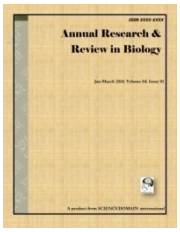

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Valuing Nature: Public Perception of Value Added by Native and Invasive Non-Native Species to a Recreational Trail Experience

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Authors' contributions

This work was carried out in collaboration between all authors. All authors designed the study, author NJM collected the data, author PKM performed the statistical analysis and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

Research Article

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ABSTRACT

Aims: To assess the effect of four animal and four plant species on the perceived monetary value of users' single experience of a recreational trail. To assess the effect on perceived value of identifying to users that four of the species are invasive non-native species (INNS) with adverse impacts on native species.
Study Design: An image-based questionnaire was used to assess perceived monetary value of the species before and immediately after being given information on their INNS status.
Place and Duration of Study: The Camel Trail, North Cornwall UK, used by about ½ million people annually, April and May 2011.
Methodology: Fifty one Camel Trail users completed the questionnaire.
Results: Trail users positively valued all eight species when first shown them. Mean values ranged from £0.066 to £0.104. However, species were valued significantly differently (non-parametric repeated measures ANOVA, H = 55.3, 7 DF, $P < .0001$). Users showed significant agreement on the rank order of the value of the eight species (Kendall's coefficient of concordance, W = 0.155, $\chi^2 = 55.3$, 7 DF, $P < .0001$). After the four INNS were identified to users, these INNS were devalued by 115% to 180%. Again there were significant differences between species values (H = 16.9, 3 DF, $P = .0007$) and significant agreement between users on the rank order value of INNS (W = 0.11 χ^2 =

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16.9, 7 DF, *P* = .001).
Conclusion: Using a simple image-based questionnaire to assess perceived monetary value of species can provide evidence to assess the cost of managing INNS.

Keywords: INNS; perceived value; monetary value; image-based questionnaire.

1. INTRODUCTION

The impact that invasive non-native species (INNS) can have on habitats is often used as a justification for control programmes [1-4]. However, the public perception of invasive species may be very different from that of habitat managers [5,6], giving rise to potential conflict with those attempting to reinstate the habitat [7,8]. Many non-native species were originally introduced as ornamental species and are often perceived to add to the aesthetic value of the landscape [9]. Understanding public perception [10] is a crucial aspect of management [11]. It also provides an opportunity to attach a monetary value to the benefits of management, which can be essential in justifying the cost [12-14]. Most invasive non-native species have been deliberately or accidentally released into the wild [15,16], and an improved understanding of the impact these species have and the costs they incur [17], form an important part in challenging the public behaviour that gives rise to their release into the environment [18].

Structured questionnaires can be used to assess people's environmental preferences, including stated monetary value, which is often assessed by a Willingness To Pay (WTP), i.e. how much they would be prepared to pay to receive something from the environment [19,20]. We report a stated preference approach using an image-based questionnaire that is straightforward to implement, can be used by non-specialist environmental volunteers and which could inform a WTP approach. It therefore has the potential to help better understand the public perception of INNS and their management. We used the approach to answer two main questions: (1) What is the perceived monetary value to users of a recreational trail of experiencing (or knowing to be present) eight common species? (2) Does this value change when four of the species are identified as invasive non-native species?

2. METHODOLOGY

2.1 Study Area

The Camel Trail in North Cornwall, UK is considered to be one of the most popular [21] and successful [22] multi-use trails in the UK. It runs for 29 km from near the village of Blisland (50.5167, -4.6833) on Bodmin Moor to the fishing village of Padstow (50.5384, -4.9378) near the mouth of the Camel estuary. For most of its length it follows a disused railway line and this has the effect of creating a corridor so that most users' experience is similar. There are about ½ million users annually, mostly cyclists or walkers. The study was carried out near Wadebridge (50.5178, -4.8353), which is close to the mid-point of the most popular section of the trail (Padstow to Bodmin) and the location of several cycle hire businesses.

2.2 Questionnaire Design

Data on perceived monetary value of species likely to be experienced by trail users were collected by means of a questionnaire showing photographs of eight species (Fig. 1). The

images were selected to be of comparable size, quality and composition. Most came from the open access Arkive image database [23]. Species were not named, but they were grouped; native species in the left-hand column, invasive non-native species (INNS) in the right-hand. They were also further grouped; animals by taxon (*Lutra lutra* (Linnaeus 1758) with *Oryctolagus cuniculus* (Linnaeus 1758), *Cygnus olor* (Gmelin 1789) with *Branta canadensis* (Linnaeus 1758)) and plants by common trail location (verge, *Primula vulgaris* Huds. with *Rhododendron ponticum* L.; wet area, *Iris pseudacorus* L. with *Impatiens glandulifera* Royle). In the first part of the questionnaire these grouping patterns were not identified or explained.

Each image had an associated monetary value scale from 10p through 0p to -10p (10p = £0.1, approximately €0.13 and $0.16) (Fig. 1). This scale was chosen because respondents to a pilot questionnaire indicated that this was an appropriate range of values.

The second stage of the questionnaire (Fig. 2) differed from the first in three ways:

1) The detail of the heading text was changed (Fig. 2) to explain the INNS status of species in the right-hand column and its likely impacts,
2) Each INNS image was outlined in red,
3) The estimated annual cost (from Williams et al. [24]) was given under each INNS image.

2.3 Data Collection

Users of the Camel Trail were invited to complete the questionnaire, most commonly while they were waiting to collect or return hired cycles. They were asked to assign a monetary value to the effect on their current Camel Trail experience of seeing each of eight species depicted on the questionnaire, or knowing that the illustrated species was present even if it wasn't seen. Monetary value was assigned by marking the scale beside each image. On completing the first part of the questionnaire (Fig. 1), they were shown the second part (Fig. 2), informed that the four species in the right-hand column were INNS with adverse impacts on native species (this was reinforced by the estimated annual cost of that species (from Williams et al. [24]) being displayed below each image), and asked to indicate a new value on the scale. Fifty one Camel Trail users completed the questionnaire in April and May 2011. The ratio of cyclists to walkers completing questionnaires (4:1) was similar to the ratio of these trail user groups at this time of year.

2.4 Data Analysis

Marks on the monetary value scale were subsequently assigned by eye to the nearest whole pence (£0.01) value and marks above 10p and below -10p were assigned values of 12p and -12p respectively. The values were analysed with non-parametric repeated measures analysis of variance and Wilcoxon matched pair signed ranks tests (e.g. [25]). The extent of agreement on value between trail users was analysed with Kendall's coefficient of concordance (e.g. [26]). Statistical analyses were performed with SPSS version 19 or Gilbert et al.'s [27] Excel-based open access package for Barnard et al. [25].

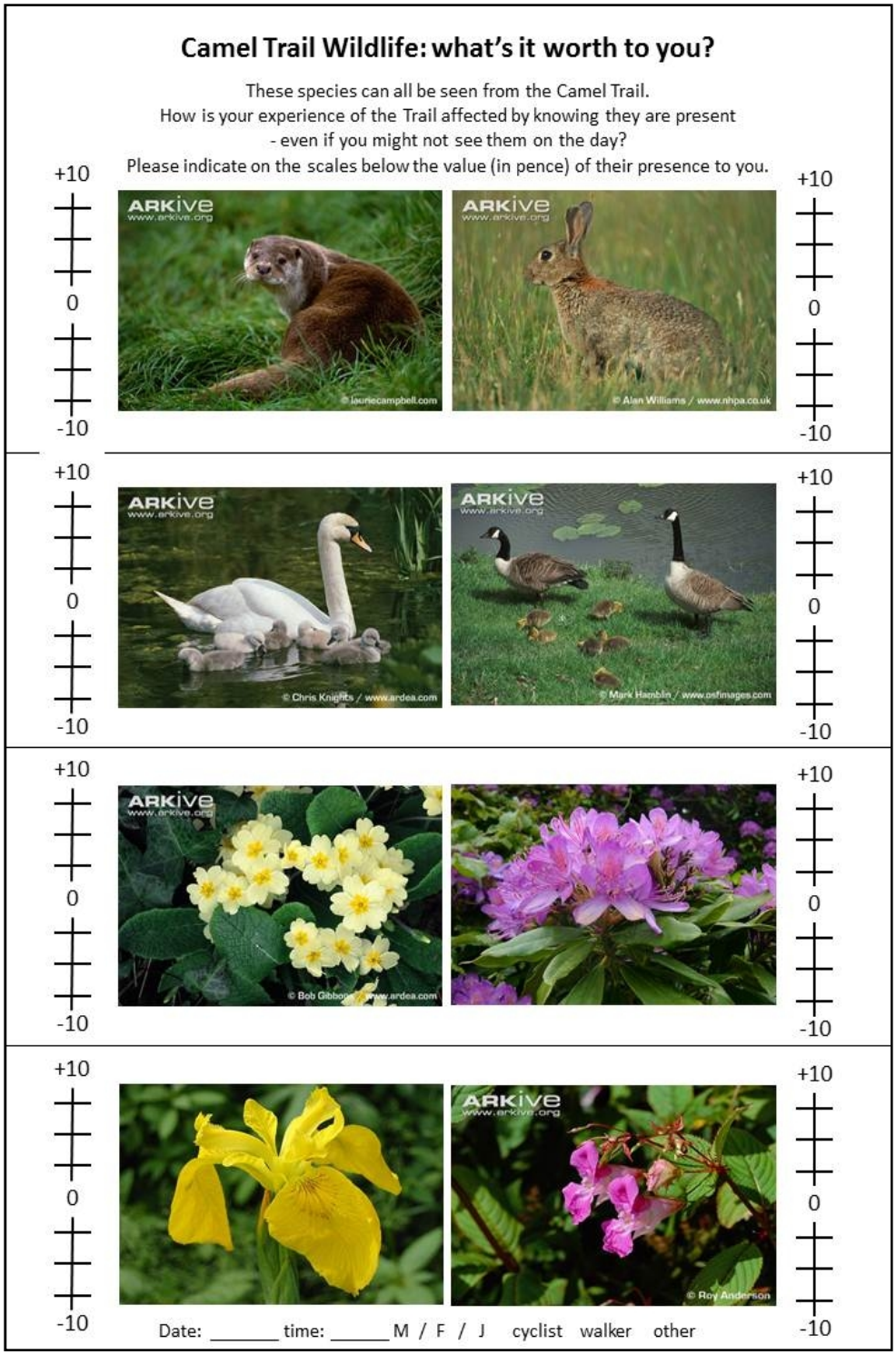

Fig. 1. The image-based questionnaire used in part 1 of the study

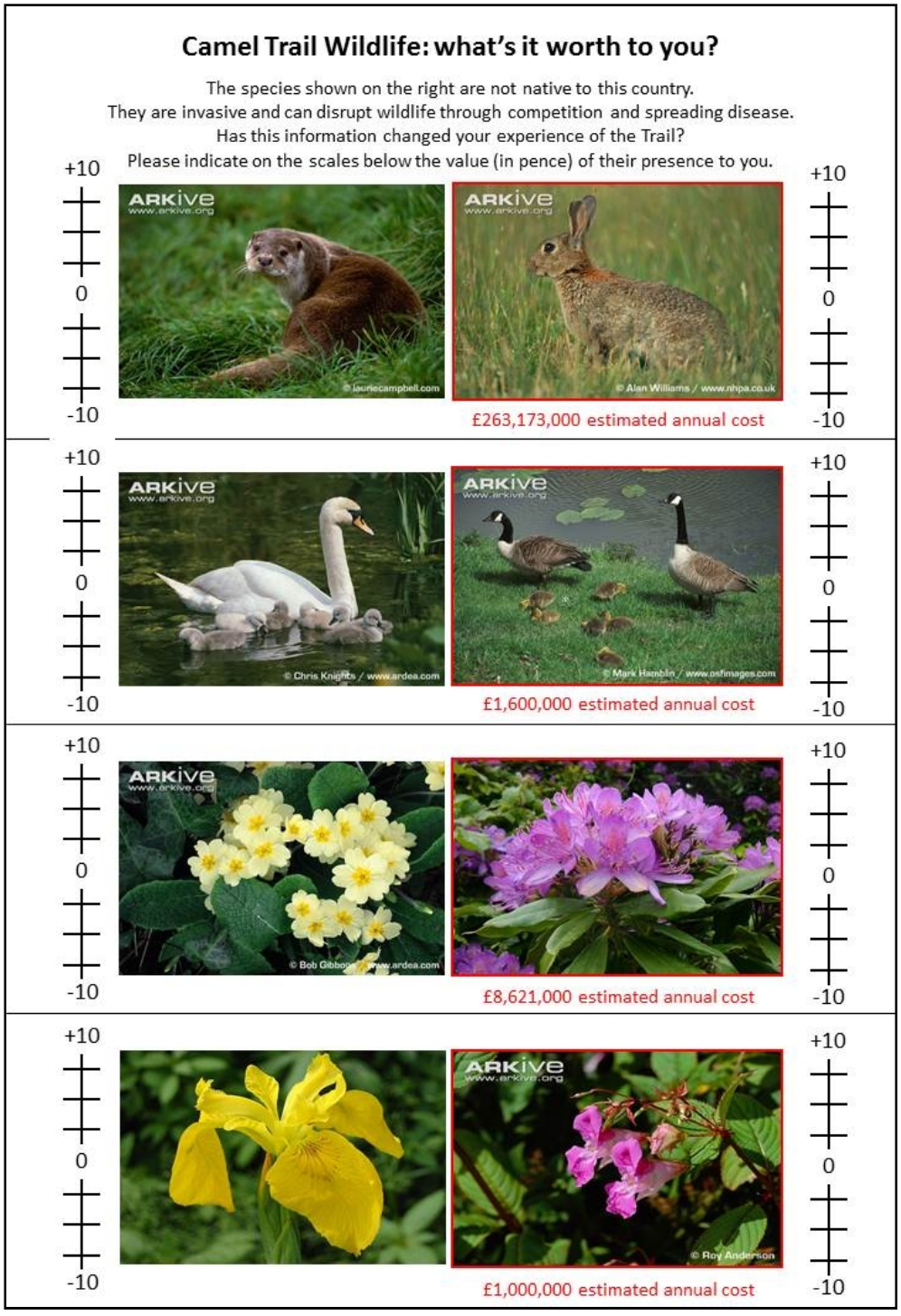

Fig. 2. The image-based questionnaire used in part 2 of the study

3. RESULTS

Camel Trail users considered that all eight species shown to them in part 1 of the questionnaire added to the monetary value of their current trail experience. However, species were valued significantly differently with mean values ranging from 6.6p to 10.4p (Table 1; non-parametric repeated measures ANOVA, H = 55.3, 7 DF, $P < .0001$). There was significant agreement between users on the rank order of the value of the eight species (Kendall's coefficient of concordance, W = 0.155, χ^2 = 55.3, 7 DF, $P < .0001$). However, the rank order indicated by the mean values in Table 1 matches users' rank order only for the most valued species (*L. lutra*) and the two least valued species (*I. glandulifera*, *B. canadensis*). Users ranked the other five species in the order *R. ponticum* > *C. olor* > *O. cuniculus* > *P. vulgaris* > *I. pseudacorus*, whereas the order of mean values (Table 1) is *C. olor* > *R. ponticum* > *P. vulgaris* > *I. pseudacorus* > *O. cuniculus*.

Table 1. Monetary value assigned to 8 species by 51 Camel Trail users in response to part 1 of the questionnaire

Species	Value*	Species	Value*
Lutra lutra	10.39 ± 0.25	*Oryctolagus cuniculus*	7.55 ± 0.77
Cygnus olor	8.43 ± 0.41	*Branta canadensis*	6.55 ± 0.69
Primula vulgaris	8.06 ± 0.53	*Rhododendron ponticum*	8.31 ± 0.53
Iris pseudacorus	7.84 ± 0.44	*Impatiens glandulifera*	6.69 ± 0.72

** Values are mean pence (= £0.01) ± se, n=51.*

In part 1 of the questionnaire INNS were not identified, nor was the native - invasive pairing of species images. Nevertheless, native species were significantly more highly valued than the INNS they were paired with for three of the four image pairings (Wilcoxon matched pairs signed ranks test: *L. lutra* & *O. cuniculus*, z = 6.21, $P < .00001$; *C. olor* & *B. canadensis*, z = 5.22, $P < .00001$; *I. pseudocorus* & *I. glandulifera*, z = 2.35, $P = .0189$). This pattern suggests that some users were aware of some INNS and the issues related to them. This interpretation is supported by the minimum values assigned to species; these were 0 or positive for natives (except *P. vulgaris* which was -7) and either -7 or -12 for INNS. It is also supported by the considerably higher level of agreement shown within native species (W = 0.223, χ^2 = 34.1, 3 DF, $P < .0001$) than within INNS (W = 0.078, χ^2 = 11.9, 3 DF, $P = .008$). However, factors other than knowledge of INNS also play a role, as shown by the significantly higher value of *R. ponticum* compared with the native *P. vulgaris* (z = 3.4, $P = .0007$).

Part 2 of the questionnaire was completed after INNS were identified to Camel Trail users. Trail users then generally assigned negative values to all four INNS with the consequence that mean values ranged from -1.2p to -5.3p and the change in valuation ranged from -8.7p to -12p (Table 2); a change in mean value of -115% to -180%. Again there were significant differences between species (H = 16.9, 3 DF, $P = .0007$) and significant agreement on the rank order of INNS (W = 0.11 χ^2 = 16.9, 7 DF, $P = .001$). The effect of providing information on INNS status and effects was an increased level of agreement on INNS value; in part 1 of the questionnaire W = 0.078 whereas in part 2, W = 0.11.

Table 2. Monetary value assigned to 4 INNS by 51 Camel Trail users in response to part 2 of the questionnaire

Species	Revised value*	Change in value**
Oryctolagus cuniculus	-1.16 ± 1.07	-8.71 ± 1.09
Branta canadensis	-2.41 ± 0.97	-8.96 ± 1.04
Rhododendron ponticum	-3.73 ± 1.02	-12.04 ± 1.06
Impatiens glandulifera	-5.33 ± 0.87	-12.02 ± 1.01

** Revised value is the mean value in pence (= £0.01) ± se, n=51, assigned to the four species identified as INNS in this part of the questionnaire.*

*** Change in value is the difference between the part 1 (Table 1) and part 2 questionnaire value (Table 2 revised value) in pence (=£0.01) ± se, n=51.*

However, the devaluing effect of INNS information was not universal. While 86-96% of respondents devalued INNS (or had already assigned them the maximum negative value), a few respondents (one for *O. cuniculus* and *B. canadensis*, two for *R. ponticum* and *I. glandulifera*) increased the value of INNS. Also, three respondents still assigned a maximum positive value to INNS (two to *O. cuniculus* and one to *B. canadensis*). This suggests that a minority of individuals either misunderstood the information, or their value of a species is not mainly related to its invasive status and likely effects on native wildlife (see also [20]). The second explanation seems more likely to be true, because valuations against the general trend were not consistent within a respondent.

4. DISCUSSION

Our study has shown that on the basis of images and in the absence of information on species identity and invasive status, all species are considered to contribute positively (although not equally) to a single trail experience. However, providing some information on INNS status briefly and individually to trail users led to a significant devaluing of the contribution that INNS make to a trail experience. The study also showed that the level of knowledge on the identity and effect of INNS is rather low in the public who use trails. This is interesting because trail users might be expected to have a higher level of knowledge of the environment than the general public. If this expectation is correct it suggests that the general public's knowledge of INNS is even lower.

The image-based questionnaire approach has shown that it is possible to gather quantitative data on perceived monetary value of individual species from users of a public space. The data can be used to establish the relative perceived value of species. However, the results from a pilot questionnaire suggested that the range of values used in the study is likely to be a reasonable approximation to absolute valuations. This suggestion is supported by the relative lack of discussion of values by respondents during data collection (Nicola Morris, personal communication, May 2011) and by the relatively small percentage (23%) of initial responses of maximum value. We suggest that data of the type collected by this questionnaire can contribute to assessing the cost effectiveness of management plans for INNS, adding to approaches based on simple economic cost (e.g. [28]). For example, the average devaluation of a single trail experience of *I. glandulifera* was £0.0533 per questionnaire respondent. If we assume that this devaluation is the same for each Camel Trail user per year, then the total cost (based on 500,000 users per year) is £26,650. For *O. cuniculus* the devaluation was £0.0116, giving a total cost of £5,800. These values could be used as a starting point for discussions of proportionate management cost and budget allocation for INNS management, both for the Camel Trail and for public amenity areas that

are similar to the Camel Trail. We suggest that for the potential of this approach for management cost assessments to be realized, the effect of the range of values presented in image-based questionnaires and the willingness of management budget holders to use such assessments be investigated further.

5. CONCLUSION

We conclude that the perceived monetary value to users of a recreational trail of experiencing (or knowing to be present) eight common species can be assessed by an image-based questionnaire. We found that perceived value changed when four of the species were identified as INNS. We suggest that such perceived values can be used when assessing the cost of managing INNS, and that, as a starting point, proportionate expenditure would be a management plan for an INNS with a similar budget to the perceived decrease in perceived value caused by that species.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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