WHO IS WATCHING WHOM? CHECKS FOR IMPACTS OF TOURISTS ON YELLOW-EYED PENGUINS *MEGADYPTES ANTIPODES*

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SUMMARY

RATZ, H. & THOMPSON, C. 1999. Who is watching whom? Checks for impacts of tourists on Yellow-eyed Penguins *Megadyptes antipodes. Marine Ornithology* 27: 205–210.

The Yellow-eyed Penguin Conservation Reserve at Penguin Place, Dunedin, New Zealand is an ecotourism venture where visitors view breeding Yellow-eyed Penguins *Megadyptes antipodes* at close range from hides and covered trenches. Yellow-eyed Penguins are a timid and secretive species that could be regarded as unsuitable for observation at close range. The increase of Yellow-eyed Penguin nests was greater since 1984/85 in the colony visited continuously by tourists compared to the adjacent control colony with no public access. No difference was detected in the breeding success between the colony visited by tourists and the colony without visits by tourists. The impact of the presence of tour groups on the feeding behaviour of chicks was investigated at two-chick nests at the guard-stage during the summers of 1994/95 and 1995/96. The number of food-transfers was counted in five-minute intervals for 30 minutes. No difference was found in the patterns of feeding sequences. However, power analyses suggested that the difference would have to have been fairly large to be detected. This provides an indication that no apparent differences in patterns of feeding between the two colonies existed, but a larger sample size is required to reach a more definite conclusion.

INTRODUCTION

Ecotourism can provide a valuable contribution to conservation, local economies and the education of the general public about wildlife (Brockelman & Dearden 1990, Duffus & Dearden 1990, Jacobson & Robles 1992) but it may also cause disturbance to wildlife. The effect of disturbance created by the proximity of people can be assessed at three levels. Inter-annual effects have been recorded as a reduction in absolute abundance (Thomson 1977, Anderson & Keith 1980, Safina & Burger 1983, Burger & Galli 1987, Anderson 1988, Wilson *et al.* 1990, Stephenson 1993), and/or a localised shift in distribution (Anderson & Keith 1980, Burger & Gochfield 1993, Jacobson & Lopez 1994). Intra-annual effects have been recorded as a reduction in breeding success (Hunt 1972, Roberts & Roberts 1973, Gillett *et al.* 1975, Kury & Gochfield 1975, Robert & Ralph 1975, Ellison & Cleary 1978, Thremblay & Ellison 1979, Anderson & Keith 1980, Safina & Burger 1983, Anderson 1988, Culik *et al.* 1990), and/or shifts in the centre of activity (Harrow 1971, Kuck *et al.* 1985, Anderson 1988, Gese *et al.* 1989, Anderson *et al.* 1990). Instantaneous effects have been recorded as a behavioural response such as fleeing or increased vigilance (Kury & Gochfield 1975, Burger 1981, 1986, Kovacs & Innes 1990, Burger & Gochfield 1991), and as a physiological response such as an increase in heart rate (Ball & Amlaner 1980, Culik *et al.* 1990, Wilson *et al.* 1991).

For example, in the case of Adélie Penguins *Pygoscelis adeliae* all three levels of disturbance effects have been recorded. Inter-annual effects have been recorded as long-term decreases in the sizes of colonies (Thomson 1977, Wilson *et al.* 1990), and intra-annual effects as reductions in breeding success (Thomson 1977, Culik *et al.* 1990, Giese 1996). Three different types of instantaneous effects have been documented (Culik *et al.* 1990, Wilson *et al.* 1991): the presence of a human beside a major access route caused the penguins to deviate up to 70 m. Incubating adults did not flee until a human intruder was 0.3 m from the nest, while adults with small chicks fled at a distance of 1.3 m and adults with larger chicks fled at a distance of 6.1m. The heart rate increased despite the absence of any external manifestation of stress when incubating birds were approached (Wilson *et al.* 1991, Culik *et al.* 1990). Therefore an apparent lack of a visible reaction does not indicate the absence of stress.

Yellow-eyed Penguins *Megadyptes antipodes* are timid and wary of people and hides are vital if normal behaviour is to be observed at close range (Marchant & Higgins 1990). Being very flighty could make them the least suitable penguin species for ecotourism, but this feature also highlights the potential of disturbance. However, there has been no previous assessment of the impact that the proximity of people has on Yellow-eyed Penguins.

The Yellow-eyed Penguin Conservation Reserve at Penguin Place, Dunedin, New Zealand is an ecotourism venture instigated by Scott Clarke and landowner Howard McGrouther. Tourists are guided through a Yellow-eyed Penguin breeding colony and view penguins from a series of covered trenches and observation hides. This colony is adjacent to a second colony on the same property where public entry is prohibited. This study investigated trends in long-term nest numbers, breeding success in five consecutive years and the feeding pattern of chicks by their parents between the colony visited by tourists and the undisturbed colony. As with all species of

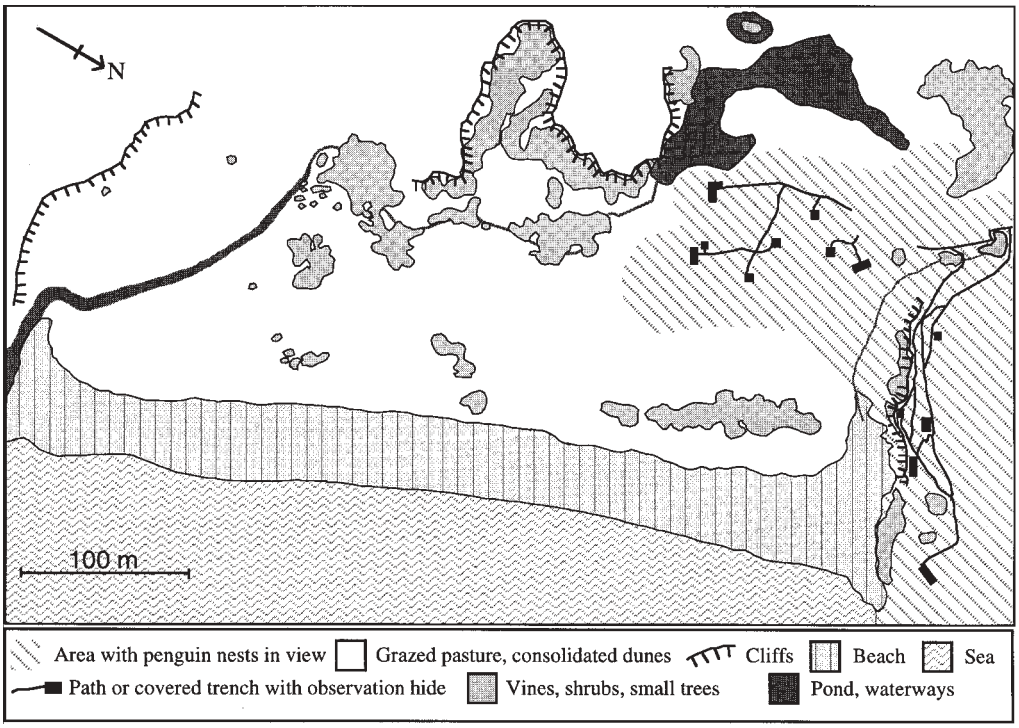

Fig. 1. *Yellow-eyed Penguin breeding colony, Pipikaretu Beach. Otago Peninsula, New Zealand.*

penguins both parents feed the chicks by incomplete regurgitation (Marchant & Higgins 1990). This procedure in Yellow-eyed Penguins at the guard stage has been described by Richdale (1957), but the temporal pattern of the sequence of regurgitations has not been documented previously. We hypothesise that any distress in parents or chicks caused by the proximity of people will be reflected in a change in the pattern of feeding. The detection of any changes would show that the presence of tourists has an impact that might not be reflected in breeding success or abundance of the penguins.

METHODS

Study areas

The two study areas, Pipikaretu Beach (170°45'E, 45°48'S) (Fig. 1) and Ryans Beach (170°45'E, 45°49'S) are adjacent sandy beaches only 500 m apart situated near the tip of Otago Peninsula, Dunedin, New Zealand. Pipikaretu Beach is 500 m long and faces northeast. Ryans Beach is 550 m long and faces east. The two beaches are virtually identical in features relevant to Yellow-eyed Penguins. In each a foreshore dune and abutting consolidated dune with a combined area of about five hectares are flanked by cliffs or steep slopes. The foreshore dunes have a partial cover of Marram Grass *Ammophila arenaria*. Most of the consolidated dunes are covered in pasture grasses and isolated patches of vines, shrubs and small trees. Grassed areas are interspersed with patches of bare sand that vary annually in extent. Nests at both beaches are spread through the consolidated dunes and wooden nest boxes have been deployed to supplement the small amount of vegetation suitable for nest sites.

All nests in both colonies are monitored twice weekly for breeding success during the presence of eggs and chicks, subjecting both colonies essentially to the same level of activities by scientists and landowners. Ryans Beach is entered legally only by the landowner and scientists. The small part of the foreshore of Pipikaretu Beach has public access until the early afternoon, and the northern half of the colony is visited by tour groups throughout the year. In 1992, trenches were dug approximately 1 m wide and waist-deep and were covered with camouflage netting raised 1 m above the surrounding terrain. These lead into observations hides with an average floor area of 10 m^2 and provide close-up viewing (minimum distance 0.5 m) of the penguins.

Study design

Nest numbers were recorded in 1984/85 (H. McGrouther pers. comm.) in both colonies by means of locating nests. Nest numbers were recorded between 1985/86 and 1990/91 at Pipikaretu Beach (S. Clarke pers. comm.). At Ryans Beach they were estimated in 1986/87 and 1988/89 by means of counting penguins returning into the colony (J.T. Darby pers. comm.) and a further estimate for 1989/90 was reported in Marchant & Higgins (1990). Nests were located and breeding success recorded in both colonies in 1991/92 (Ratz *et al.* 1992), in 1992/93 (Fechney *et al.* 1993), in 1993/94 (Moller *et al.* 1995) and in 1994/95 and 1995/96 (J.T. Darby & K.-A. Edge pers. comm.). Records of nest numbers therefore represent the minimum number of nests present in the colony; estimates have not been evaluated for their validity but are the only record available. A general linear model was used to test for homogeneity of slopes of the increase in nest numbers at Pipikaretu Beach and Ryans Beach, with the year as a covariate.

The number of nests that were in view of either trenches, hides or walking paths (Fig. 1) were recorded for four years, 1992/93 to 1995/96 at Pipikaretu Beach. The proportion of nests in view (number of nests in view/total number of nests) were compared over the four-year period using a chi square test.

Nest success has been recorded for every nest in both colonies since 1991/92, therefore the age of the chicks during the

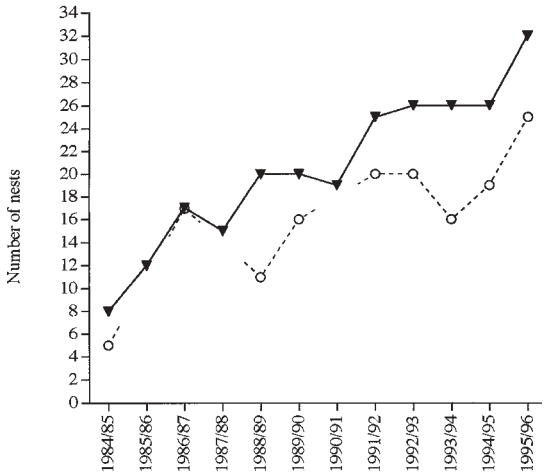

Fig. 2. *Annual numbers of Yellow-eyed Penguin nests at Pipikaretu Beach with tourists (-▼-) and Ryans Beach without tourists (- ○ -).*

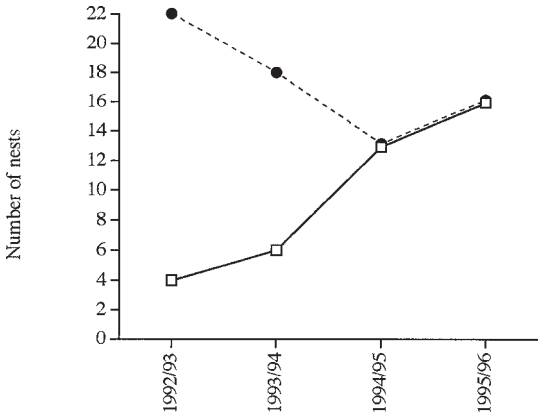

Fig. 3. *Annual numbers of Yellow-eyed Penguins in view (-□-) and out of view (-●-) of tourists at Pipikaretu Beach.*

observations was known. Fledging success was calculated as the number of chicks fledged per number of eggs hatched. A logistic regression was used to test for differences in fledging success rates between Pipikaretu Beach and Ryans Beach. A power analysis (Agresti 1990) was also performed.

A feeding sequence was defined as a series of food transfers from the parent to either chick after the return of this parent to the nest. Arrival of the adult at the nest was designated as the beginning of the feeding sequence. Returning adults were observed feeding their chicks between 24 November and 20 December 1994 and 20 and 23 December 1995 at Pipikaretu Beach and between 27 December 1994 and 8 January 1995 at Ryans Beach. It was unknown which parent was feeding the chicks and some nests were observed more than once. The chicks were on average 37 and 53 days old (range 20–46 and 48–58 days) at Pipikaretu Beach and Ryans Beach, respectively, when they were observed. The total duration of the chick period is 106 days (range 97–118 days) (Richdale 1957) and all observations were taken in the second quartile of development and all observed feeding sequences were at two-chick nests during the guard stage. Initially nine observations were made at Pipikaretu Beach for one hour but no food was transferred after 30 minutes and so the observation time was reduced to six time periods of five minutes each.

The treatment block of data was collected at Pipikaretu Beach where the feeding sequences were observed from the observation hides in the presence of tour groups. The control block of data was collected at Ryans Beach where the feeding sequences were observed with 10×24 binoculars from a distance. Care was taken to ensure that these penguins were unaware of the presence of the observer and that the observer was the only person present in the vicinity. The distances between the observer and the feeding adult and chicks were measured for both colonies.

To test for a difference between the patterns of food transfers at Pipikaretu Beach and Ryans Beach the least square means of the proportion of food transfers for each time period were calculated. Only the first four time periods were used because in the two last periods feeding had ceased in almost all cases. The least square means accounted for the unequal numbers of observations at each nest before performing a multivariate analysis of repeated measures. The size of the minimum detectable difference was determined using a power calculation.

RESULTS

Tourist numbers

From 1985 to 1991/92 one group of up to 12 tourists was taken daily into the breeding area at Pipikaretu Beach in the late afternoon. Since 1992, groups of up to 15 people visited the colony throughout the day from September to April and in the late afternoon from May to August. The numbers of tourists have steadily increased since the instigation of visits throughout the day from 10 000 in 1992/93, 20 000 in 1993/94, 23 000 in 1994/95 and to 31 000 in 1995/96.

The groups are taken by a trained guide along a hill side to the headland at the northern end of the colony to view penguins on the beach. Then groups are taken into the colony through a series of covered trenches and observation hides for close-up viewing. Flash photography is prohibited.

Inter-annual effect on nest numbers

The number of pairs breeding has increased in both colonies since 1984/85 (Fig. 2), and the rate of increase in nest numbers (inter-annual) showed no evidence of statistical difference ($F = 1.85$, df = 1,17, $P = 0.1918$) between Pipikaretu Beach and Ryans Beach. At Pipikaretu Beach the proportion of nests in view of tourists has changed significantly in the four-year period ($\chi^2 = 9.966$, df = 3, $P = 0.019$) (Fig. 3). *Post-hoc* testing showed no significant difference between 1992/93 and 19993/94 or between 1994/95 and 1995/96. The overall significance appears to be related to an increase in the proportion of nests in view between 1994/95 and 1995/96 versus 1992/93 and 1993/94.

Intra-annual effect on breeding success

Annual fledging success (Fig. 4) showed a significant change over the five years ($\chi^2 = 29.120$, df = 4, $P < 0.0001$). There was no significant difference between Pipikaretu Beach and Ryans Beach after accounting for this year to year variation ($\chi^2 = 0.802$, df = 1, $P = 0.3705$). Power calculations showed that the study had approximately 90% power to detect consistent

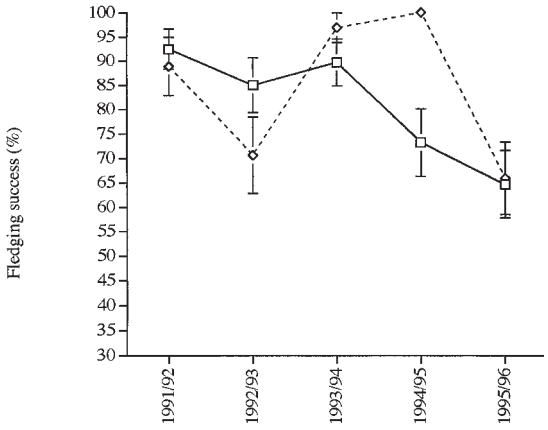

Fig. 4. *Annual fledging success (with standard error) of Yellow-eyed Penguins at Pipikaretu Beach (◇) and Ryans Beach (□).*

differences of about 12% in yearly fledging rates at the 5% significance level at the two beaches. Therefore if a consistent difference exists, it is likely to be smaller than 12%.

Instantaneous effect on feeding behaviour

Totals of 11 and eight feeding sequences were recorded at Pipikaretu Beach and Ryans Beach, respectively. At Pipikaretu Beach six feeding sequences were recorded in the 1994/95 summer and five in the 1995/96 summer whereas all records at Ryans Beach were made in 1994/95 summer (Fig. 5) It was logistically impossible to make the observations at the two colonies parallel rather than in sequence with respect to age of chicks. The mean distance between the observation hide and the chicks being fed was 14 m (range 9–23 m) at Pipikaretu Beach. The mean distance at Ryans Beach was 62 m (range 16–116 m).

The least square means of the proportions of food transfers (Table 1) were analysed using a multivariate repeated measures test between the feeding pattern of Pipikaretu Beach and Ryans Beach showed no significant difference ($F = 1.6284$, df = 3,5, $P = 0.2952$). However, power calculations showed the study had only 21% power to detect a large effect at the 5% level of significance (Cohen 1988, Buchner *et al.* 1997).

TABLE 1

Least squares means of proportions of food transfers occurring in the first four time periods

Location	0–5 min	5–10 min	10–15 min	15–20 min
Pipikaretu Beach	0.5151	0.3166	0.0783	0.0629
Standard error	0.0731	0.0368	0.0249	0.0299
Ryans Beach	0.5025	0.3751	0.0946	0.0139
Standard error	0.0855	0.0143	0.0291	0.0349

DISCUSSION

The increase in Yellow-eyed Penguin nest numbers was higher at Pipikaretu Beach than at Ryans Beach, the control, but the difference in increase between the two colonies was not significant. Overall both colonies show a marked increase in nest numbers over the 12 years and therefore the increasing number of tourists have not had a detrimental impact on the increase of the number of breeding pairs at Pipikaretu Beach. The nest numbers at Pipikaretu Beach have been either the same or even higher than at Ryans Beach since the establishment of the tourist operation. At Pipikaretu Beach the number of nests visible from the observation hides increased at a faster rate than did the number of nests out of view through the four years of rapid increase of tourist numbers. The reverse result would have been expected if tourism was having a detrimental impact.

Fledging success was variable between the years, but no difference was detected between the colony visited by tourists and the control. The power analysis showed that this study should have picked up a relatively small difference in fledging success (12%). Fledging success of Yellow-eyed Penguins varies between years and between locations (Moore 1992). The low record for fledging success in the last year at both beaches may have been caused by the large increase in nest numbers. Such a high recruitment of first-time breeders will decrease overall fledging success because they have been shown to have a lower breeding success than experienced pairs (Richdale 1957). Therefore the observed fluctuations are highly unlikely to be due to the proximity of people.

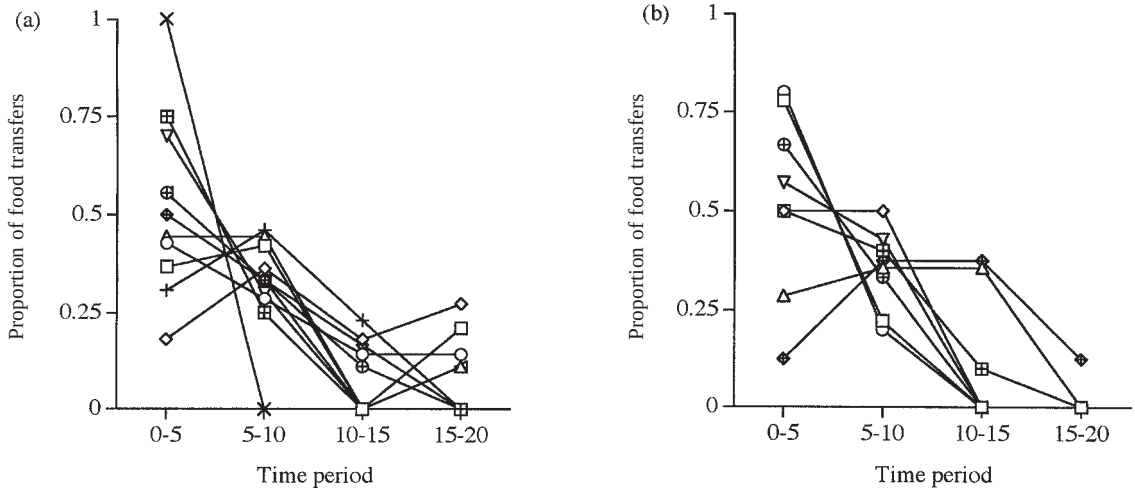

Fig. 5. *Proportions of food transfers for each adult return observed at (a) Pipikaretu Beach and (b) at Ryans Beach.*

No significant difference was found in the pattern of chick feeding by parents between the colony where tourists were observing the feeding and the colony where no tour groups were taken. However, the power calculations indicated that due to the small sample size and the repeated measures at some nests, the difference between the two colonies would have to have been large before they would have been detected. Nests showed huge variability (Fig. 5) but the first two time periods had almost identical least square means of proportions of food transfers (Table 1) and a considerable delay would have been expected if the tourists had a negative impact. However, this still only indicates that there were no apparent differences in patterns of feeding between the two colonies. More observations would be required in order to have power to detect more subtle differences in feeding pattern, which at the time of this study was not feasible.

Both the adults and the chicks seemed to have habituated to the presence of tour groups in the trenches and hides. They often approached and spent considerable time in close proximity (up to half a metre away) of the hides and preened, allopreened, slept and adults interacted with chicks and other adults (pers. obs.). Their general behaviour therefore appears not to be altered significantly by the proximity of tourists. When a group was in an observation hide, penguins sometimes approached and stared into the hide for two to 30 minutes and even pecked at camera equipment or hands (pers. obs.). These observations indicated that the penguins are aware of the movement in the hides and observe the activity. However, if a person had left the trenches and had approached a penguin, it would respond by fleeing as did penguins at Ryans Beach (pers. obs.). Penguins breeding in view of tourists appeared to have become habituated to people at eye level or below in hides and trenches and did not perceive them as threats provided that the people stayed behind the camouflage netting.

The behaviour of the penguins indicated that they were not adversely affected by the presence of people in the trenches. Further tests of the instantaneous response of penguins to the proximity of people would be provided by measures of heart rates of incubating Yellow-eyed Penguins. Four paired experiments are envisaged to compare between

1. nests in view of tourist hides at Pipikaretu Beach in the presence and the absence of tourists;
2. nests out of view of tourist hides at Pipikaretu Beach in the presence and in the absence of an exposed person walking towards the nests;
3. nests at Ryans in the presence and in the absence of an exposed person walking towards the nest; and
4. the presence of an exposed person walking towards a nest in view of tourist hides at Pipikaretu Beach compared with 1. to 3.

Any detrimental impacts of an ecotourism venture must be identified and eliminated if the venture is intended to remain sustainable in perpetuity. The Yellow-eyed Penguin Conservation Reserve has been nationally recognised with the New Zealand Ecotourism Award in 1996 and it was the runner-up for the Award for Service to the Environment in 1996 by the New Zealand Tourism Award Board. Conservation research and management should be financed from profits. The South Island population of Yellow-eyed Penguins is regionally threatened (Marchant & Higgins 1990) and its conservation is considered a priority (Department of Conservation 1991). The conservation effort is undertaken by the Department of Conservation, the Yellow-eyed Penguin Trust and interested private individuals. The entrance fee to Penguin Place funds an extensive revegetation programme, predator control, provisions of nest boxes, the treatment and convalescence of injured or starving birds, and ongoing research into the impact of tourism and other aspects of the behaviour and ecology of Yellow-eyed Penguins at Pipikaretu Beach and Ryans Beach.

ACKNOWLEDGEMENTS

Thanks are due to Howard and Elizabeth McGrouther, Scott Clarke and Barbara Morrison, the owners of Penguin Place, for the opportunity to do this work and their support in making it all possible, to all the guides who have helped and supported the observations, to J.T. Darby and K.-A. Edge for access to unpublished breeding data, to Chris Lalas for all the discussions about penguins, ideas and comments on various stages of the manuscript, and to Henrik Moller for helpful comments on the paper.

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