single national addition to taxes since this minimises problems of differing rates of time preference among the respondents. Following this, and immediately prior to the willingness to pay question (question 3), the implications of the action plans were restated to clarify the scenario for the respondent. The willingness to pay question used a referendum type format to elicit whether the respondent would be prepared to pay a single additional tax payment of £x towards the implementation of the action plan for the species concerned. The monetary values used ranged from £1 to £20 (Table 1). Each respondent was faced with only one monetary value in the willingness to pay question.

The final section of the questionnaire was designed to obtain background information on the respondents. Respondents were asked if they were a member of any conservation group or environmental organisation (question 4). They were also asked if they walked frequently in the countryside (question 5). An indication of the socio-economic status of the respondent was then obtained by ascertaining their annual household income (question 6). This was split into five categories from < £10 000 to > £40 000 (Table 1). Finally the age of the respondent was assessed (question 7). This was split into five categories from < 20 to > 50 (Table 1). In addition, the sex of the respondent was determined by the interviewer at the start of the questionnaire. Any incomplete questionnaires were discarded.

Logistic regression was used to determine the significant factors affecting willingness to pay. In these models, willingness to pay was therefore a dichotomous dependent variable with alternative states yes/no. The independent variables used are shown in Table 1.

Table 1. Independent variables used in the logistic regression models for willingness to pay

Independent variable name	Description
Species	Whether the questionnaire focused on the otter, water vole or both species together; categorical variable (otter/water vole/both species)
Sex	Sex of respondent; dichotomous variable (male/female)
Awareness	Awareness of the general fact that many British mammals are under threat from human activities; dichotomous variable (yes/no)
Threat	Awareness of specific nature of threats to otter and water vole, i.e. pollution of streams and rivers, habitat loss, etc.; dichotomous variable (yes/no)
Amount	The amount specified as a single tax supplement in the willingness to pay question; categorical variable (£1, £2, £5, £10, £20)
Member	Whether the respondent is a member of a conservation group or environmental organisation; dichotomous variable (yes/no)
Walk	Whether the respondent walks frequently in the countryside; dichotomous variable (yes/no)
Income	Respondent's household income grouping; categorical variable (< £10 000, £10–20 000, £20–30 000, £30–40 000, > £40 000)
Age	Respondent's age grouping in years; categorical variable (< 20, 20–29, 30–39, 40–49, > 50)

Logistic regression models were used to predict willingness to pay and find mean values for willingness to pay for the different action plans. These were developed using a forward conditional stepwise procedure, and the goodness-of-fit of the models was estimated using the maximum log-likelihood ratio. The standard form of the logistic model relating the proportion, p, of a dependent variable to an independent variable X is:

$$p = \frac{e^{a+bX}}{1 + e^{a+bX}},$$

where a is the constant coefficient and b is the coefficient of variable X. The logit transform of $p \to \ln(p/1-p)$ is related to X by the simple linear regression:

$$\ln(p/(1-p)) = a + bX$$

(Sokal & Rohlf, 1995). The mean willingness to pay is defined as the amount where the probability of a yes answer (p) is 0·5, i.e. where $\ln(p/(1-p)) = 0$. This was, therefore, evaluated for each best-fit model by solving an equation of the following form for X_0:

$$a + b_0X_0 + (b_1X_1 + b_2X_2 + \ldots\ldots b_nX_n) = 0,$$

where b_0 is the coefficient on the mean of the amount variable, X_0, and $b_1 \ldots b_n$ and $X_1 \ldots X_n$ are the coefficients and means, respectively, of the remaining independent variables in the model.

Aggregation of the survey data in the context of the biodiversity action plans

In order to compare the relative economic values obtained from the telephone survey with the costs of the action plans, the values need to be expressed in the same way. Aggregation of the mean willingness to pay values over the tax-paying population of the North Yorkshire region by simple multiplication will provide a total regional willingness to pay for the action plans. This figure therefore represents the total present value of the action plans for the otter and the water vole to the North Yorkshire population.

In order to compare these figures with the costs of the action plans, the latter also have to be converted to present values. Only per annum costs for the years 1997, 2000 and 2010 are given for the action plans, and there is no indication of how these costs were derived or whether the costs would be ongoing after 2010 (Anon, 1995*a*,*b*). The conversion of these separate per annum costs to a single present value therefore requires that assumptions are made about costs between the three dates specified. We assume, in the absence of further information, that there is a steady, exponential increase or decrease between the costs at the specified dates, and that there is no further expenditure after 2010. The present value of the action plans then can be obtained from the following formula. Let the costs be incurred over a period starting c years from now and lasting g years, and let real per annum costs at the start and end of the period be a and b, respectively. Then, we assume that the real per annum cost at time t during the period is $ae^{x(t-c)}$, where

$$e^x = (b/a)^{1/g}. \quad (1)$$

The present value (PV) of the costs over the time period is then given by

$$PV = \frac{ae^{-\delta c}}{\delta - x}[1 - e^{-(\delta - x)g}] \quad (2)$$

where δ is the discount rate. To calculate PVs of costs occurring in the two periods 1997–2000 and 2000–2010, eqn 2 is used twice to give

$$PV = \frac{a_1}{\delta - x_1}[1 - e^{-3(\delta - x_1)}] + \frac{a_2e^{-3\delta}}{\delta - x_2}[1 - e^{-10(\delta - x_2)}]. \quad (3)$$

Here, a_1, a_2 and x_1, x_2 are, respectively, the initial per annum costs and exponential growth rates for periods 1997–2000 and 2000–2010, with growth rates being calculated from the interpolation formula (1).

RESULTS

Economic values of the otter and the water vole

The telephone survey yielded 315 questionnaires suitable for statistical analysis (otter, $n = 105$; water vole, $n = 105$; both species together, $n = 105$) from 494 telephone calls, a response rate of 64%. This sample represents 0·05% of the entire population of North Yorkshire (Anon, 1991; Table 2). There was a clear difference in the gender of people answering the telephone, with females receiving 60% and males 40% of the calls. However, there was no significant difference between the genders regarding their willingness to answer the questionnaire, with 36% of females and 37% of males refusing to answer ($\chi^2 = 0{\cdot}07$, d.f. = 1, n.s.).

Table 2 shows the age profile of the respondents, with over 50% of respondents being >50 years old. To

Table 2. Comparison of age profile of respondents with that of the North Yorkshire population.

Figures in parentheses represent actual sample and population sizes

Age (years)	Respondents (%)	North Yorkshire population (%)
<20	1·6 (5)	7·8 (45 262)
20–29	12·7 (40)	17·0 (98 743)
30–39	16·5 (52)	16·2 (93 870)
40–49	27·0 (85)	17·2 (99 719)
>50	42·2 (133)	41·8 (242 226)
Total	100·0 (315)	100·0 (579 820)

determine whether this age profile was representative of the population of North Yorkshire, data were obtained from the 1991 census (Anon, 1991). There was a significant difference between the survey sample and the North Yorkshire population (Table 2, $\chi^2 = 36{\cdot}6$, d.f. = 4, $p < 0{\cdot}001$), with age groups < 20 and 20–29 being under-represented and age group 40–49 being over-represented in the survey sample, respectively. However, there was no significant difference between the survey sample and the North Yorkshire population when age groups 20–49 were combined into one category ($\chi^2 = 1{\cdot}21$, d.f. = 1, n.s.).

There was no significant difference between the respondents to the three questionnaires in terms of gender (Table 3, $\chi^2 = 0{\cdot}19$, d.f. = 2, n.s.), age (Table 3, $\chi^2 = 7{\cdot}22$, d.f. = 8, n.s.) or income (Table 3, $\chi^2 = 8{\cdot}03$, d.f. = 8, n.s.). The average household income increased with age up to the fourth cohort (40–49 years), but then declined to the fifth cohort (> 50 years) where the majority of respondents (53%) had an income of < £10 000. Of all respondents, 68% had annual household earnings of < £20 000.

The behavioural and attitudinal characteristics of the respondents are shown in Table 4. When asked whether they were aware of the general fact that many British mammals were under threat, 77% of all respondents said that they were. However, when the question concerned species-specific threats, the overall percentage of those aware of the threats decreased to 55%. However, more people (66%) were aware of the specific threats to otter populations than they were of those to water vole populations (53%). Of all respondents, 62% walked frequently in the countryside, and 23% were members of a conservation group or environmental organisation.

The results of the willingness to pay questions revealed a general enthusiasm for mammal conservation in Britain, with 58% of respondents willing to pay the amount specified in their questionnaire. There was an inverse relationship between willingness to pay and the amount specified for both species individually and for both species together (Table 5). The total decline in willingness to pay with amount specified was similar for the otter and the water vole (52 and 58%, respectively over the entire range of amounts specified), but less for both species together (38%). For the otter, willingness to pay remained relatively constant up to a specified amount of £5 and then decreased with every higher specified amount, declining sharply between £10 and £20. This was in contrast to the pattern for the water vole and both species together, which showed more consistent declines over the whole range of amounts specified. The gender of respondents had little effect on willingness to pay, with 64% of females and 63% of males being willing to pay the amount specified. However, 40% of females were willing to pay £20, compared with only 18% of males.

Respondents who were aware of the general threats to British mammals and those who were aware of the specific threats to the different species were generally more willing to pay the specified amount towards the action plans than those who were not. Respondents who walked frequently in the countryside or were members of environmental organisations were also more likely to be willing to pay towards the action plans (Table 6).

For the otter action plan (model 1), the amount specified, the age of each respondent and membership of an environmental organisation were all significant factors included in the logistic regression model determining willingness to pay. For the water vole action plan (model 2), the amount specified was the only significant variable, and for the action plans for both species together (model 3), the amount specified and whether or not the respondent walked frequently in the countryside were both significant factors. A model combining the results of the two individual species questionnaires was also developed (model 4). For this model, the significant factors

Table 3. Comparison of sex, age and income structure of respondents for the three questionnaires ($n = 315$)

Variable	Category	Questionnaire type		
		Otter (%)	Water vole (%)	Both species (%)
Sex	Male	43	44	46
	Female	57	56	54
Age (years)	< 20	4	2	0
	20–29	17	12	11
	30–39	16	19	15
	40–49	26	27	32
	> 50	41	45	47
Income (£)	< 10 000	37	35	30
	10–20 000	43	36	34
	20–30 000	11	19	25
	30–40 000	8	10	9
	> 50 000	5	5	7

Table 4. Behavioural and attitudinal characteristics of respondents.

Values are expressed as percentages of total replies. Figures in parentheses represent sample sizes. Variables are described in full in Table 1

Variable	Yes	No
Awareness	77·1 (243)	22·8 (72)
Threat	55·5 (175)	44·4 (140)
Member	22·8 (72)	77·1 (243)
Walk	62·0 (195)	38·0 (120)

Table 5. The effect of amount specified on the respondents' willingness to pay towards the action plans for the otter, the water vole and both species together

Amount (£)	Willingness to pay (% of respondents)		
	Otter	Water vole	Both species
1	81	81	71
2	81	62	61
5	81	56	56
10	62	42	56
20	29	23	33

Table 6. The effects of respondents' knowledge and behavioural characteristics on their willingness to pay a specified amount towards the action plans for the otter, the water vole and both species together

Characteristics are described in full in Table 1

Characteristic	Knowledge/ behaviour	Willingness to pay (%)		
		Otter	Water vole	Both species
Awareness	Yes	69	54	56
	No	42	32	56
Threat	Yes	67	50	62
	No	58	51	60
Member	Yes	80	70	69
	No	58	47	51
Walk	Yes	67	53	62
	No	60	45	57

affecting willingness to pay were the same as those for the otter model. However, species was not a significant factor (Table 7). All four models were significant overall.

The otter and combined species models (models 1 and 4) were the best, having the highest model χ^2 values and the greatest predictive power, being able to classify willingness to pay (yes/no) with an accuracy of over 70%. The water vole model (model 2) had a similar predictive power, but a lower χ^2 value, indicating a worse fit to the data. The mean willingness to pay values obtained from the models were £11·91 for the otter (model 1), £7·44 for the water vole (model 2), £10·92 for both species together (model 3) and £10·12 for either species (model 4) (Table 8).

Aggregation of the survey data in the context of the biodiversity action plans

If people under the age of 20 are excluded as non-tax-payers, the aggregate willingness to pay towards the

Table 7. Parameter estimates for logistic regression models of willingness to pay for the action plans for the otter, water vole and both species together

Independent variables are described in full in Table 1. Model 1, otter; model 2, water vole; model 3, both species together; model 4, otter and water vole combined (see text for details)

Model	Independent variable	Coefficient b	Standard error (±)	Significance (p)
1	Age	−0·54	0·23	<0·01
	Member	1·31	0·65	<0·05
	Amount	−0·17	0·44	<0·0001
	Threat	1·48	0·62	<0·01
	Constant	2·65	1·10	<0·01
2	Amount	−0·13	0·03	<0·0005
	Constant	0·94	0·31	<0·005
3	Amount	−0·08	0·03	<0·01
	Walk	1·23	0·46	<0·01
	Constant	0·02	0·42	n.s.
4	Age	−0·40	0·15	<0·01
	Member	1·07	0·43	<0·01
	Amount	−0·14	0·03	<0·0001
	Threat	1·05	0·40	<0·01
	Constant	1·94	0·70	<0·005

Table 8. Summary statistics and mean willingness to pay derived from the logistic regression models of willingness to pay for the action plans for the otter, water vole and both species together

Independent variables are described in full in Table 1. The model χ^2 is the difference between −2 log likelihood for the model with a constant only, and −2 log likelihood for the current model. It therefore tests the null hypothesis that the coefficients for all of the terms in the current model, except the constant, are zero. Model 1, otter; model 2, water vole; model 3, both species together; model 4, individual otter and water vole results combined (see text for details)

	Model			
	1	2	3	4
Model χ^2	36·98	16·40	13·65	59·62
% correct classification	78·10	69·52	34·76	71·90
Significance (p)	<0·0001	<0·0001	<0·001	<0·0001
Mean willingness to pay (£)	11·91	7·44	10·92	10·12

action plans for the North Yorkshire population is £6·4 million for the otter, £4·0 million for the water vole and £5·8 million for both species together. Using formula (3) described above and the standard UK government-approved discount rate of 6% (Hanley & Spash, 1993), the present values of the action plans are about £0·8 million and £1·0 million for the otter and water vole, respectively. Using the same assumptions, the total present values for all the action plans described in the UK biodiversity steering group report are about £26·0 million for the 116 species plans and £236·2 million for the 16 habitat plans (Table 9).

DISCUSSION

Contingent valuation may be based upon data collected using postal (Kerr & Cullen, 1995), telephone (Frey, 1984), in-person interviews or some combination of these (Dalecki *et al.*, 1993). In-person interviews are preferable overall for contingent valuation studies

Table 9. Indicative per annum costs and calculated present values of the action plans for the otter, the water vole, all 116 species and all 16 habitats described in the UK biodiversity steering group report

Indicative costs are taken from the UK biodiversity steering group report (Anon, 1995*a*,*b*). Present values are calculated from per annum indicative costs, assuming an exponential increase or decrease between costed years, a 6% discount rate and that the action plans cease in 2010 (see text for details)

	Indicative per annum costs (£K)			Present value (£K)
	1997	2000	2010	
Otter	105	90	70	774
Water vole	150	110	105	1032
All 116 species	3809	2904	2418	26016
All 16 habitats	12870	24520	37160	236192

(Arrow *et al.*, 1993). However, telephone surveys have some distinct advantages in comparison with the other techniques. In contrast with postal surveys, telephone surveys do not suffer from low response rates and non-response bias, and tend to yield more conservative willingness to pay values (Loomis & King, 1994). Compared with in-person interviews, they are more cost-effective and allow greater ease of centralised supervision (Arrow *et al.*, 1993; Schuman, 1996). Although telephone surveys have been criticised because of difficulties of conveying accurate information about the market to the respondent, the choice of two high-profile species for this study minimised these problems. Furthermore, in order to eliminate information bias, the information provided for each species was kept consistent in both format and content between the questionnaires (Samples *et al.*, 1986; Keller & Staelin, 1987; Hoevenagel & van der Linden, 1993). The use of three different questionnaires, one for each of the two species separately and one for both species together, also allowed an assessment of the extent of any embedding effect, i.e. the extent to which expressed willingness to pay for species conservation was symbolic (i.e. independent of the number of species) rather than additive (Kahneman & Knetsch, 1992).

Dichotomous choice questions are generally accepted to result in less uncertainty than open-ended questions and remove the problems of very high or very low bids (Arrow *et al.*, 1993; Bateman *et al.*, 1995), although this is not undisputed (Willis, 1995). They tend to give higher estimates of willingness to pay, compared with open-ended questions (Bateman *et al.*, 1995), although Loomis and White (1996) found that the format of the questionnaire was relatively unimportant in determining willingness to pay for endangered species. One major drawback of referendum type surveys is that they require a larger sample size than open-ended formats to achieve comparable statistical reliability (Mitchell & Carson, 1989; Willis, 1995), and a random sample size of around 1000 is recommended (Arrow *et al.*, 1993). This inevitably makes them much more expensive to conduct. However, the high predictive power and statistical reliability of the models obtained from the relatively low sample size used in this study ($n = 315$) demonstrate that reliable results can in fact be obtained from smaller sample sizes using simple but carefully constructed questionnaires where medium to high response rates are obtained.

Some loss of accuracy is inevitable with smaller sample sizes, so the values obtained for mean willingness to pay, but especially aggregate willingness to pay, should be treated with some caution. Nevertheless, the results of this study have clearly demonstrated considerable public support for mammal conservation in the UK. It is possible that the respondents gave an over-estimate of the willingness to pay because they realised that the market was hypothetical (Arrow *et al.*, 1993). However, the low level of protest responses and a strong interest to participate both suggest that the respondents attempted to give reliable answers.

The covariate coefficients from the logistic regression models indicated that the most influential variables in determining respondents' willingness to pay were their age, the specified tax amount, whether they were aware of the threats to that specific species, whether they were a member of a conservation organisation and whether they walked frequently in the countryside. The first two of these showed negative correlations with willingness to pay, whereas the latter three all showed positive correlations with willingness to pay. The latter three variables all reflect a greater interest in wildlife and conservation than for the population as a whole.

The mean willingness to pay for the otter (£11·91) was considerably higher than that obtained for the water vole (£7·44). There are two possible reasons for this difference. The first is the differing status of the national populations of the two species. Although the otter population is currently slowly increasing, otters are still quite rare in most places. In contrast, whereas the water vole population is in substantial decline, water voles are still relatively common. The results suggest that the public may perceive rarity *per se* as being more important than whether a population is increasing or declining (i.e. the degree of active threat). The second factor that may be important is the differing public perception of the two species. Otters are well known by most people and are a 'flagship' conservation species. In contrast, water voles are relatively less well known. In both cases, however, the value nominally attributed to the species by the general public also may include an implicit value for the communities and ecosystems in which they live. This may also reflect the level of knowledge or information that a respondent has in respect of the species concerned.

The results of this study also provide a clear demonstration of the embedding effect (Kahneman & Knetsch, 1992), with the mean willingness to pay for both species together being significantly less than the aggregated values for each species individually, and similar to that for the otter alone. This suggests that the expressed willingness to pay was more symbolic than additive, and that people may have been reacting to the presence of the 'flagship' otter *per se* rather than basing their decision on any quantified assessment of rarity or threat. We suggest that the value attributed by people to a group of species using the contingent valuation method will be approximately the same as that they would give to the single highest valued species in the group (the 'flagship' hypothesis). Public profile therefore may be as important as rarity or the degree of threat in determining a species' economic value.

Loomis and White (1996) reviewed the use of contingent valuation to measure the economic values of rare and endangered species in the USA. Willingness to pay as annual payments varied between species from less than $10 per household for fish, such as the striped shiner, up to $60 for high profile conservation species such as the northern spotted owl. Willingness to pay as single payments varied from $15 for the Arctic grayling up to $216 for the bald eagle. These authors found that the size of the proposed change in populations of rare and endangered species was a significant factor determining willingness to pay, and suggested that this showed that willingness to pay results are not merely symbolic, but sensitive to the magnitude of changes proposed. However, they also found that the type of species (i.e. whether a bird, fish or marine mammal) was significant, which would tend to counteract the importance of the change in population size parameter. Moreover, they did not include any measure of the rarity or public profile of the species, which the present study has shown to be of importance, and which the individual willingness to pay values quoted in their review also suggest should be highly significant. Samples *et al.* (1986) investigated the effect of information disclosure on willingness to pay for endangered species conservation. They found that physical appearance of the species was a significant factor affecting willingness to pay, but that when information on endangered status was revealed at the same time, this affected the willingness to pay for different species. Clearly, more work is needed to assess the relative importance of population size, population trends, proposed changes in population size and public profile in determining the relative economic values of different threatened species.

Great care must be taken when considering aggregate willingness to pay values, especially with regard to the representativeness of the survey sample to the population over which the mean value is being aggregated. The sample population in the present study represented 0·05% of the North Yorkshire population. Although this figure is low, it represents a sampling rate similar to other contingent valuation studies (Hanley & Spash, 1993). Furthermore, the demographic and socio-economic consistency between the respondents for the three questionnaires suggests that aggregation of the mean willingness to pay from the sample population to the population of North Yorkshire should be reliable. The difference in age distribution between the sample population and the North Yorkshire population, and the possible difference in income distribution that would result, are not important here because neither age nor income was a significant factor in any of the models. However, since the North Yorkshire population could not be held to be representative of the UK population (with a relatively high proportion living in rural areas, as evidenced by the high proportion who walked frequently in the countryside), further aggregation beyond the level of the North Yorkshire population is not valid.

The aggregate willingness to pay values for the otter and water vole calculated for the North Yorkshire population on the basis of the survey results are between four and six times greater than the present values of the UK action plans for these two species. Even allowing for various complicating factors affecting the willingness to pay values, these aggregate values substantially exceed the present values of the action plans for these two species. To put these figures into perspective, planned public expenditure provision for payments under agri-environment schemes in the UK in 1995/96 was about £100 million, English Nature's planned spending in 1995/96 was £41 million, that of the Countryside Council for Wales £17 million and that of Scottish Natural Heritage £40 million. The indicative costs identified in the species action plans make no assumptions about where the costs may lie, and the contribution of private sector funding is important. On average, half of the cost of the action plans now in hand has been borne by the non-government sector, and in 1991, non-government organisations spent about £80 million on conservation in England and Wales (Anon, 1995*a*). Although a significant portion of any money spent may come therefore from the private sector, there will still be a substantial burden on the taxpayer if the action plans are to be realised, whether this occurs through additional taxation or the redistribution of existing environmental expenditure.

This study has shown that eliciting willingness to pay using contingent valuation provides a simple and reliable method for quantifying the relative economic values of threatened mammals, and that the insights gained are therefore useful for the future development of environmental policy and tactical decision-making. Furthermore, the aggregation of the willingness to pay values over the entire population of North Yorkshire has revealed values well in excess of the indicative costs of the UK action plans for the conservation of the otter and the water vole. This represents a strong argument for implementing the respective programmes, especially in the context of a more liberal economic framework where the general public have a more prominent role in determining public expenditure priorities. The results also demonstrate the importance of high profile 'flagship' species such as the otter in determining the extent of public support for conservation, and the consequent importance of such species for the investment of resources into the conservation of the communities and ecosystems within which they live. This suggests that improved information should assist in gaining support for the conservation of other species and habitats, and provides further support for the view that the provision of information should be a high priority in nature conservation programmes both locally and nationally.

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APPENDIX

General form of questionnaire for eliciting willingness to pay for species conservation

The differences between the three questionnaires used, where applicable, are identified by OT (otter only), WV (water vole only) and TO (both species together). For details of variations in the specified amount payable see text. Sections spoken by the interviewer are italicised

Name of interviewer
Telephone number of respondent
Sex of respondent

Hello, my name is x. *I am at York University undertaking research in the conservation of mammal species. Your name was randomly selected by computer. Would you be willing to spare two minutes to answer some questions on this subject? Your answers will be confidential and will not be used in any way other than for my research.*

As you may know, many British mammal species are under threat from the activities of humans and have declined in number over the last 25 years.

Q1. *Were you aware that many British mammals are under threat from human activities?* Yes/No

A UK steering group has recently put forward action plans for the conservation of eight important mammal species in Britain, including the {(OT) *otter*/(WV) *water vole*/(TO) *otter and water vole*}.

{(OT) *Otters*/(WV) *water voles*/(TO) *otters and water voles*} *are found in various parts of Britain including Yorkshire. However, it is unlikely that you will ever see one unless you walk frequently in the countryside.*

{(OT) *The main threat to otter numbers is the pollution of streams and rivers.* (WV) *The main threats to water vole numbers are the pollution of streams and rivers, predation and habitat loss.* (TO) *The main threat to otter numbers is the pollution of streams and rivers. The main threats to water vole numbers are the pollution of streams and rivers, predation and habitat loss.*}

Q2. *Were you aware of these threats to the* {(OT) *otter*/(WV) *water vole*/(TO) *otter and water vole*}? Yes/No

{(OT) *The estimated UK otter population is 7500 and the otter is not in immediate danger of extinction. During the last 10 years the population has been slowly increasing.* (WV) *The estimated UK water vole population is 1·1 million, and the water vole is not in immediate danger of extinction. However, the population has decreased by up to 50% over the last 25 years and is still falling.* (TO) *The estimated UK otter population is 7500, and the otter is not in immediate danger of extinction. During the last 10 years, the population has been slowly increasing. The estimated UK water vole population is 1·1 million, and the water vole is not in immediate danger of extinction. However, the population has decreased by up to 50% over the last 25 years and is still falling.*}

{(OT) *The aim of the action plan is to maintain otter populations and, where possible, restore them to all areas inhabited 25 years ago by the year 2010.* (WV) *The aim of the action plan is to maintain water vole populations and where possible restore them to all areas inhabited 25 years ago by the year 2010.* (TO) *The aim of the action plans is to maintain populations of these two mammals and, where possible, restore them to all areas inhabited 25 years ago by the year 2010.*}

To do this will require money. One way of raising this money would be by a single national addition to taxes.

Some people may be in favour of this because it will reduce the threats to the {(OT) *otter*/(WV) *water vole*/(TO) *otter and water vole*}. *Others may be against it because the* {(OT) *otter*/(WV) *water vole*/(TO) *otter and water vole*} *is/are not in immediate danger of extinction, or they do not think it is worth the money.*

Q3. *Would you be willing to pay a single national addition to taxes of* £x *towards the action plan to reduce the threats to the* {(OT) *otter*/(WV) *water vole*/(TO) *otter and water vole*}? Yes/No

Q4. *Are you a member of any conservation group or environmental organisation?* Yes/No

Q5. *Do you walk frequently in the countryside?* Yes/No

Q6. *In which of these ranges does your annual household income fall?*	Q7. *To which of the following age groups do you belong?*
< £10 000	< 20
£10 000–20 000	20–29
£20 000–30 000	30–39
£30 000–40 000	40–49
> £40 000	> 50