

The effects of human disturbance on Magellanic Penguin *Spheniscus magellanicus* behaviour and breeding success

PABLO YORIO and P. DEE BOERSMA

Summary

Magellanic Penguins *Spheniscus magellanicus* along the Patagonian coast, Argentina, are increasingly exposed to human activities, especially to a growing tourist industry. We quantified the effects of human visitation and disturbance on the behaviour and breeding of Magellanic Penguins. Nesting penguins differed in their response to human approach, allowing a significantly closer approach before responding with threat and defensive displays in the tourist area than in areas rarely visited by people. When approached during incubation, no penguins abandoned their nest. Breeding success and fledgling weights were similar in the tourist area and non-tourist areas. Magellanic Penguins appear to be tolerant of human visitation, and penguins breeding in the tourist area become accustomed to people walking among their nests. We suggest visitation may be compatible with penguin reproduction if visits are controlled.

El Pingüino de Magallanes *Spheniscus magellanicus* de las costas patagónicas de la Argentina, está expuesto a las crecientes actividades humanas, especialmente el aumento de la demanda turística. Se han cuantificado los efectos de las visitas y molestias del hombre en el comportamiento y reproducción de la especie. Los pingüinos mostraron diferencias en su respuesta frente a la proximidad humana, permitiendo un acercamiento significativamente mayor antes de responder con actitudes defensivas en áreas frecuentadas por los turistas en comparación con aquellas rara vez visitadas. La proximidad humana durante la época de incubación no supuso en ninguna ocasión el abandono de nidos. El éxito reproductivo y los pesos de los jóvenes al abandonar el nido resultaron similares en la zona turística y en la menos frecuentada. El Pingüino de Magallanes parece tolerar la presencia del hombre, y aquellos que nidifican en el área turística se habitúan a los visitantes que caminan entre sus nidos. Sugerimos que las visitas pueden ser compatibles con la reproducción de la especie siempre y cuando las mismas estén controladas.

Introduction

Growing interest in ecotourism in wildlife areas has increased the need to understand the effects of human disturbance on animal populations so that development can be compatible with wildlife needs. The effect of human disturbance on colonial birds, especially on seabirds, is variable, ranging from temporary stress to desertion of the nest or colony site (see reviews by Manuwal 1978, Anderson and Keith 1980, Burger 1981). Among these effects, the most severe and long-lasting is the disruption of reproduction that results in temporary or permanent nest abandonment. Temporary abandonment induced by humans can lower reproductive success by increasing egg or chick loss to predation (Kury and

Gochfeld 1975, Hockey and Hallinan 1981), increasing offspring mortality due to exposure (Hunt 1972), or interfering with other parental behaviours that benefit the offspring, e.g. feeding (Hunt 1972, Robert and Ralph 1975, Veen 1977, Schreiber 1979, Hand 1980). Induced permanent abandonment, on the other hand, inevitably results in complete breeding failure.

Human disturbance has resulted in lowered breeding success in several penguin species: e.g. the Humboldt *Spheniscus humboldti* (Hays 1976), Jackass *S. demersus* (Frost *et al.* 1976, Hockey and Hallinan 1981), Adelie *Pygoscelis adeliae* (Thomson 1977, Muller-Schwarze 1985, Wilson *et al.* 1990), Gentoo *P. papua* (Croxall *et al.* 1984), and Yellow-eyed *Megadyptes antipodes* (Roberts and Roberts 1973). The Magellanic Penguin *Spheniscus magellanicus* breeding along the Patagonian coast of Argentina has been increasingly exposed to human activities. These penguins are one of the major tourist attractions in some areas and are frequently visited because many colonies are accessible by road. For example, visitation at the colony at Punta Tombo, Chubut, is extraordinarily high, with over 40,000 tourists visiting during the seven-month penguin breeding season (Boersma *et al.* 1990b). Knowledge of how human visitation affects penguin behaviour and breeding success is needed to minimize negative effects on the penguins, particularly in reserves that are frequently visited by tourists. Without an understanding of the impact of tourists on penguins, long-term sustainability of this species and tourism will be difficult to effect. In this study we quantified the effects of human visitation and disturbance on the behaviour and breeding of Magellanic Penguins at Punta Tombo.

Methods

Study site and species

Punta Tombo, Argentina (44°02'S 65°11'W), is the largest continental breeding colony of Magellanic Penguins (Boswall and MacIver 1975), with approximately 225,000 breeding pairs (Boersma 1988). Magellanic Penguins have a seasonal breeding schedule, arriving at the colony in late August or early September. Penguins nest in vegetated areas under bushes or in burrows in bare areas (Boswall and MacIver 1975). They lay two eggs in early October, hatch chicks in November, fledge chicks in late January and February, and moult before they migrate north in March or early April. Both sexes defend the nest-site, incubate eggs and feed young.

Punta Tombo is a provincial reserve of approximately 210 ha with a designated tourist area consisting of a fenced parking area and tourist trail. The penguin colony covers over 250 ha. Tourists visit the area from September to March and are restricted to a relatively small area (c. 2.5 ha) close to the beach (Figure 1).

Disturbance and penguin behaviour

During the 1989–1990 season, we quantified the behavioural responses and nest abandonment frequency of penguins visited by humans in four different areas of the colony: (1) the tourist area, (2) the entrance access road, (3) a restricted area off-limits to visitors, and (4) a scientific study area.

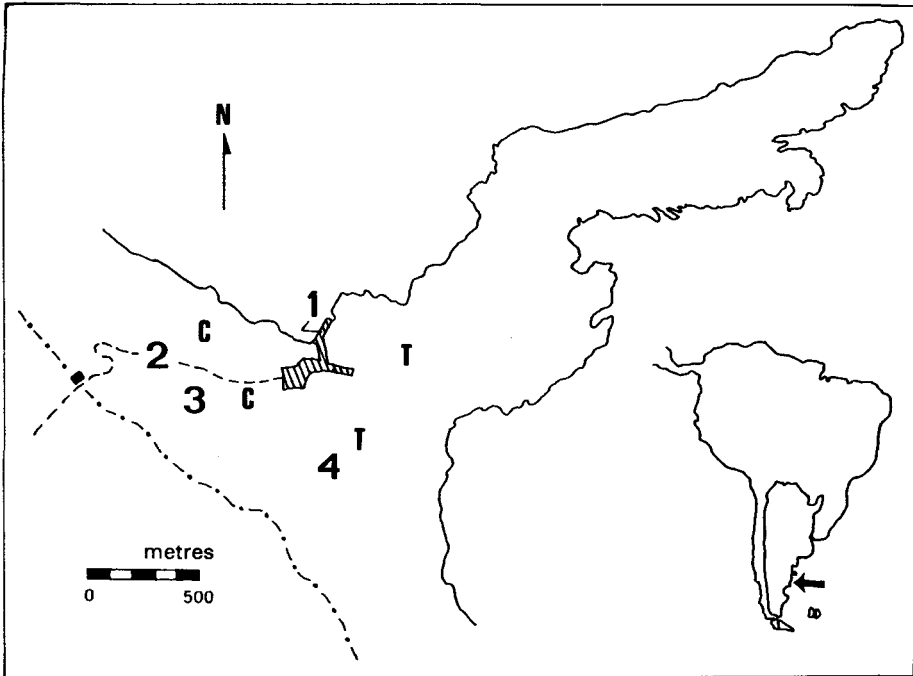


Figure 1. Map of Punta Tombo showing the location of the areas used in the study. 1, tourist area; 2, road area; 3, study area; 4, restricted area; C, control areas; T, transects; hatched area, tourist trail and parking lot; filled rectangle, reserve buildings; dashed line, road; dashed/dotted line, penguin colony boundaries.

The first of these is a fenced area where tourists walk among nests; breeding birds can be approached by tourists and on occasion are touched by them. Tourists visit the reserve daily from early September to late March (Boersma *et al.* 1990b). Visitors arrive either by car, alone or in groups of up to six people, or in tour buses with up to 60 people. Visits last for an average of one hour. On some occasions several hundred people are in the tourist area at the same time.

The access road connects the reserve entrance to the tourist area parking lot, a distance of about 1 km. Cars are not allowed to stop nor are visitors allowed to walk along the road, although these rules are broken occasionally. We defined the access road area as the area within 15 m of this road. Within this area, penguins are exposed several times each day to slowly passing vehicles, and to park rangers and researchers walking along the road.

The restricted area, not exposed to tourists, is about 500 m inland from the coast. Researchers and park rangers rarely walk through this area.

In the scientific study area, which researchers visited daily for about an hour, each nest was checked for between 15 seconds and three minutes while adults, eggs and chicks were identified. We handled adults and eggs once, and measured chicks several times during the breeding season. Additionally, we regularly walked through this area en route to other locations in the reserve.

We quantified the behavioural responses of penguins in bush habitat and in bush nests by walking directly but slowly to the nest ("approaches") from 25 m

away to within 0.5 m of the nest cup. When a penguin changed its behaviour, PY noted the distance from the nest and for 10 seconds watched the penguin's behaviour and coded its response. Behaviour categories used were: (a) alert (when the penguin turned its head to face the approaching person), (b) alternate stare (the head was rotated alternately and irregularly from side to side but sometimes held briefly on one side), (c) standing up (penguins were lying in nests before they were approached), and (d) nest abandonment. The alternate stare is used by Adelie Penguins for territorial defence (Spurr 1975), and is considered the commonest threat display used by the Jackass Penguin when its nest is approached too closely by another penguin or a human (Eggleton and Siegfried 1981). The same behaviour, called head movement, is seen in the Galápagos Penguin *Spheniscus mendiculus* (Boersma 1976). If the penguin left its nest when approached, we scored the outcome as temporary abandonment owing to human disturbance. In addition, during incubation one person walked transects through bush and burrow habitat while a second observer watched from a distance to see if the disturbance caused any penguin to leave its nest.

Approaches to 20–30 nests were made in each of the four areas during settlement (17–20 September), incubation (19–22 October) and the chick stage (6–14 December). All nests approached during the egg and chick stages had eggs and chicks respectively. Since there may be sex differences in response, we sampled penguins of the same sex in all areas during the settlement and incubation approaches, and sampled the same number of males and females in each of the areas during the chick stage approaches. Penguins were sexed based on colony attendance patterns and visual appearance. Penguins approached during settlement were likely to be males, as sampling was done before females start to arrive, and penguins approached during the incubation period were likely to be females, as females generally take the first incubation spell (Scolaro 1984, Boersma *et al.* 1990a). Sex was confirmed visually: males have larger heads and bills than females.

General observations were also made on the behavioural responses of penguins to people, both tourists and researchers, during the 1983 to 1989 breeding seasons.

Nest abandonment

To assess the frequency of penguin temporary nest abandonment that could result from human visitation to areas outside the tourist trail, we walked transects in two different habitats during the first week of November 1990, before chicks started to hatch. The treatment here differed from the behavioural approaches in that nests were not approached directly; instead, we simulated a tourist walking slowly and non-stop among nests. We walked six transects in bare high-density burrow habitat and two in bush habitat. These were different areas from the ones used for the direct approaches. One person walked at a slow and constant speed along 100 m transects, counting all the nests within 1 m where penguins were able to see the person. We recorded whether penguins left the nest when approached and, because of our criterion of visual contact, we counted only nests with openings facing the transect. A second person walked

30 m behind the first to determine how many penguins abandoned the nest after the first person had passed it.

Breeding success

The effects of tourist visitation on breeding success were quantified by comparing a sample of nests within the tourist area to a sample of nests 5–20 m outside the fenced tourist area. Nests were checked six times during the breeding season, and at each visit adult presence and nest contents were noted. Nests were not marked and no adults, eggs or chicks were handled.

Additionally, breeding success in the tourist area was compared with a sample of nests from two areas of the colony at a similar distance from the sea as the tourist area, but where tourists were not allowed. These were different nests from the ones approached to quantify penguin behaviour. We quantified breeding success by counting nests and their contents in eight circular areas of 100 m², which were sampled after peak egg-laying (15–17 October), after peak chick-hatching (14–16 November), and before chicks started fledging (17 January). At each visit adult presence and nest contents were recorded. No penguins, eggs or chicks were handled. Breeding success was defined as the number of chicks surviving at the last check (mid-January) per nest where eggs were laid. Chicks surviving to mid-January are very likely to fledge (Boersma, unpublished data). Nests from both control areas were grouped for the analysis.

Visitation could affect chick growth by either interrupting chick feedings or increasing the periods of inattentance at the nest by parents. To test this effect, we weighed 50 chicks at fledging (5 and 6 February) with a spring scale (to nearest 10 g) in each of two areas: within the tourist area and an area near one of the control areas.

Results

Disturbance and behaviour

Penguins differed in their reaction to being approached depending on where they nested. At all stages of the breeding cycle, birds in the tourist area allowed a closer approach before showing alert behaviour or displaying the alternate stare than those in the other areas (Figures 2 and 3). Birds reacted at the greatest distance to approach in the area of lowest visitation. The response distance was in all cases significantly smaller for the tourist area than for the restricted area (Table 1). The response in both the road and study areas was intermediate.

During settlement and chick stage, the percentage of penguins standing up in response to human approach corresponded inversely to the amount of visitation the area received. It was highest in the area of lowest human exposure and lowest on the tourist trail (Table 2).

Only in the restricted area during settlement did penguins leave their nests (6.66%, $n = 30$). Some penguins in the tourist area did not change their behaviour observably when approached (settlement: 25% [$n = 28$]; incubation: 15% [$n = 20$]; chick stage: 19% [$n = 31$]).

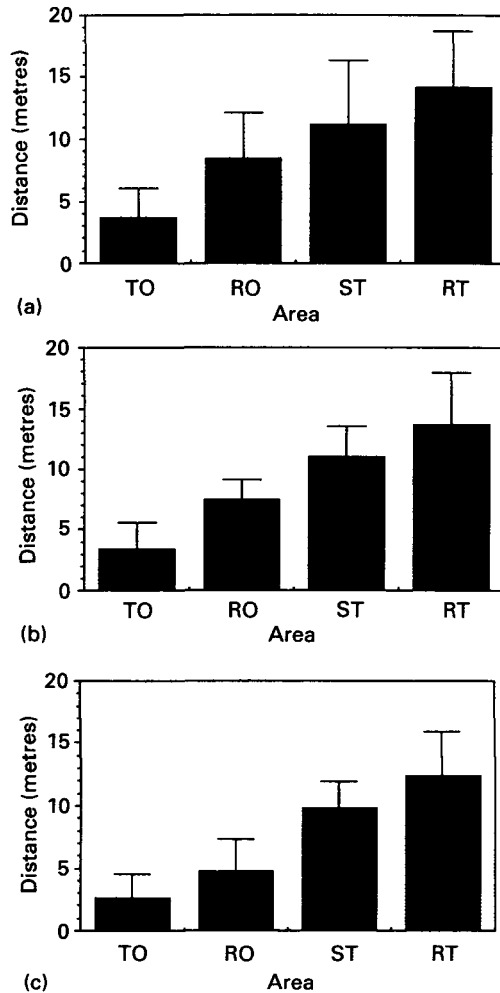


Figure 2. Mean distance (standard deviation is shown with error bars) at which penguins began to respond to human approach with alert behaviour at the four areas at three stages of the breeding cycle (TO, tourist area; RO, road area; ST, study area; RT, restricted area). Distances differed significantly among areas (Kruskal–Wallis test: (a) Settlement: $T = 41.66$, $p < 0.001$; (b) Incubation: $T = 41.57$, $p < 0.001$; (c) Chick stage: $T = 64.99$, $p < 0.001$).

Nest abandonment

During incubation, a total of 286 burrow nests and 82 bush nests were approached by walking along the eight transects, and no penguins left their nests. Several birds along the bush habitat transects stood up or turned, still on the eggs, when the researcher walked by. Penguins in burrows can rarely stand up or shift position, because of the confines of the nest.

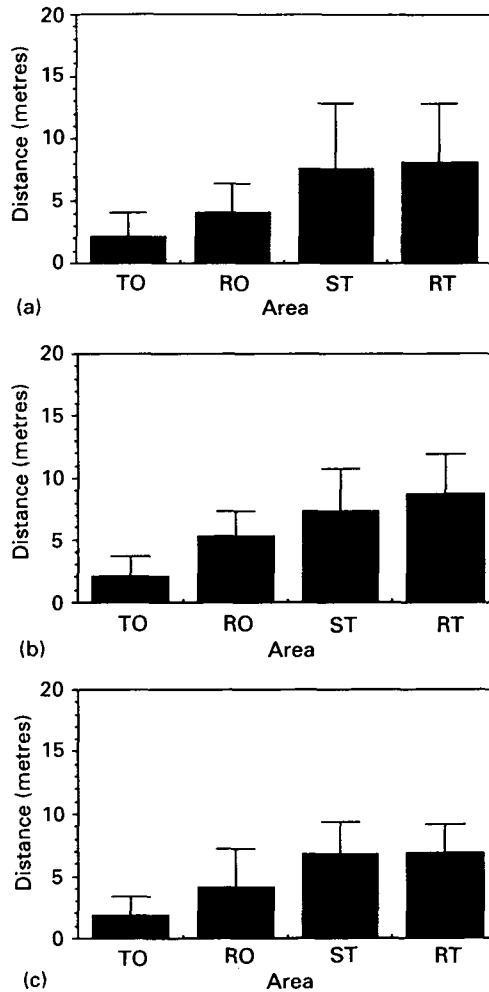


Figure 3. Mean distance (standard deviation is shown with error bars) at which penguins began displaying the alternate stare in response to human approach at the four areas at three stages of the breeding cycle (TO, tourist area; RO, road area; ST, study area; RT, restricted area). Distances were significantly different among areas (Kruskal–Wallis test: (a) Settlement: $T = 26.02$, $p < 0.001$; (b) Incubation: $T = 27.06$, $p < 0.001$; (c) Chick stage: $T = 35.43$, $P < 0.001$).

General observations

On the basis of opportunistic observations, it appears that Magellanic Penguins tend to react to human presence according to the way people behave while moving within the colony. Penguins are more likely to act nervously or flee if people walk fast or make quick movements. In general, penguins attempt to avoid humans or flee at greater distances in the open than in more structurally complex habitats (e.g. bush habitat). Birds outside their nests ran into the nest at the approach of an intruder. Nests generally afford good protection against

Table 1. Mean distances at which penguins began to respond with alert and alternate stare displays to human approach at the tourist and restricted areas.

Behavioural category	Period	Tourist area		Restricted area		Significance ^a
		m	s.D.	m	s.D.	
Alert	Settlement	3.63	2.41	14.21	4.50	U = 6.5 (15,24)**
	Incubation	3.44	2.14	13.62	4.26	U = 2.0 (15,16)**
	Chick stage	2.62	1.85	12.39	3.52	U = 0.0 (21,28)**
Alternate stare	Settlement	2.11	1.92	8.12	4.76	U = 16.5 (8,28)**
	Incubation	2.00	1.63	8.68	3.25	U = 1.08 (8,19)**
	Chick stage	1.81	1.55	6.86	2.25	U = 26.5 (16,29)**

^aMann-Whitney U test; * $p < 0.003$, ** $p < 0.001$.

Table 2. Percentage of birds standing up at the approach of the researcher in areas with different degrees of exposure to human visitation.

	Tour		Road		Study		Restr	
	%	(n)	%	(n)	%	(n)	%	(n)
Settlement	7.14	(28)	8	(25)	16.67	(18)	50	(30)
Incubation	0	(20)	6.67	(15)	20	(20)	5	(20)
Chick stage	0	(31)	0	(24)	14.29	(28)	33.33	(30)

Tour, tourist area; Road, road area; Study, scientific study area; Restr, restricted area.

predators. This is especially true for burrows, as their entrances are usually small (Boswall and MacIver 1975, de Bary Pereda 1990), and once inside, penguins face the entrance with their strong beaks.

In contrast, penguins without nests flee when approached. Thus, reaction to human presence leading to an escape response is more frequent during the periods of the breeding cycle when non-breeders wander within the colony (i.e. November to January). Similarly, this effect of human disturbance increases during chick-rearing, when penguins are travelling to and from their nests to feed their offspring. These fleeing penguins tend to amplify the effect of human disturbance, as they also disturb nesting penguins that are in their nests.

In summary, the intensity of disturbance, habitat structure, the bird's breeding status, and the behaviour of nearby birds all appeared to influence penguin behaviour. Nevertheless, there is a great deal of individual variability in response to human exposure and handling. For example, when handling penguins during research, we observed individual differences in the behavioural response among study birds, ranging from running away to calmly submitting to being measured, even when the methods and handling were the same.

Opportunistic observations on penguins banded as chicks or during their first

Table 3. Number of active nests, eggs laid, and chicks surviving to mid-January, and breeding success, for the tourist area, the area beside the tourist area and the control areas.

Area	Nests (<i>n</i>)	Eggs (<i>n</i>)	Chicks (<i>n</i>)	Success (chicks/active nest)
Tourist	36	71	38	1.06
Tourist-near	26	51	24	0.92
Control	54	117	56	1.04

year show that penguins recruiting into the breeding population settle in areas frequented by people. During 1990, six young penguins were seen in nests within 20 m of the road and four in nests within the tourist area, of which two bred.

Breeding success

Breeding success in the tourist area was actually higher than though similar to that in the area outside and near the tourist area ($X^2 = 0.50$ d.f. = 1, NS), and to that in the control areas ($X^2 = 0.72$ d.f. = 1, NS) (Table 3).

Weight at fledging was similar for chicks raised within the tourist area (mean = 2.40 kg, s.d. = 0.35, $n = 50$) and in the area not visited by tourists (mean = 2.33 kg, s.d. = 0.33, $n = 50$) (t -test, $t = 0.88$, $p = 0.38$).

Discussion

Most nesting seabird colonies are sensitive to human visitation, with human disturbance usually leading to changes in behaviour and lowered breeding success (Anderson and Keith 1980, Burger 1981). Studies on some species have shown, however, that birds that are frequently exposed to humans become more tolerant of human presence owing to habituation or learning (Burger and Gochfeld 1981, 1983, Humphrey *et al.* 1987, Young 1990). Our study shows that, in contrast to most seabirds, Magellanic Penguins breeding at Punta Tombo are relatively tolerant of humans, and that they show a differential behavioural response according to their previous exposure to people.

Magellanic Penguins on the tourist trail allowed a closer approach to their nest before responding than birds nesting in the area where humans rarely visited, and some penguins even resumed resting with their eyes closed after seeing the intruder. Only in the restricted area did penguins leave their nest or move nervously within the nest site. This suggests penguins that are not accustomed to people may experience lower breeding success when disturbed.

Even though in both the study and the tourist areas penguins saw people daily, they responded at a greater distance in the study area. The activities of people and the number of visitors differ between the two areas, and this may contribute to the observed difference. Likewise, the difference in response may be due to differences in exposure, as penguins in the study area are visited only briefly while penguins on the tourist trail often have several hours of continuous contact with people. Response to humans by beach groups of Jackass Penguins has been shown to vary according to the amount of disturbance, with regularly

disturbed groups being less responsive to human approach than partially disturbed or undisturbed groups (van Heezik and Seddon 1990).

It may be argued that even though penguins breeding in the tourist area show a significantly weaker behavioural response to approach, they may be affected by people. A significant increase in heart rate has been observed in birds which otherwise showed no behavioural response to an approaching potential predator (Kanwisher *et al.* 1978, Ball and Amlaner 1980, Culik *et al.* 1990). However, tame or habituated birds had a lower heart rate when approached than the heart rate in previously undisturbed birds (Stout and Schwab 1980, Heise 1989).

Temporary or permanent nest abandonment of incubating birds was not observed in the Magellanic Penguin, and only a few nests were abandoned at the approach of researchers during the settlement period. This is in contrast to what is observed in many seabird species, where birds leave the nest following human intrusion into their breeding colonies (Manuwal 1978, Anderson and Keith 1980). In some species, human disturbance can result in nest desertion rates of up to 50% or more, e.g. Rhinoceros Auklet *Cerorhinca monocerata* and Tufted Puffin *Lunda cirrhata* (Manuwal 1978), or can cause whole colony desertions, e.g. Sandwich Tern *Sterna sandwicensis* (Cullen 1960) and Royal Tern *S. maxima* (Buckley and Buckley 1972).

Though not found in this study, nest abandonment during incubation owing to tourist disturbance has been previously reported for Magellanic Penguins at Punta Tombo (Boswall and MacIver 1975, Gochfeld 1980). In the present study, we quantified the effect of one person walking slowly with brief pauses through the nesting area. Other types and intensities of human-penguin interactions could, however, result in increased nest abandonment. Group size may affect disturbance; larger groups of people increase disturbance in the Fulmar *Fulmarus glacialis*, causing a significant reduction in hatching and breeding success (Ollason and Dunnet 1980). Speed of approach and handling have been observed to lead to a more extreme reaction of birds and strongly to increase heart rate (Ball and Amlaner 1980). Walking quickly through the colony or along the beach causes birds to flee, and penguins in our study areas occasionally abandoned the nest when they were handled often or when visits to nests were longer.

Temporary nest abandonment during settlement could affect nest-site selection or mate acquisition, and subsequently affect breeding success. Abandonment of the nest-site during the egg stage can reduce hatching success; unattended penguin eggs are more likely to be lost to opportunistic predators than attended eggs (Yorio and Boersma in prep.). Human disturbance could also affect nest attendance by parents, possibly altering chick feeding frequency and thus their subsequent growth. However, no differences were found in the weight at fledging between the chicks raised within the tourist area and near the control area. Moreover, breeding success of pairs nesting in the tourist area was similar to that of birds in areas of the colony not visited by tourists and was apparently not affected by human visitation.

Disturbance can decrease the recruitment rate of young breeders into the area affected (Ainley *et al.* 1983, Croxall *et al.* 1990, Wilson *et al.* 1990, but see Young 1990). Even though young penguins at Punta Tombo have settled in the tourist area and near the road, showing that some individuals are not affected by

human activity, recruitment to areas frequented by people could be depressed. Further data are needed before we can rule out negative effects of tourist visitation on the settlement patterns of breeding birds.

In summary, Magellanic Penguins at Punta Tombo are relatively tolerant of human visitation. Penguins breeding in the tourist area are accustomed to people walking among their nests, and tourist visitation did not decrease breeding success. Although when setting up tourist areas there might be an initial impact on the penguins, these patterns suggest that once they have been established visitation may be compatible with penguin reproduction if visits are restricted to those areas and people walk slowly when near penguins. Careful management of tourist areas in penguin colonies is needed to allow the development of the tourist industry, with its economic, recreational and educational benefits, while protecting the Magellanic Penguin. Tourism at the penguin colony at Punta Tombo has the potential to be a sustainable development option for Argentina.

Acknowledgements

Research was funded by Wildlife Conservation International, a division of the New York Zoological Society, and made possible by a joint agreement between the Society and the Organismo Provincial de Turismo of Chubut. David Stokes, Mary Hogg and Amy MacKendry helped gather the data. We also thank William Conway, Gene Fowler, Martha Groom, Ellen Gryj, Arthur Kettle, Nancy Langston and David Stokes for helpful comments on earlier drafts of this paper.

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P. YORIO

Wildlife Conservation International, The Bronx Zoo, New York 10460, U.S.A.

P. D. BOERSMA

Institute for Environmental Studies and Department of Zoology, FM-12, University of Washington, Seattle WA 98195, U.S.A.