Biological Conservation 144 (2011) 2728–2732

Contents lists available at ScienceDirect

Biological Conservation

journal homepage: www.elsevier.com/locate/biocon

Short communication

The value of species rarity in biodiversity recreation: A birdwatching example

Josephine E. Booth [a,1], Kevin J. Gaston [a], Karl L. Evans [a], Paul R. Armsworth [a,b,*]

[a] Biodiversity and Macroecology Group, Department of Animal and Plant Sciences, University of Sheffield, Sheffield, S10 2TN, UK
[b] Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville, TN 37996-1610, USA

ARTICLE INFO

Article history:
Received 12 July 2010
Received in revised form 9 February 2011
Accepted 13 February 2011
Available online 10 August 2011

Keywords:
Biodiversity
Birdwatching
Ecotourism
Protected area
Rarity
Recreation
Value

ABSTRACT

Wildlife viewing recreation offers conservationists opportunities for education and generating revenue but can also have detrimental ecological impacts. To manage these opportunities and impacts effectively, a better understanding is needed of what people value in wildlife viewing events. We examine the relationship between species rarity and value for wildlife viewing recreation. We undertook visitor counts of birdwatchers attending rare (vagrant) bird sightings and collected home postcodes to assess the distances these individuals travelled to achieve these sightings. We also undertook visitor counts at common bird viewing locations for comparison. We regressed birdwatcher numbers against rarity, site protection status, time the bird had been on site and day of the week when the count took place. We undertook these analyses for rare bird sightings only, using a continuous measure of rarity, and for both rare and common species combined, using a categorical rarity index. Species rarity was the clearest predictor of visitor numbers in both the analyses. When studying rare birds only, we found the functional form of the relationship between rarity and visitor numbers to be inverse and asymptotic. Individuals also travelled further to see rarer species. However, while exceptional numbers of visitors attended exceptionally rare bird sightings, the marginal value of rarity appeared to be relatively low. Despite the opportunity for revenue raising and education provided by rare bird sightings, a comparison of visitor numbers at sightings inside and outside protected areas showed no evidence that managers of protected areas capitalise on these opportunities.

1. Introduction

To broaden and deepen support for conservation in society, we need to understand what aspects of biodiversity people value, to reflect these values in conservation policies and actions, and to enhance them through outreach and education. Such values can include both economic and non-economic representations of anthropogenic preferences regarding biodiversity. Many characteristics of biodiversity can be associated with value. People may value diversity itself (Fuller et al., 2007) or individual species that are particularly rare (Tisdell and Swarna Nantha, 2007; Angulo and Courchamp, 2009) or charismatic (Richardson and Loomis, 2009).

Wildlife viewing recreation offers opportunities for educating people about biodiversity and for generating revenue for conservation. However, the accompanying recreational disturbance can impact species and habitats (Taylor and Knight, 2003; Pearce-Higgins et al., 2007; Reed and Merenlender, 2008; Kangas et al., 2010). To manage these opportunities and impacts effectively, we need to understand better what people value in wildlife viewing events (Reynolds and Braithwaite, 2001). Some authors have suggested that if people value rarity in wildlife viewing recreation and recreation activities have detrimental ecological impacts, then a species may suffer from an "anthropogenic Allee effect" putting it at risk of extinction (Courchamp et al., 2006; Angulo and Courchamp, 2009). In this hypothesis, rarity attracts more visitors to see the species, whose impacts cause further declines in the species abundance, setting up a dangerous feedback loop. However, despite its critical role in this hypothesis, the nature of the relationship between species rarity and the value people attribute to wildlife viewing is not well understood (Angulo and Courchamp, 2009).

Estimating the value of rarity has attracted attention from biologists (Courchamp et al., 2006; Gault et al., 2008; Angulo and Courchamp, 2009) and other disciplines (Koford and Tschoegl, 1998). Many studies on species rarity focus on extractive use values from hunting and trade (Courchamp et al., 2006; Gault et al., 2008) or existence values (Christie et al., 2006; Tisdell and Swarna Nantha, 2007), the values people attribute just to knowing that a particular species or ecosystem exists. The value of rarity that is realised through wildlife viewing recreation has received less attention.

Past studies of the value people attribute to the rarity of species in wildlife viewing have concentrated on species in zoos (Maresova

* Corresponding author at: Department of Ecology and Evolutionary Biology, University of Tennessee, Knoxville, TN 37996-1610, USA. Tel.: +1 (865) 974 9748; fax: +1 (865) 974 3067.

E-mail address: p.armsworth@utk.edu (P.R. Armsworth).

[1] Current address: Centre for Science Education, Sheffield Hallam University, Howard Street, Sheffield S1 1WB, UK.

0006-3207/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.biocon.2011.02.018

and Frynta, 2008; Angulo et al., 2009) and other *ex situ* contexts (Angulo and Courchamp, 2009). This shortcoming is perhaps due to the challenge of associating a particular wildlife viewing event *in situ* with an individual species while still observing sufficient wildlife viewing events for comparable species to make inferences regarding rarity. Studies demonstrating that species rarity has value typically compare only two species or types, one rare and one more common (Christie et al., 2006; Tisdell and Swarna Nantha, 2007; Gault et al., 2008; Angulo and Courchamp, 2009), saying nothing about the functional form of the relationship between rarity and value, or about the marginal change in value that results from a marginal change in rarity.

We undertake a field-based examination of the value of species rarity in wildlife viewing. By observing a range of wildlife viewing events for species of varying rarity, we provide an assessment of the functional form between rarity and value and estimate the marginal value of rarity. To do this, we capitalise on an unusual example of wildlife viewing, specifically vagrant bird sightings, which enables us to examine the value attached to extremely rare events.

Birdwatching is the fastest growing segment of the ecotourism market with the potential to generate significant conservation income (Şekercioğlu, 2002). For example, Hvenegaard et al. (1989) estimate the local income generated by birding visitors to Point Pellee, a small national park in Canada, to be $3.2 million, and Şekercioğlu (2002) estimates the annual income from five birding sites in the USA at US$2.4 million to US$40 million. A subset of birdwatchers, known as ''twitchers'' in the UK and ''listers'' in the USA, travel long distances and expend significant resources to see rare birds. The definition of rarity here is an unusual one, in that the most valued sightings are often vagrant birds that have strayed from traditional migratory routes and are observed outside their customary geographic range, where they may be relatively abundant.

We examine how the rarity of birds affects the number of birdwatchers that come to view them, using the number of birdwatchers as a simple measure of value. We discuss other measures of value (travel-cost) later.

2. Materials and methods

2.1. Dataset 1 – rare birds only

We collected data from 45 rare bird sightings on 29 sites across the UK over three birdwatching ''seasons'' – autumn 2007, spring 2008 and autumn 2008. We obtained notifications of sightings from specialised paging services for birdwatchers. We recorded the maximum number of people viewing a bird, day of the week, location and species. We also noted the number of days that had elapsed since the focal individual was first observed and whether the sighting occurred on a protected area. We calculated the average number of sightings of the species in the UK per year since recording for the species began (taken from annual reports published in British Birds up to 2006) as a continuous measure of rarity.

2.2. Dataset 2 – rare and common birds combined

For comparison with the data on rarities, we collected similar data for more common species at 14 additional sites in Yorkshire and Norfolk. For this second analysis, we combined the data on common species with the data on rare species in these regions, giving a total sample of 63 observations. To analyse the combined dataset, we used a categorical measure of rarity, with 1 representing species having more than 1000 individuals in the UK, 2 those with fewer than 1000 individuals, 3 scarcities, 4 rare birds, and 5 birds considered to be megas – i.e. very rare. The latter three categories were classified following the system used in 2008 by the Birdguides website (http://www.birdguides.com), a website for dedicated birders that holds detailed information on bird species and sightings in Great Britain and runs the pager service used for this study. The categories are established using information from the British Birds journal and the British Birds Rarities Committee (http://www.bbrc.org.uk).

2.3. Distances travelled to rare bird sightings

We collected home postcodes from birdwatchers at two bird sightings: the brown flycatcher (*Muscicapa dauurica*), the second recorded sighting of this species in Britain, and the red-flanked bluetail (*Tarsiger cyanurus*), another ''mega'' at the time of data collection but one recorded 38 times between 1950 and 2006. These sightings took place at different times at one location (Old Fall Plantation in the Flamborough Outer Headland Local Nature Reserve in Yorkshire).

2.4. Statistical analysis

For Dataset 1 (*rare birds only*), we regressed birdwatcher numbers against our continuous measure of rarity, site protection status (binary categorical), time since the bird was first detected on site (days), and whether visitor numbers were counted on a weekend or weekday (binary categorical). Visitor numbers, the continuous rarity index and time on site were log transformed to base ten to meet assumptions of normality. We included the time the bird had been on site prior to the visitor count in case there had been any fall off in visitor numbers before we arrived. We tested for an effect of the interaction between rarity and protected area status (rarity index $*$ site status) to allow for non-additive effects. Other interaction terms were not included.

For Dataset 2 (*rare and common birds combined*), we regressed birdwatcher numbers against our categorical measure of rarity (1–5 scale), site protection status (binary categorical), the interaction of these two variables, and whether visitor numbers were counted on a weekend or weekday (binary categorical). Including the time the bird had been on site would not have been appropriate for more common species.

For both sets of analyses, we first checked predictor variables for collinearity. We followed standard protocols to implement an information theoretic approach to model selection (Burnham and Anderson, 2002). We constructed all possible models given our predictor variables (19 models for Dataset 1: *rare birds only* and 9 models for Dataset 2: *rare and common birds combined*). We used the Akaike Information Criteria (AIC) to calculate model weights. Model weights estimate the probability that each model is true assuming that the truth lies inside the model set. The smallest number of models whose cumulative weights summed to 0.95 was included in the 95% confidence set of models. We conducted model averaging across this set of models to assess the influence of each predictor variable.

3. Results

3.1. Rare birds only

The number of people viewing rare birds ranged from 2 to 300. Focusing first on our continuous measure of rarity, 10 models were retained in the 95% confidence set (Table S1) and all of these included rarity as one of the predictor variables. The model with the lowest AIC value retained rarity alone and had an r^2 of 0.24.

Table 1
Model averaged parameter estimates and partial r^2 values across the 95% confidence set of models for Dataset 1 (*rare birds only*) when rarity is scored as average number of sightings in the UK per year since recording for the species began.

	Rarity index	Site status		Weekend/day		Days seen	Rarity index ∗ site status	
		0	1	0	1		0	1
Weighted parameter estimates	−0.20	0.04	0.00	0.00	0.00	0.01	−0.02	0.00
Weighted partial r^2	0.22	0.00		0.00		0.00	0.00	

Model averaging across the 95% confidence set of models demonstrated that the variation in birdwatcher numbers explained by our predictor variables is almost entirely explained by species rarity (Table 1; Fig. 1). The negative slope coefficient that relates the log of visitor numbers to the log of the rarity index (Table 1) indicates that the relationship between these terms after back-transforming is approximated by an inverse power law, which approaches an asymptote as species become increasingly rare (Fig. 1, inset). Moreover, the slope coefficient, which is formally equivalent to the elasticity of visitor numbers with respect to rarity, allows one to estimate the marginal change in value as measured by visitor numbers associated with a marginal change in rarity.

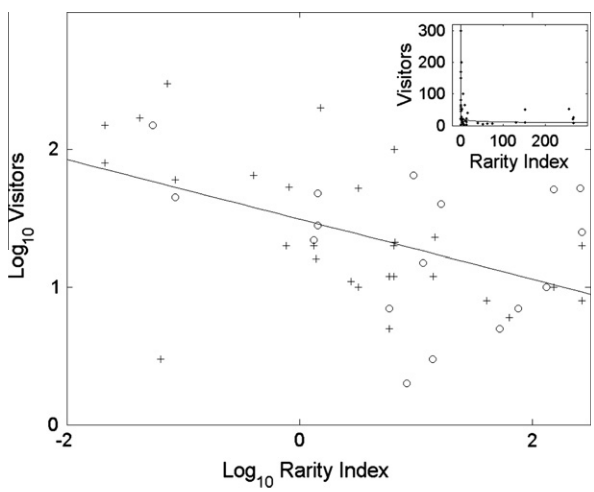

Fig. 1. Relationship between number of birdwatchers and bird rarity as measured by the average number of sightings of the species in the UK per year since recording began for Dataset 1 (*rare birds only*). Sightings that occurred on protected areas are marked with crosses (+) and those outside protected areas with open circles (○). The best fit line is from the model with the lowest Akaike Information Criterion score that includes only bird rarity as a predictor variable ($\log_{10}$ visitors = 1.492 − 0.217 $\log_{10}$ rarity, $n = 45$, $r^2 = 0.24$). The inset panel shows the untransformed data along with the back-transform of the best fit line.

3.2. Rare and common birds combined

For our discrete rarity index that includes more common species as well, six models were retained in the 95% confidence set and again all of these included rarity as one of the predictor variables (Table S2). The model containing the rarity score, protected area status and the interaction term was the most parsimonious ($r^2 = 0.54$). Again, bird rarity is the key factor driving the number of people viewing a bird, with more people viewing rarer birds (Table 2).

3.3. Distances travelled to rare bird sightings

We used postcode data from the sightings of the brown flycatcher and red-flanked bluetail to estimate Euclidean distances travelled by birdwatchers. We compared these to equivalent distances travelled by a sample of countryside recreationalists derived from questionnaire surveys conducted in 2006 (Booth et al., 2009). Birdwatchers travelled significantly further to view the brown flycatcher than the red-flanked bluetail, and for both sightings birdwatchers travelled further than general countryside recreationalists (Table 3, Kruskal–Wallis test, $H(2) = 140.66$, $p < 0.01$).

4. Discussion

Past studies of rarity in other goods have hypothesised that rarity value arises from people valuing the knowledge that they are consuming something unique that others cannot enjoy (Stoller, 1984; Koford and Tschoegl, 1998). Wildlife viewing is unusual in

Table 2
Model averaged parameter estimates and partial r^2 values from model average across the 95% confidence set of models for Dataset 2 (*rare and common birds combined*) using a categorical rarity index (1 is most common and 5 most rare).

	Rarity score					Site status		Weekend/day		Rarity score ∗ site status				
	1	2	3	4	5	0	1	0	1	1	2	3	4	5
Weighted parameter estimates	−1.32	−1.28	−0.92	−0.86	0.00	0.03	0.00	−0.02	0.00	0.06	0.00	−0.02	0.22	0.00
Weighted partial r^2			0.43			0.07		0.00				0.01		

Table 3
Distances travelled to sightings of brown flycatcher, red-flanked bluetail and by general countryside recreationalists. Kruskal–Wallis revealed a significant difference ($H(2) = 140.66$, $p < 0.01$) and Mann–Whitney tests for planned pairwise comparisons shown after Bonferroni adjustment to significance levels.

Targets	Median travel distance (km)	Comparison	
		Red-flanked bluetail	Brown flycatcher
Red-flanked bluetail	96.35		
Brown flycatcher	142.61	$U = 656.50$, $p < 0.01$	
Countryside recreationalists	11.10	$U = 2788.00$, $p < 0.01$	$U = 5491.00$, $p < 0.01$

this regard, because it represents the rarity of a non-rival good – one person consuming the good does not typically preclude others from doing the same, unless wildlife viewing activity is extremely detrimental to the species. This study presents a field-based estimate of the marginal value of species rarity for wildlife viewing.

Rarity had a strong influence on birdwatcher numbers. Our discrete measure of rarity, using the data collected at both rare and common bird viewings (*rare and common birds combined*), revealed a stronger relationship ($r^2 = 0.54$) than when analyses were restricted to very rare species (*rare birds only* $r^2 = 0.24$); we assume that this is simply a consequence of the greater variation in species rarity in the combined analysis. However, our continuous measure of rarity, using visitor numbers from rare bird sightings alone (*rare birds only*), has the advantage of allowing us to assess the functional form of the relationship between rarity and birdwatcher numbers, showing that the number of people viewing a bird increases asymptotically as species become exceptionally rare (Fig. 1, inset panel). Additional studies that include alternative predictor variables and attempt to assess what characteristics make one rare bird sighting more appealing to dedicated birdwatchers than another sighting of a species of comparable rarity would be worthwhile; possible factors would include the aesthetic appeal of the focal species.

While our results demonstrate that exceptional numbers of people will come to view exceptional rarities, the relevant coefficient in Table 1 is such that, on average, one species would have to be 24 times as rare as another in order to achieve just a doubling of visitor numbers. Had we used alternative measures of value, such as one based on travel cost methods, the value of birdwatching might have proven more responsive to incremental changes in rarity. Using the two species in Table 3 as an example, one is 19 times rarer than the other and had 3.2 times the number of visitors, more than would be predicted from the regression. If travel costs are roughly proportional to distances travelled, then we would estimate that such an increase in rarity would result in an increase in value of 4.7 rather than the tripling of value estimated by counting the number of birdwatchers. However, we are still left with the conclusion that the marginal increase in value that results from a marginal change in rarity is relatively small.

We collected demographic data on a sample of 30 visitors at one bird sighting on a protected area (the brown flycatcher, *M. dauurica*). Following methods presented in Booth et al. (2010), we are able to compare the demographic and socioeconomic make-up of visitors at this rare bird sighting to the wider UK population and also to general countryside recreationalists on protected areas in this region (see Booth et al. (2010) for data on these comparator groups). Those attending this rare bird sighting comprise a particular subset of society. Most strikingly, all surveyed individuals were male and white. Following methods presented in Booth et al. (2010) for estimating lifestyle characteristics of households using postcode data, we found that birders were economically unrepresentative of UK society, but that there was less of a bias towards more privileged groups than is found among general countryside recreationalists visiting protected areas (Booth, 2009; Booth et al., 2010).

By estimating the functional form of the relationship between rarity and value for multiple species in the field, our study offers an important advance over previous research that only demonstrated that rare species are more highly valued than common ones. However, our study design exploited a rather special situation – wildlife viewing of vagrant individuals. This allowed us to build a sufficiently rich sample of observations that could be attributed to species of known rarity. Moreover it allowed us to include species of extreme rarity the value of which would otherwise be difficult to assess. The inclusion of extremely rare species is important for evidencing the asymptotic behaviour shown in Fig. 1. Our design also had the advantage that wildlife viewing was concentrated into a short pulse of activity making it relatively quick to survey. Looking for opportunities to repeat the study on more established, native species clearly is important. One possibility would be to implement standardised visitor counts that span the breeding season at viewing spots for publicised nest-sites of rare, native bird species.

4.1. Conservation relevance of vagrant bird sightings

Wildlife viewing at vagrant bird sightings is itself of conservation interest. On the one hand, conservation groups seeking to raise the profile of conservation issues can capitalise on these unusual and newsworthy events and use them for revenue generation and outreach. Tellingly, at four vagrant bird sightings where we collected more detailed data, between 79% and 82% of those viewing vagrant birds were paying members of the UK's largest bird conservation charity (the Royal Society for the Protection of Birds). Among general countryside recreationalists, we found this percentage to be just 23% (Booth, 2009). Therefore, there is clear overlap between those who attend vagrant bird sightings and those most engaged with supporting bird conservation. Some land managers were clearly exploiting opportunities for revenue raising (e.g. through *impromptu* parking charges) and outreach (e.g. through press coverage) created by vagrant bird sightings. But overall, we found no difference in visitor numbers attending rare bird sightings on and off protected areas, suggesting this potential is perhaps not being as effectively exploited as it could be.

On the other hand, rare bird sightings could also pose a significant threat to the ecological value of a site. Recreation disturbance can impact species and habitats (Taylor and Knight, 2003; Pearce-Higgins et al., 2007; Reed and Merenlender, 2008; Kangas et al., 2010), including when the disturbance is applied as a short, intense pulse of recreation activity (Gallet et al., 2004) as is the case when mega rarities are sighted. The authors' own observations and anecdotal evidence from site managers interviewed during the survey indicate that visitors at rare bird sightings occasionally will climb over fences and trespass in order to see a particularly rare species. The appearance of a mega rarity over a period of some days will place a great deal of pressure on a protected area, requiring management of potentially negative impacts.

Our results would enable land managers to estimate the likely level of disturbance and/or the scale of revenue raising opportunities presented when a vagrant bird appears on site and to enact relevant management strategies. Importantly, this information would not be available to site managers from regular visitor count surveys, because of the unpredictable and pulsed nature of the recreation activity involved.

Acknowledgements

JEB was supported by the UK Population Biology Network (UKPopNet) on behalf of the Natural Environment Research Council (Agreement R8-H12-01 and NER/S/R/2005/13940) and Natural England. KJG was supported by the Royal Society; KJG and KLE were supported by the Leverhulme Trust. We thank site managers and owners and R.A. Fuller and L. Evans for assistance with data collection.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.biocon.2011.02.018.

References

Angulo, E., Courchamp, F., 2009. Rare species are valued big time. PLoS ONE 4, e5215.

Angulo, E., Deves, A.L., Saint Jalmes, M., Courchamp, F., 2009. Fatal attraction: rare species in the spotlight. Proc. Roy. Soc. Lond. B 276, 1331–1337.

Booth, J.E., 2009. Human–nature interactions: protected areas and nature conservation in the UK. Ph.D. Thesis, University of Sheffield, Sheffield, UK.

Booth, J.E., Gaston, K.J., Armsworth, P.R., 2009. Public understanding of protected area designation. Biol. Conserv. 142, 3196–3200.

Booth, J.E., Gaston, K.J., Armsworth, P.R., 2010. Who benefits from recreational use of protected areas? Ecol. Soc. 15, 19.

Burnham, K.P., Anderson, D.R., 2002. Model Selection and Multimodel Inference: A Practical Information-Theoretic Approach, second ed. Springer, New York.

Christie, M., Hanley, N., Warren, J., Murphy, K., Wright, R., Hyde, T., 2006. Valuing the diversity of biodiversity. Ecol. Econ. 58, 304–317.

Courchamp, F., Angulo, E., Rivalan, P., Hall, R.J., Signoret, L., Bull, L., Meinard, Y., 2006. Rarity value and species extinction: the anthropogenic Allee effect. PLoS Biol. 4, 2405–2410.

Fuller, R.A., Irvine, K.N., Devine-Wright, P., Warren, P.H., Gaston, K.J., 2007. Psychological benefits of greenspace increase with biodiversity. Biol. Lett. 3, 390–394.

Gallet, S., Lemauviel, S., Roze, F., 2004. Responses of three heathland shrubs to single or repeated experimental trampling. Environ. Manage. 33, 821–829.

Gault, A., Meinard, Y., Courchamp, F., 2008. Consumers' taste for rarity drives sturgeons to extinction. Conserv. Lett. 1, 199–207.

Hvenegaard, G.T., Butler, J.R., Krystofiak, D.K., 1989. Economic values of bird watching at Point Pelee National Park, Canada. Wildlife Soc. Bull. 17, 526–531.

Kangas, K., Luoto, M., Ihantola, A., Tomppo, E., Siikamaki, P., 2010. Recreation-induced changes in boreal bird communities in protected areas. Ecol. Appl. 20, 1775–1786.

Koford, K., Tschoegl, A.E., 1998. The market value of rarity. J. Econ. Behav. Organ. 34, 445–457.

Maresova, J., Frynta, D., 2008. Noah's Ark is full of common species attractive to humans: the case of boid snakes in zoos. Ecol. Econ. 64, 554–558.

Pearce-Higgins, J.W., Finney, S.K., Yalden, D.W., Langston, R.H.W., 2007. Testing the effects of recreational disturbance on two upland breeding waders. Ibis 149 (S1), 45–55.

Reed, S.E., Merenlender, A.M., 2008. Quiet, nonconsumptive recreation reduces protected area effectiveness. Conserv. Lett. 1, 146–154.

Reynolds, P.C., Braithwaite, D., 2001. Towards a conceptual framework for wildlife tourism. Tourism Manage. 22, 31–42.

Richardson, L., Loomis, J., 2009. The total economic value of threatened, endangered and rare species: an updated meta-analysis. Ecol. Econ. 68, 1535–1548.

Şekercioğlu, Ç.H., 2002. Impacts of birdwatching on human and avian communities. Environ. Conserv. 29, 282–289.

Stoller, M.A., 1984. The economics of collectable goods. J. Cult. Econ. 8, 91–104.

Taylor, A.R., Knight, R.L., 2003. Wildlife responses to recreation and associated visitor perceptions. Ecol. Appl. 13, 951–963.

Tisdell, C., Swarna Nantha, H., 2007. Comparison of funding and demand for the conservation of the charismatic koala with those for the critically endangered wombat *Lasiorhinus krefftii*. Biodivers. Conserv. 16, 1261–1281.