Journal of Environmental Management 92 (2011) 1564–1568

Contents lists available at ScienceDirect

Journal of Environmental Management

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

Reducing visitors' group size increases the number of birds during educational activities: Implications for management of nature-based recreation

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ARTICLE INFO

Article history:
Received 22 October 2009
Received in revised form
8 December 2010
Accepted 5 January 2011
Available online 4 February 2011

Keywords:
Human disturbance
Recreation
Visitors' group size
Bird assemblages
Nestedness
Environmental education

ABSTRACT

Organized tours to watch wildlife are popular recreational and educational activities, in which the visitor expectative (to observe as many and as diverse animals as possible) runs parallel to conservation purposes. However, the presence of visitors may cause negative impacts on wildlife, which makes recreation difficult to manage. Thus, restricting visitor's load to minimize impacts on fauna may be advisable, but too much restriction may end up disappointing the public. We analysed how visitors' group size influences the number and variety of birds observed during an educational activity directed to scholars, in a forested area where public access is otherwise restricted. We observed fewer birds, but not fewer species, as the size of scholars' groups increased. Such effect was apparently mediated by a few species demonstrating reduced tolerance to increased group size. Our results support the idea that reducing the size of visitors' groups not only helps to minimize the negative impacts on wildlife derived from leisure activities, but also allows visitors to watch more wildlife. Therefore, organizing visitors in small numbers is recommended in the design of activities directed to groups of people visiting natural areas.

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1. Introduction

Nature-based tourism and recreation may generate positive attitudes towards conservation and favour local socio-economic development (Bogner, 1998; Jacobson and Robles, 1992; Sekercioglu, 2002; Shrestha et al., 2007). However, nature recreation also has associated impacts. For example, outdoor activities that people often view as harmless (like hiking, biking or wildlife photography) have negative consequences on wildlife. Disturbed animals often interrupt temporarily vital activities such as feeding or breeding, which may reduce survival or breeding success (Ellenberg et al., 2006; Müllner et al., 2004; Murison et al., 2007; Yasué, 2005). If disturbance events are strong and repeated, many animals may end up abandoning the affected area, which may reduce the size of local populations and alter community assemblages (Fernández-Juricic, 2000; Mallord et al., 2007).

Current management of recreational activities aims to reduce human impact to make leisure and education in natural areas compatible with conservation (Liddle, 1997). Management actions often include defining buffer areas with restricted public access, signposting, concentrating service infrastructures (parking lots, visitor centres, restaurants, picnic areas and others), and establishing trails to prevent visitors from uncontrolled dispersal (Finney et al., 2005; Geneletti and van Duren, 2008; Medeiros et al., 2007). However, managers face the dilemma how to limit the number of visitors to a natural area, because severe restriction may be unpopular and thereby compromise public support to conservation policies, while uncontrolled leisure could deteriorate wildlife habitat (Butler, 1980). The question is relevant but remains poorly investigated, arguably because of the difficulty of delineating general management guidelines when disturbance effects greatly depend on local characteristics such as the kind and frequency of recreational activities, the season and time of day when they take place, the behaviour of the visitors, the type of habitat or the structure of the animal community to mention a few (Bolduc and Guillemette, 2003; Bouton et al., 2005; Knight and Cole, 1995). Nevertheless, understanding wildlife responses to variable visitor numbers is critical if we are to correctly manage nature-based recreation.

A key issue in the management of the number of visitors allowed in natural areas is deciding on the appropriate size of visitors' groups. Organizing visitors in large groups may reduce the number of visits, which may be advisable if repeated impact has

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doi:10.1016/j.jenvman.2011.01.006

stronger effects on wildlife (Murison et al., 2007). However, this may have unwanted consequences if the impact of recreation on wildlife increases with the size of visitors' groups. For example, most animals flee from humans, and large groups of people may represent greater perceived risk of predation (Frid and Dill, 2002; Geist et al., 2005). The likely existence of such antipredatory behaviours has two important implications for the management of recreational activities. From a conservation point of view, knowledge of the behavioural responses of animals in relation to visitors' group size may be instrumental for the establishment of set-back distances or buffer areas (a decision which is often based on animal flight initiation distances measured when fleeing from one person; Beale and Monaghan, 2004a; Whitfield et al., 2008). From a recreation management perspective of the natural areas, the fact that animals may be more prone to hide or escape from large groups of people may reduce the rewards of recreational activities when visitors are too many.

We studied whether increasing the size of visitors' groups affects the number and variety of birds that could be watched by inexpert scholars guided through a natural area during an educational activity. The expected observation of large groups of visitors recording fewer birds may reflect impacts of intensified recreational activities on wild birds. Besides, variation among species in human tolerance may translate into species-specific responses to variation in visitors' group size. Therefore, we studied whether some species are more prone than others to decrease in numbers or even be missed of the bird species list as the size of visitors' group increases. Exploring the relationship between visitors' group size and bird numbers is relevant to managers not only because it may provide evidence of recreation impacts on wildlife. It is also important because forming large groups may impair the birding experience of the public visiting the area, which may be a relevant issue in the design of recreational activities.

2. Methods

2.1. Study area

Our study was framed within the program 'Explora El Encín', an educational activity which is mainly directed to primary schools. The activity takes place in a 14 ha wood planted approximately 40 years ago on agricultural land (Alcalá de Henares, central Spain, UTM 30T474414, 4486457). Afforestation with various species led to an artificial mix of deciduous and coniferous trees, among which the most common species are elms (*Ulmus* sp.), poplars (*Populus* sp.), black locusts (*Robinia pseudoacacia*), cypresses (*Cupressus arizonica* and *Cupressus sempervirens*), and pines (*Pinus halepensis* and *Pinus pinea*). Undergrowth is poorly developed and mainly consists of brambles (*Rubus* sp.), hawthorns (*Crataegus monogyna*) and wild roses (*Rosa* sp.).

The program 'Explora El Encín' started in 2002, and involves guided tours for groups of up to 20 scholars, with a limitation of 60 scholars per day. Such limitation is not motivated by concerns about impacts on wildlife (the wood is an artificial environment of little conservation interest), but is established in order to make it possible for the staff to correctly handle the activity. Each group is supervised by two monitors who ensure that scholars do not walk out of the paths or delimited picnic areas. Visitors are guided through a path that is equipped with explanatory panels describing the plant and animal species that can be seen in the wood.

The wood is particularly suitable for a study of the impact of recreation on wildlife because it is closed to the public. As a consequence, the presence of people other than visitors is rare (the only noticeable activity other than guided visits is occasional maintenance work). In addition, most recreational visits take place from April to July, which makes recreation coincide with the breeding season of most species. However, our decision to study real groups of visitors in a controlled environment limited our possibilities to work with a large sample size. Visitor load ranged between 12 and 57 scholars per day (average 33 scholars) split in two or three groups per day, with two to three visits per week.

2.2. Bird counts

From April to July 2004, an observer walked aside groups of scholars recording all birds heard or seen within a 25-m wide belt on either side of the path. All counts were performed by the same observer (C. Remacha) to avoid personal bias. The visitors' itinerary was divided into two 150-m long transects separated by a distance of 170 m, which were considered as independent census units. Census data were collected during visits starting at two different times (10 h and 11 h), avoiding rainy weather. Groups walked at different speed thereby introducing variation in census duration. In all, we worked with 11 groups visiting the area at 10 h (three groups in April, four in May, two in June and two in July) and six groups visiting at 11 h (two in April and four in May). The smaller sample size for counts at 11 h was due to the fact that late tours often started before earlier tours had finished.

A specific goal of our study is to understand the ecological factors that affect the number and variety of species that could be observed in relation to visitors' group size. For example, the number of birds and species seen in each transect during each census may depend on the different threshold of tolerance to human disturbance of each species (Blumstein et al., 2005). The least tolerant species are likely to be the first to be missed with increasing visitors' group size, leading to a nested order of species loss. We used nestedness analysis to test whether the drop of species from our counts was random in relation to visitors' group size, or followed a hierarchical order that made the rarest species always less likely to be detected by large groups of visitors. Nestedness measures to what degree the species included in species-poor counts are subsets of species from progressively species-richer counts (for details on the rationale of the process see Atmar and Patterson, 1993).

2.3. Statistical analyses

We first analysed the effect of visitors' group size on the occurrence and numbers of each species. We used Mann–Whitney *U*-tests to examine the association between visitors' group size and species occurrence, for which we excluded species scoring less than three presences and three absences. We also conducted General Linear Models (GLM) to analyse changes in the number of individuals of each species separately in relation to visitors' group size, controlling for census duration and date. In the latter analyses we excluded the counts in which the corresponding species was absent, to avoid confusion between changes in individual numbers and variation in frequency of occurrence. Besides, in order to increase the reliability of these analyses, we excluded the species that occurred in less than 10 counts. Because of the small sample size available, we pooled together the two transects and times of day in all within-species analyses. The latter decision was based on the fact that all species were equally distributed between times of day, and only two species were heterogeneously distributed between transect locations, the tree sparrow *Passer montanus* (more frequently recorded in the first transect: $\chi^2_1 = 6.48$; $p = 0.01$) and the blackbird *Turdus merula* (more frequently recorded in the second transect: $\chi^2_1 = 9.67$; $p = 0.002$).

We used GLM to assess if the number of birds or the number of species were correlated with group size, controlling for factors that

Table 1
Average size (mean ± SD) of visitors' groups for counts with presence and absence of each of the bird species with at least three presences or absences, and results of Mann–Whitney *U*-tests for the association between visitors' group size and occurrence of each species.

Species[a]	Visitors' group size				Mann–Whitney *U* test	
	Presence	*n*	Absence	*n*	Z	*P*
Wood pigeon *Columba palumbus*	14.5 ± 3.5	4	15.2 ± 3.5	30	−0.05	0.98
Collared dove *Streptopelia decaocto*	12.9 ± 3.8	10	16.0 ± 3.2	24	−2.32	0.02
Wren *Troglodytes troglodytes*	15.0 ± 5.0	3	15.1 ± 3.6	31	−0.12	0.91
Nightingale *Luscinia megarhynchos*	14.8 ± 3.9	10	15.3 ± 3.6	24	−0.30	0.78
Blackbird *Turdus merula*	15.3 ± 3.4	18	15.0 ± 4.0	16	0.10	0.93
Great tit *Parus major*	17.3 ± 2.1	3	14.9 ± 3.7	31	1.16	0.26
Tree sparrow *Passer montanus*	14.3 ± 4.9	7	15.3 ± 3.3	27	−0.51	0.62
Chaffinch *Fringilla coelebs*	13.7 ± 4.9	6	15.4 ± 3.3	28	−0.82	0.44
Greenfinch *Carduelis chloris*	15.3 ± 3.5	26	14.5 ± 4.2	8	0.45	0.68
Goldfinch *Carduelis carduelis*	15.3 ± 3.7	29	14.0 ± 3.4	5	0.83	0.42

[a] We only analysed species that scored at least three presences and three absences. The serin scored only two negative counts, and seven species scored one or two positive counts (green woodpecker, melodious warbler, blackcap, pied flycatcher, blue tit, spotless starling and house sparrow).

might affect the outcome of bird counts (census duration, transect location, time of day and date). We tested two-way interactions between visitors' group size and the categorical factors (transect location and time of day), and removed any non-significant interaction term from the final model (Engqvist, 2005).

To conduct the nestedness analysis, we arranged data in a presence-absence matrix with species in columns and counts in rows, both sorted by decreasing number of presences. We compared the number of observed absences in this matrix to the number of expected ones, which was generated at random using the software Nestedness Calculator (Atmar and Patterson, 1995). This program measures the degree of nestedness in the matrix by means of the so called temperature of the system (T), which ranges from 0 (a perfectly nested matrix) to 100 (a random matrix). The statistical significance of T is obtained through Monte Carlo simulation using T values derived from random matrices of the same size, which allows for computing the probability of randomly producing a matrix that is as nested or more nested than the observed matrix (Atmar and Patterson, 1995). We assessed the influence of visitors' group size on nestedness by means of GLM using the ranking order of each count in the most nested matrix as the dependent variable, and controlling for census duration, transect location, time of day and date. A significant effect would mean that an ordered loss of species runs parallel to changes in the corresponding variable. Because of the particular statistical distribution of the ranking order of counts, we also computed one-way non-parametric analyses of the relationships between each variable and nestedness ranking order, using Spearman rank correlations or Mann-Whitney U-tests for continuous or discrete predictors, respectively.

3. Results

The size of visitors' groups ranged from 7 to 20 people. We recorded 18 species during scholars' visits (Appendix 1). Ten species scored at least three presences and three absences, of which only the collared dove (*Streptopelia decaocto*) decreased its frequency of occurrence as the size of groups of scholars increased (Table 1). Mann–Whitney *U*-tests showed that changes in the frequency of occurrence of other species were due to phenology. Thus, chaffinches (*Fringilla coelebs*) were more commonly found early in the season ($Z = 2.22$; $p = 0.026$) while goldfinches (*Carduelis carduelis*) were more commonly found late in the season ($Z = -2.15$; $p = 0.029$).

Increasing the size of visitors' groups was seldom correlated to within-species change in bird numbers, as shown by the analysis of positive counts of the six species scoring at least 10 presences (Appendix 1). Thus, only the serin (*Serinus serinus*) decreased its numbers with increasing visitors' group size ($F_{1,28} = 17.49$; $\beta = -0.39$; $p < 0.001$), controlling for date ($F_{1,28} = 0.41$; $\beta = -0.06$; $p = 0.52$) and census duration ($F_{1,28} = 52.86$; $\beta = 0.69$; $p < 0.001$). For the other species, the same analysis produced not significant effects of group size on the number of individuals (all effects of group size with $p > 0.28$).

Visitors' group size was negatively correlated with the total number of birds observed (Fig. 1), controlling for the effect of transect location, time of day, census duration and date (Table 2). However, this trend was created by the two species that decreased in frequency of occurrence (the collared dove) or individual numbers (the serin) with increasing group size (see results above). Thus, when we repeated the latter analysis excluding these two species, the negative correlation between group size and bird numbers was no longer significant ($F_{1,28} = 0.80$; $\beta = -0.14$; $p = 0.38$).

We did not find significant effects of group size on species richness, controlling for the effect of transect location, time of day, census duration and date (Table 2). Consequently, although the matrix of species occurrence in each count was significantly nested (observed $T = 21.8$, average T in random matrices = 54.65, SD = 5.28, $p < 0.001$), the nested loss of species from species-rich to species-poor counts was not explained by variation in group size. Only date and census duration were associated with the ranking order of counts in the matrix: counts performed early in the season and long-lasting counts scored more species (Table 3).

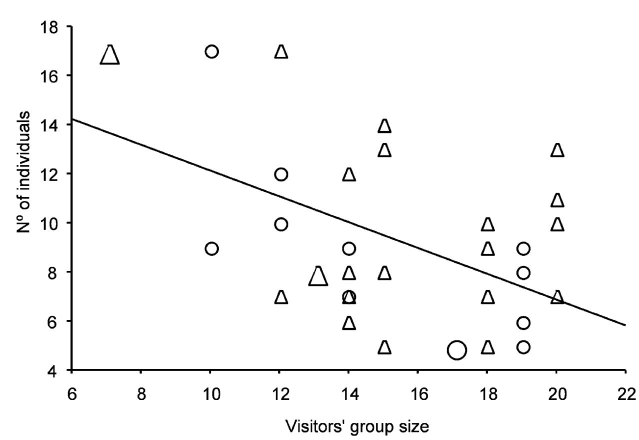

Fig. 1. Relationship between visitors' group size and the total number of birds observed in counts. Triangles represent early-morning counts (10 h) and circles late-morning counts (11 h). Small symbols correspond to single data points, and large symbols indicate two overlapping points.

Table 2
Results of GLM analyses of the total number of birds and the number of species in relation to visitors' group size, controlling for the effect of confounding variables.

	Number of birds			Number of species		
	β	$F_{1,28}$	P	β	$F_{1,28}$	P
Visitor's group size	−0.36	8.81	0.006	−0.04	0.08	0.77
Transect location		0.71	0.41		2.55	0.12
Census duration	0.53	14.25	< 0.001	0.15	0.72	0.40
Time of day		0.71	0.41		4.15	0.05
Date	−0.16	1.20	0.28	−0.43	5.25	0.03

4. Discussion

We recorded fewer birds as the size of visitors' groups increased. This pattern was partially caused by the loss of a species (the collared dove) that was less often recorded when groups were large. Besides, increased group size was associated with a decrease in numbers of a frequently occurring species (the serin). Therefore, the negative correlation between visitors' group size and bird numbers was apparently not general, but it was mediated by the response of a few species demonstrating reduced tolerance to increased group size.

Tolerance to human disturbance is a species-specific trait in birds, which may depend on various factors including body size, flocking behaviour or foraging habits to mention a few (Blumstein et al., 2005). Variation in tolerance among species may sometimes give rise to nested patterns of species loss related to variable levels of human presence (Fernández-Juricic, 2002). We found a nested pattern of species loss from species-rich to species-poor counts. However, such pattern could not be related to visitors' group size (it was rather explained by seasonal changes in the structure of the bird assemblage and census duration). That we failed to detect a nested loss of species in relation to group size may be explained by the fact that only one species (the collared dove) decreased probability of occurrence with increasing visitors' group size. Nested patterns could be difficult to detect in species-poor bird assemblages, like the one we studied. However, nestedness analysis could be very helpful to anticipate the impacts of visitors' group size on more diverse bird assemblages typical of natural habitats.

Our results suggest that birds may demonstrate reduced tolerance to human disturbance not only by reducing their frequency of occurrence, but also by reducing the number of individuals when faced with large groups of visitors. Whether the least tolerant species disappear completely or just reduce their numbers in risky situations may depend on species' abundance. Thus, rare intolerant species are particularly prone to be missed completely, while abundant intolerant species may decrease in numbers but still be detected. The question remains as to why other species did not react by changing numbers in the face of increased visitors' group size (thereby behaving as apparently tolerant species). A possible explanation is that most species actually tolerate human presence in our study area, which is somewhat feasible because repeated presence of harmless groups of people may have led to the habituation of individuals (Runyan and Blumstein, 2004; Rodríguez-Prieto et al., 2009). However, tolerance is difficult to demonstrate in the wild. For example, we conducted our study during the breeding season, when birds devote much time to activities that are tightly linked to fitness (such as mating or nesting). Therefore, interrupting activity in the face of increased perceived risk could be very costly, which may explain why most species did not react against human disturbance, even if they were possibly affected (Beale and Monaghan, 2004b). According to this view, constrains on behaviour might mask other bird responses against human disturbance, which may produce a wrong impression of reduced human impacts on wildlife in correlational studies.

The presence of humans may alter the behaviour of wild animals (Manor and Saltz, 2003; Mori et al., 2001), and density of visitors or group size may increase such impacts (Grossberg et al., 2003; Kuhar, 2008; Martínez-Abraín et al., 2008). Therefore, a strong reaction to large visitors' groups could be a direct consequence of group size (if a large group of potential predators mean an increased risk), or be mediated by changes in visitors' behaviour associated with group size. Large groups are usually noisier than small groups and noise rather than group size could be the main clue used by birds to assess risk (Burger and Gochfeld, 1998; Birke, 2002). We did not measure noise levels and therefore cannot separate the effects of group size and visitors' behaviour in our study, although monitors helped to keep noise levels low during our surveys. Further research on the proximate cause of the negative effect of visitors' group size on bird numbers will prove useful for managers to attenuate such impacts.

Table 3
Results of GLM analyses of census ranking order in the maximally nested matrix of species occurrences, in relation to visitors' group size and several confounding factors. One-way effects estimated using non-parametric approaches (Spearman rank correlation or Mann–Whitney *U*-tests) are also shown.

	GLM		Non-parametric one-way effects		
	$F_{1,28}$	P	Spearman r	Mann–Whitney Z	P
Visitor's group size	0.38	0.544	0.19		0.293
Transect location	1.10	0.304		0.81	0.433
Census duration	0.73	0.401	−0.47		0.005
Time of day	2.27	0.143		−1.23	0.231
Date	3.02	0.093	0.34		0.049

5. Conclusions

Our study shows that increasing visitors' group size has an impact on wildlife, as large groups were associated with decreased bird numbers. As an important implication of this result, reducing group size may help to achieve the goals of a birding activity directed to scholars, because the more birds are seen, the more educational resources are available. Therefore, organizing visitors in large groups may be discouraged from both the perspective of wildlife conservation and the visitors' point of view.

Limiting the size of groups of people visiting natural areas is a widely accepted management technique, which is becoming more stringent in recent times (Monz et al., 2000). Our study shows that keeping groups of visitors small may both reduce impacts on avifauna and help to fulfil public demands. However, if the visitor load is kept constant, reducing the size of groups will necessarily increase the number of disturbance events, which may negatively impact on wildlife (Mallord et al., 2007; Murison et al., 2007). The alternative option (reducing overall visitor load) may alleviate human impacts, but it may also have unwanted consequences if people lose interest in the area or in its educational facilities, or even react against protection in the worst case (Zaradic et al., 2009). Therefore, if visitor expectations and conservation priorities are to be reconciled, management actions should try to find an optimal balance between group size and number of visits, so that nature-based recreation remains enjoyable without compromising local conservation and educational goals.

Acknowledgments

We thank Eva Hernández and four anonymous referees for their comments on an early draft. We are also indebted to the staff and monitors of the educational project "Explora el Encín" for their enthusiastic collaboration, which made the study possible. Our research was funded by the Instituto Madrileño de Investigación y Desarrollo Rural, Agrario y Alimentario (IMIDRA: project FP06-DR4 to JD, and a fellowship to CR), and the Spanish Ministry of Science and Technology (project CGL2007-62937/BOS, to JP).

Appendix 1.

List of the species detected, with frequency of occurrence in counts (number and percentage of counts with presence of the species, $n = 34$ counts) and number of individuals in counts with presence of the species (mean ± s.e.).

Species	Occurrence	Individuals per transect
Woodpigeon (*Columba palumbus*)	4 (12%)	1.25 ± 0.25
Collared dove (*Streptopelia decaocto*)	10 (29%)	1.60 ± 0.22
Green woodpecker (*Picus viridis*)	1 (3%)	1
Wren (*Troglodytes troglodytes*)	3 (9%)	1.00 ± 0.00
Nightingale (*Luscinia megarhynchos*)	10 (29%)	1.50 ± 0.17
Blackbird (*Turdus merula*)	18 (53%)	1.17 ± 0.09
Melodious warbler (*Hippolais polyglotta*)	2 (6%)	1.00 ± 0.00
Blackcap (*Sylvia atricapilla*)	2 (6%)	1.00 ± 0.00
Pied flycatcher (*Ficedula hypoleuca*)	1 (3%)	1
Blue tit (*Cyanistes caeruleus*)	1 (3%)	1
Great tit (*Parus major*)	3 (9%)	2.00 ± 0.58
Spotless starling (*Sturnus unicolor*)	2 (6%)	1.00 ± 0.00
House sparrow (*Passer domesticus*)	1 (3%)	1
Tree sparrow (*Passer montanus*)	7 (21%)	1.29 ± 0.18
Chaffinch (*Fringilla coelebs*)	6 (18%)	1.00 ± 0.00
Serin (*Serinus serinus*)	32 (94%)	3.16 ± 0.32
Greenfinch (*Carduelis chloris*)	26 (76%)	1.27 ± 0.10
Goldfinch (*Carduelis carduelis*)	29 (85%)	2.52 ± 0.20
Unidentified birds	13 (38%)	1.77 ± 0.43

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