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ARTICLE

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Fence effects on the behavioural responses of South American fur seals to tourist approaches

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Abstract Animals that breed in coastal colonies, such as pinnipeds, usually attract tourism, which can negatively affect their resting and breeding behaviour if not managed properly. One strategy to reduce human disturbance is to set up fences, but little is known about their local effectiveness. Our purpose was to assess the behavioural responses of South American fur seals (*Arctocephaalus australis*) towards tourist approaches before and after the implementation of fences in Cabo Polonio colony (Uruguay). We found that human disturbance levels were similar between years and that the presence of a fence reduced (1) overall fur seal responses to tourists by 60%, (2) the most intense behavioural responses (threat, attack, leaving the colony) by more than half, (3) the responses to large tourist groups (>2 people), which were the most disturbing, (4) the responses to closer (<10 m) tourist approaches, and (5) the responses involving more intrusive tourist behaviours (running, shouting, hand waving). Overall, we showed that after the erection of the fence not only human–wildlife interactions were reduced but also the most stressful fur seal behavioural responses. Although further studies are necessary, our results suggest that the implementation of fences can be a simple and affordable means of minimising human disturbance effects on pinnipeds at local levels (e.g., within colonies), particularly if combined with other strategies (e.g., changes in tourist attitudes).

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Introduction

Visiting areas of conservation interest has turned into an increasingly popular and profitable activity, particularly when tourists have the opportunity to watch flagship species with certain spatial and temporal predictability. This is the case in coastal areas, where the patchy distribution of some species (e.g., marine bird and mammal colonies) allows easy access and the development of infrastructure for visitors (Tershy et al. 1997; Yorio et al. 2001; Kirkwood et al. 2003). However, this may generate a conflict of interests: ecotourism may be a source of income for local communities but uncontrolled visitor access can have a negative impact on the target species through human disturbance effects at the individual (e.g., Sterck 1998; Creel et al. 2002) and population levels (e.g., Fernández-Juricic 2000; Verhulst et al. 2001).

One management alternative to reduce the local effects of human disturbance is to restrict visitor movements and approaches to wildlife through the implementation of physical barriers, such as fences (e.g., Burger et al. 1995; Larson 1995). The few studies conducted on fence effects have dealt only with birds, which increased their tolerance towards visitors walking on the opposite side of the fence (Ikuta and Blumstein 2003), and whose populations increased substantially after areas with previous hunting pressure were restricted (Madsen and Fox 1995).

Fences can be classified into two types: the "zoo" type, which prevents people and wildlife from crossing the protective threshold due to its height (>1.5–2 m, depending on the species) and structure (small mesh wire); and the "countryside" type, which is generally built as a fence for livestock, with poles and a few parallel wire strings. This fence can be crossed by people and it works mainly as a signal of a putative limit rather than as a complete barrier. There are

two advantages of the countryside type of fence: it does not disrupt the scenery and it does not restrict the movements of all wildlife, as does the zoo fence type. Generally, the effectiveness of countryside fences in reducing human disturbance depends upon additional control by guards or self-restraining attitudes by tourists.

Pinniped colonies are usually subject to intense visitation levels (Tershy et al. 1997; Engelhard et al. 2001; Lalas and Bradshaw 2001), but relatively little is known about the effects of tourism and logistically simple strategies to reduce the negative influence on some species (Kirkwood et al. 2003). Although fences are in place around some colonies, no study, to our knowledge, has assessed whether and how behavioural responses vary after their implementation. Responses can vary from increased alert behaviours to vacating the colony, which could lead to a decrease in the use of a breeding or resting area.

The purpose of this study was to assess fence effects on the *behavioural* responses of South American fur seals (*Arctocephaalus australis*) in Cabo Polonio (Uruguay) by analysing their responses to tourist approaches 1 year before and 5 years after the erection of a countryside-type fence to protect the colony, but without active control of tourists. Specifically, we compared between years tourist behaviour and the mean number of fur seals reacting per tourist approach, taking into account type of tourist group, approach distances, tourist attitudes, and types of fur seal response.

Fences are expected to decrease the frequency of human–wildlife interactions by spatially restraining human access, provided tourists respect their protective function. However, because fences may function only as physical and not as visual or auditory barriers, to demonstrate their effect fully, it is necessary to show not only that human–wildlife interactions are reduced due to a spatial displacement of human disturbance, but also that the behavioural responses of animals change. If the fences were effective in this colony, given similar levels of human visitation between years, we would expect the average number of fur seals reacting per approach to decrease, as would the intense behavioural responses (e.g., threats, attacks on tourists, vacating the colony), the responses to large tourist groups, the responses to close tourist approaches, and the responses to intrusive tourist behaviour.

Materials and methods

Study approach

One way of characterising the behavioural responses of fur seals to tourists before and after the erection of fences is to sample several colonies. However, differences in habituation among locations may bias the results, as has been shown elsewhere (e.g., Cooke 1980; Louis and Le Berre 2000; Blumstein et al. 2003). Moreover, changes in topography between colonies may modify the detectability of both focal individuals and tourists, which could affect animal responses. An additional problem is that all colonies should have fences implemented during a similar period of time to avoid temporal variations in the levels of human visitation.

Unfortunately, meeting all these conditions is often difficult (and even unethical) in a species included in Appendix II of CITES, such as the South American fur seal (Reijnders et al. 1993). However, information about how management strategies could affect the behaviour of pinnipeds towards tourists is sorely needed (Kirkwood et al. 2003). Therefore, we decided to conduct this study in the only colony in which a fence was established that allowed time comparisons after animals got habituated to its presence (for a similar approach see Ikuta and Blumstein 2003). We acknowledge that our goal is not to generalise the responses of South American fur seals to other colonies. So, while we have only one fenced colony, we thoroughly examined the behaviour of tourists and fur seals in two different years to detect whether the presence of fences could have some role in the observed responses. We believe that this type of study is relevant to determine the feasibility of local, but not regional, management practices, where managers face the problem of maximising the number of visitors that can observe wildlife without increasing the frequency of stressful responses. Therefore, our work should not be considered a population-level study.

Study area

We recorded the behaviour of South American fur seals in the only continental colony of this species, located at the extreme of Cabo Polonio (34°24′S, 53°46′W), in an area with big boulders, in front of a lighthouse (Fig. 1). This is a resting colony for juveniles, subadults, and adult males during the breeding season (Vaz Ferreira and Ponce de Leon 1984). Tourists have been visiting the colony for more than 20 years, at any time of the day and in groups of variable size. Cabo Polonio has been identified as a priority area for ecotourism development (Morello et al. 1995), with another four breeding colonies on islands.

In 1997, a fence was set up around the colony with the intention of restricting tourist approaches, making this colony a good model to compare behavioural responses to visitors. This countryside-type fence (160 m long × 1 m high) was placed approximately 35 m from the watermark, leaving about 1.5 ha for the animals to use at low tide. Fur seals had more available resting space without directly interacting with tourists after the fence was set up (see Fig. 1 for an example). We found that the maximum number of animals recorded per census was 502 in 1996 and 1,300 in 2001. These estimates do not necessarily mean an increase in the number of individuals using the resting colony after the erection of the fence, as these figures may have been affected by the presence of tourist during the census, time of day, tide level, and so forth.

We carried out our observations of fur seals and tourists in 1996 (9 November–17 December) and 2001 (22 November–16 December) to evaluate the effects of tourism 1 year before and 5 years after the implementation of the

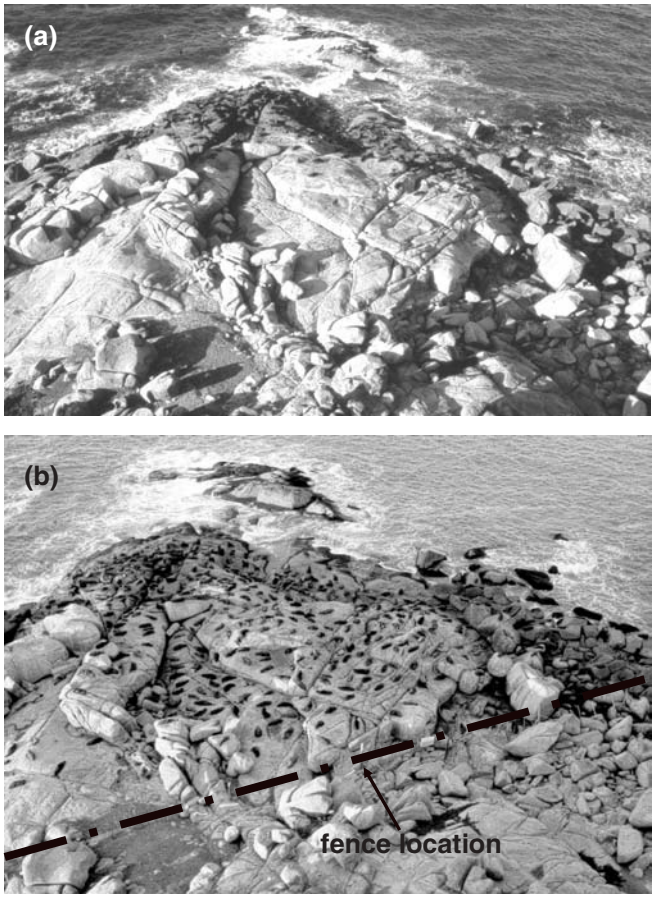

Fig. 1. Cabo Polonio colony (Uruguay) (**a**) before (1996) and (**b**) after (2001) setting up a fence to restrict the access of tourists to the colony. The location of the fence is marked because, due to the resolution of the picture, it is not distinguishable from the background

fence. We assumed that the 5-year interval allowed the animals to habituate to the new spatial configuration of human visitation. However, it should be noted that throughout this time interval parts of the fence were deteriorated to the extent that in some places visitors went through it to be closer to the fur seals. No quantitative data was recorded during the 1997–2000 period.

Behavioural observations

We daily recorded the following variables between 0900 and 1900 hours upon each approach of visitors: duration (in minutes), distance of the nearest tourist to a seal (<10 m, 10–20 m, >20–30 m, >30 m), type and size of the group of tourists, and tourist and fur seal behaviour (see details in Cassini 2001). Groups of tourists were classified into individual, couple, family (5.91 ± 0.70 individuals), and other groups (7.16 ± 10.22 individuals).

The following tourist behaviours were registered: movement speed (slow walk, normal walk, run), voice level (low, normal, shout), and hand movements (e.g., waving, clapping, or throwing). Tourist behaviour was then sorted into three categories: (1) *calm*, when the majority of the tourists moved slowly, without speaking, or spoke in low voices, and without hand waving; (2) *intermediate*, walking and speaking normally; and (3) *intrusive*, when at least one member of the group of tourists ran, shouted, and/or waved his/her hands. We calculated an *index of tourist attitude* as the average of the three types of tourist behaviour of increasing disturbance quality on an ordinal scale: 0 (calm), 1 (intermediate), and 2 (intrusive), following Cassini (2001).

The following responses of fur seals were recorded: (1) *retreats*, when one or more fur seals moved backwards a few metres; (2) *threats*, when fur seals oriented the head with open mouth with the lower canines visible and vibrissae pulled back towards the tourists (open mouth displays in otariids are an indicator of aggressiveness: Cassini 1985); (3) *attacks*, when fur seals moved towards the tourists; and (4) *leaving* the colony, when fur seals moved into the sea.

Statistical analysis

Because the distribution of some of our data did not meet the assumptions of normality and homogeneity of variances, we employed non-parametric analyses throughout. However, we present the data as means ± SD for illustrative purposes. Means were calculated pooling all the observations within a year. Frequencies of different responses considered all the observations in each category within each year. Each approach of tourists to the colony, along with the subsequent responses of fur seals, was considered an observation (for a similar approach see Cassini 2001; Fernández-Juricic et al. 2002).

Chi-square tests were used to assess variations in the composition of tourist groups and spatial distribution of visitors. The relationship between the index of tourist attitude and approach distance was analysed with Spearman rank correlation. We assessed the effects of different independent factors (year, type of group, distance to which tourists approached, tourist behaviour, and type of fur seal response) on the index of tourist attitude and the mean number of seals reacting per tourist approach with Kruskal–Wallis and Wald–Wolfowitz runs tests depending on the number of levels (>2 and 2, respectively) under consideration. The Wald–Wolfowitz runs test was used because it is not affected by the number of ties (observations that share the same position in the ranking), and our data had several similar values (e.g., zeros).

Because of the high number of probability estimations, we conducted a correction to avoid increasing the probability of type I error. Many of the corrections available (Wright 1992) are so stringent that type II errors can increase substantially, decreasing the power of individual tests (Chandler 1995). We minimised this problem with a two-tiered approach. We first identified groups of related tests (following Chandler 1995) and then performed a less conservative correction (Sidák correction, Wright 1992) over each of them. Within each group, P-values (P_i) were first ordered so that $P_1 < P_2 < \ldots < P_n$, and then each P_i was sequentially adjusted to $P_{i\,(\text{Sidák})} = 1 - (1 - P_i)^{(n-i+1)}$, with n the number of P-values in each group of tests (see Wright 1992). We reported transformed $P_{i\,(\text{Sidák})}$ values.

Results

Tourist behaviour

The composition of tourist groups did not vary between years ($\chi^2 = 0.85$, $df = 3$, $P = 0.837$), with each type of group having similar representation before and after the erection of the fence (Table 1). The number of visitors per visit remained similar between years (1996 = 3.74 ± 5.46, 2001 = 5.23 ± 6.58, $Z_{adj} = 1.86$, $P = 0.063$), and so did the duration of tourist visits (1996 = 10.26 ± 9.19 min, 2001 = 9.65 ± 12.30 min, $Z_{adj} = 0.97$, $P = 0.427$). Moreover, tourist rate did not vary significantly between years (1996 = 54.99 ± 55.82 tourists per hour of visit, 2001 = 31.64 ± 30.05 tourists per hour of visit, $Z_{adj} = 1.63$, $P = 0.212$). Overall, the level of human visitation to the Cabo Polonio colony was statistically similar in the two years.

Tourist attitude did not vary between years (mean attitude index ± SD, 1996 = 0.493 ± 0.740, 2001 = 0.483 ± 0.620, $Z_{adj} = 1.93$, $P = 0.272$), but the tourist attitude index varied significantly among different types of groups ($H_3 = 13.89$, $P < 0.01$, $n = 166$), with a tendency for larger groups (family and others) to show more disturbing attitudes than individuals and couples (Table 1). We analysed this trend further. First, there were no differences between individuals and couples ($Z_{adj} = 0.42$, $P = 0.989$, Table 1), nor between family and other groups ($Z_{adj} = -0.35$, $P = 0.998$, Table 1). Hence, we combined the data into two groups and found significant differences in attitude between small (individuals and couples) and large groups (family and others; $Z_{adj} = 2.52$, $P < 0.05$, Table 1).

We found a negative relationship between the index of tourist attitude and approach distance in both years (1996, $r = -0.22$, $P < 0.05$; 2001, $r = -0.24$, $P < 0.05$), with tourists showing more disturbing behaviours when approaching closer to fur seals. This result is related to the spatial distribution of visits, which varied between years ($\chi^2_3 = 23.26$, $P < 0.001$, Fig. 2). Without the fence (1996), the frequency of visitors at close distances (<10 m) was higher than when the fence was in place (2001). Moreover, the frequency of visitors at large distances (>30 m) increased in 2001 in relation to 1996.

Fur seal behavioural responses to tourists

Pooling all the animals responding to approaching tourists, we found that 443 fur seals reacted to 94 tourist approaches before the fence was set up (1996), and 165 fur seals reacted to 77 approaches 5 years after (2001) the fence was erected. The averaged number of fur seals reacting per approach decreased significantly after the erection of the fence (1996, 5.15 ± 13.07; 2001, 2.14 ± 6.26; $Z_{adj} = 2.17$, $P < 0.05$).

Fur seals usually reacted to approaching visitors with mild responses (retreat), and less frequently with intense responses (threat, leave, attack; Fig. 3). The averaged number of fur seals reacting with intense responses, such as threats ($Z_{adj} = 6.37$, $P < 0.001$) and leaving the colony ($Z_{adj} = 9.47$, $P < 0.001$), was lower with (2001) than without (1996) the fence (Fig. 3). Attacks on tourists were only registered in the year without the fence (total, four attacks). The averaged number of fur seals reacting with mild responses (retreats) did not differ between years ($Z_{adj} = 1.57$, $P = 0.308$).

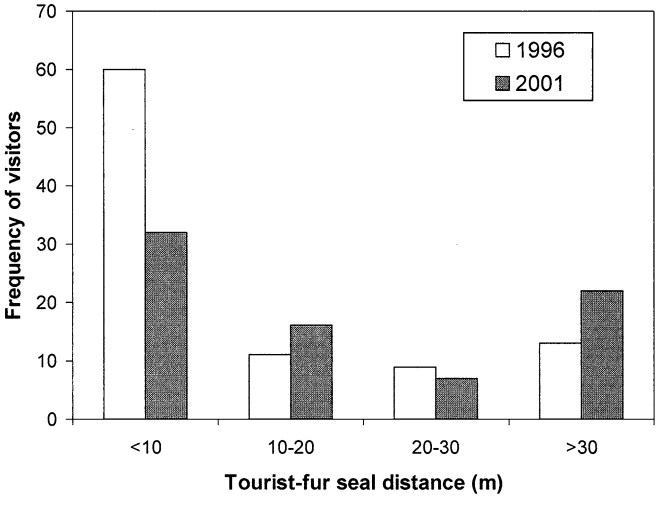

Fig. 2. Frequency of human visitation (total number of observations per year) at different distances from fur seals before (1996) and after (2001) setting up a fence in Cabo Polonio colony (Uruguay)

Table 1. Frequency of different types of tourist groups, behaviour of different groups of tourists (mean index of tourist attitude), and mean number of fur seals reacting per approach before (1996) and after (2001) setting up a fence in Cabo Polonio colony (Uruguay). The index of tourist attitude represents the mean of three types of behaviours of increasing disturbance quality: 0 (calm), 1 (intermediate), and 2 (intrusive). See text for details. Shown are means (± SD)

Group type	Frequency of tourists		Index of tourist attitude		Mean number of fur seals reacting per tourist approach	
	1996	2001	1996	2001	1996	2001
Individual	12	12	0.42 (± 0.79)	0.25 (± 0.45)	4.58 (± 11.61)	2.25 (± 2.34)
Couple	24	26	0.17 (± 0.38)	0.29 (± 0.46)	1.12 (± 2.25)	0.5 (± 1.22)
Family	11	14	0.71 (± 0.73)	0.73 (± 0.65)	4.71 (± 8.81)	4.09 (± 5.80)
Other	30	39	0.61 (± 0.85)	0.67 (± 0.71)	8.18 (± 17.75)	2.70 (± 9.17)

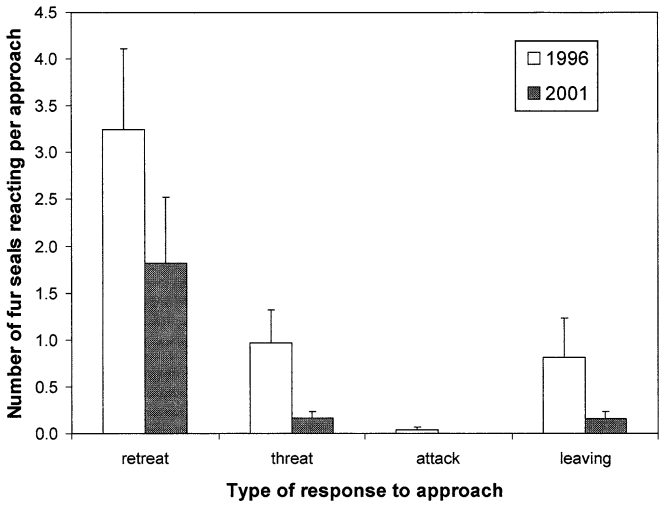

Fig. 3. Mean (± SE) number of fur seals reacting per tourist approach, considering four different types of response (retreat, threat, attack, leaving) before (1996) and after (2001) setting up a fence in Cabo Polonio colony (Uruguay)

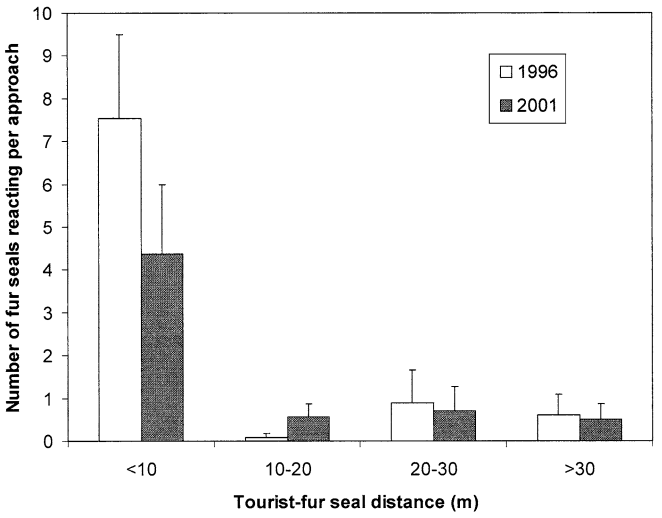

Fig. 4. Mean (± SE) number of fur seals reacting per tourist approach in relation to the distance between fur seals and tourists before (1996) and after (2001) setting up a fence in Cabo Polonio colony (Uruguay)

Fur seals responded differently in the two years depending on the type of tourist group ($H_3 = 9.28$, $P < 0.05$, $n = 168$), with fur seal responses increasing towards larger tourist groups (Table 1). Actually, we found that more fur seals reacted to family groups than to couples ($Z_{adj} = 3.89$, $P < 0.001$). The other contrasts were not significant ($P > 0.05$). By sorting the data into small (individual and couple) and large tourist groups (family and others), we found variations in the averaged number of fur seals reacting per approach between years. Small tourist groups had a greater effect on fur seal responses before than after the erection of the fence (1996, 2.21 ± 6.79; 2001, 1.08 ± 1.84, $Z_{adj} = 2.07$, $P < 0.05$). Likewise, the averaged number of fur seals reacting to large tourist groups was greater before than after implementing the fence (1996, 7.26 ± 15.87; 2001, 3.07 ± 8.34, $Z_{adj} = 2.07$, $P < 0.05$).

The averaged number of fur seals reacting per approach also varied with the distance to which tourists approached the colony ($H_3 = 32.28$, $P < 0.001$, $n = 171$, Fig. 4). Fur seal responses at distances >10 m were relatively low, without significant differences among 20, 30, and 40 m ($H_2 = 0.93$, $P = 0.948$, $n = 78$), and between years ($Z_{adj} = 1.01$, $P = 0.734$). However, the averaged number of fur seals reacting per tourist approach increased significantly at <10 m compared to >10 m ($Z_{adj} = 2.68$, $P < 0.03$, Fig. 4), and before (1996) compared to after (2001) the erection of the fence ($Z_{adj} = 2.19$, $P < 0.05$, Fig. 4).

The increasing number of tourists approaching fur seals at close distances (<10 m, Fig. 2) before the fence was set up affected the averaged number of fur seals reacting to different tourist attitudes ($H_2 = 32.92$, $P < 0.001$, $n = 169$, Fig. 5), with yearly variations. No differences between years were found when considering intermediate tourist behaviours ($Z_{adj} = -0.11$, $P = 0.999$). However, because more tourists approached closer in 1996 and those tourists showed more disturbing behaviours (see above), intrusive tourist behaviours increased the responses before (1996) compared to after (2001) the implementation of the fence ($Z_{adj} = 1.99$, $P < 0.05$, Fig. 5). Calm tourist behaviours had the opposite effect ($Z_{adj} = 3.61$, $P < 0.001$, Fig. 5).

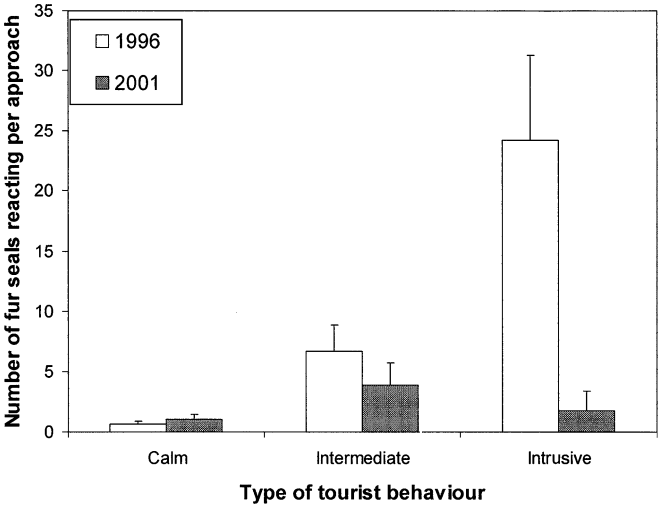

Fig. 5. Mean (± SE) number of fur seals reacting per tourist approach, considering different types of tourist behaviour (*calm*, *intermediate*, *intrusive*) before (1996) and after (2001) setting up a fence in Cabo Polonio colony (Uruguay)

Discussion

Our results show that given similar levels of human visitation in the two years, the presence of a fence reduced (1) overall fur seal responses to tourists, (2) the most intense behavioural responses (threat, attack, leaving the colony), (3) the responses to large tourist groups, (4) the responses to closer approaches, and (5) the responses involving more intrusive tourist behaviours. By characterising the degree of

intensity of both tourist and fur seal behaviours, we were able to show that the fence was effective in reducing the most aggressive and stressful fur seal responses, whereas mild behaviour of fur seals remained constant before and after the erection of the fence.

Fur seal and tourist behaviour

Behavioural assessments of the responses to tourists have been used to determine minimum approaching distances (distances beyond which humans should not approach to minimise the risk of disturbance) in colonial vertebrates (e.g., Rodgers and Smith 1995, 1997). Previous studies on pinnipeds underscore the fact that there appears to be a threshold distance (about 10 m between tourists and animals) that triggers negative behavioural responses (Le Boeuf and Panken 1977; Kovacs and Innes 1990; Cassini 2001). Fences can shift the spatial location of disturbance (Fig. 1), preventing the approach of tourists to the core of the colony (Fox and Madsen 1997). This was particularly important in Cabo Polonio, since the most disturbing tourists were those that approached closer to the animals in both years, but the fence set limits to this spatial encroachment and reduced the number of fur seals displaying negative responses.

Tourist behaviour is another important component in the degree of responses of pinnipeds to human approaches (Taylor et al. 1998; Cassini 2001). Tourists shouting, running, or waving their hands elicited more negative responses than those walking and speaking in low voices (see also Cassini 2001). We also found in both years a visitor group size effect: families increased the mean number of fur seals reacting per approach as compared to couples. This result may have been affected by the behaviour of tourists as well, since the chances of at least one member of the group showing intrusive behaviours may increase with the size of the group. Although the effects of small and large groups decreased after the fence was set up, this visitor group effect has important implications. It indicates that visitors should be advised to approach animals calmly, and that larger groups should be split and separated temporally when approaching fur seals in Cabo Polonio. Although our study site was not a breeding colony, the tourist group size effect could be of importance in breeding colonies, because intrusive tourist behaviours might reduce the time mothers spend feeding pups (Shaughnessy 1999; but see Engelhard et al. 2001). Similar relationships between tourist group size and level of disturbance have been described in other species. For instance, bird flight distance (an indicator of tolerance) was found to be positively associated with the size of visitor groups (Burger and Gochfeld 1991a, 1991b).

Management implications for pinnipeds

Are fur seal behavioural responses important for the management of pinniped colonies? We think so for two reasons. First, human visitation may trigger physiological stress responses (Millspaugh et al. 2001; Creel et al. 2002), which can negatively affect survival and reproduction, particularly if exposure to tourism is prolonged (Sapolsky 1992; Blanchard et al. 1995). Second, tourist activities may affect the use of colonies as resources for resting (our study) or breeding. If the levels of human visitation increase substantially, individuals could face a sharp decrease in the temporal and spatial availability of these resource patches (Fernández-Juricic 2000), which could lead to the colonies being vacated and changes in the distribution of individuals between colonies.

Countryside-type fences are less conspicuous and less restrictive to wildlife, but they depend upon additional controls. In this study, we showed that a countryside fence, without active control by guards, can be effective in reducing the detrimental effect of tourist presence. From a cultural perspective, this result is interesting, because local tourists visiting some Latin American pinniped colonies sometimes do not comply with the basic regulations meant to reduce human–wildlife interactions. However, the downside of this management strategy is that wildlife could be confined to the area limited by the fence, if the colony is occupied up to the point in which resting space becomes a limiting factor. Thus, annual monitoring of populations is also necessary to modify the location of fences and ensure the availability of space within the colony. This would not reduce the touristic appeal of the colony and would avoid confinement effects by fences.

Although further studies in other pinniped colonies are necessary to generalise species-specific behavioural responses to tourists, their feasibility is compromised by the vulnerability status of some species and the willingness of administrations to set up fences and assess their effectiveness. We have shown that over a period of time, fences can be a simple and affordable means of reducing stressful behaviours induced by visitors in one particular colony. Combined with other management measures (tourist guidelines, changes in tourist attitudes, etc.), fences could be a conservation strategy worth considering to minimise human disturbance effects on pinnipeds while allowing visitors to observe their behaviour. Fences could also be used to reduce the levels of disturbance to other colonial species (namely, birds) subject to human pressure from different recreational activities, such as water skis, motorboats, or pedestrians (e.g., Rodgers and Smith 1995, 1997; Burger 1998).

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