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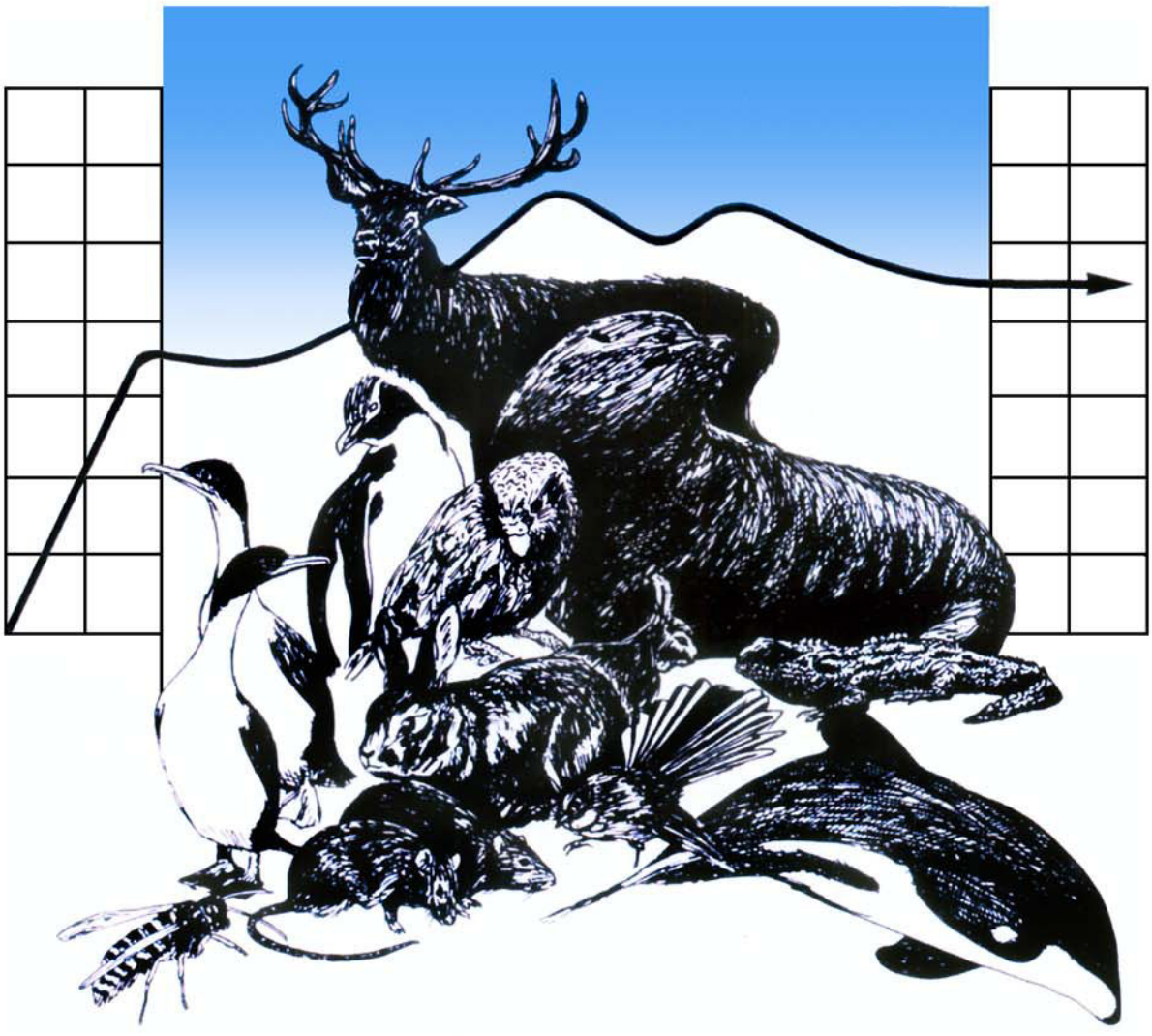

WILDLIFE MANAGEMENT

Assessing the effectiveness of temporarily excluding tourists from a Yellow-Eyed Penguin (Megadyptes antipodes) breeding beach

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Abstract

The Otago Peninsula, South Island, New Zealand, contains a large variety of native wildlife which makes it and ecotourism hotspot, offering tourists close-up encounters with some of the country's most endangered species. A paper by McClung et al. (2004) noted a decline in Yellow-eyed penguin (Megadyptes antipodes) reproductive success at Boulder Beach, one of the Peninsula's largest YEP breeding colonies. This prompted the Department of Conservation to campaign for the closure of Boulder Beach during YEP breeding seasons. A five year trial period was granted permission, and the beach was to be closed to public access from the 1st of December until the 28th of February the following year, beginning in the summer of 2006/07. The conclusion of the 2010/11 austral summer also sees the end of this trial period. This report investigates whether the closure has had any influence on chicks fledged per adult breeding pair and chick fledging weights at Boulder Beach, both of which are an indication of future recruitment and survival probability of YEPs.

Contents

1.0 Introduction

1.1 Ecotourism

Ecotourism is an ever-growing, worldwide, industry, built on the idea of sustainable development, which offers tourists up-close encounters with wildlife (Fowler 1999; Kruger 2005; Otley 2005; Tisdell & Wilson 2005; Stronza 2007). The positives of ecotourism are widely published, as it can contribute to conservation, local economies, and education for the public (Ratz & Thompson 1999; Acevedo-Gutierrez et al. 2010). However, nature-based tourism ventures can have detrimental effects on wildlife populations, as well as the environment, and the need to closely monitor and regulate human-wildlife interactions is becoming increasingly aware (Fowler 1999; Ratz & Thompson 1999; Otley 2005; Kerbiriou et al. 2009; Acevedo-Gutierrez et al. 2011).

Negative implications of ecotourism can include reduced reproductive success (Phillips & Alldredge 2000; Bouton et al. 2005; Carlini et al. 2007; Ellenberg et al. 2007) and survival rates (McClung et al. 2004; Kerbiriou et al. 2009), changes in behaviour (e.g. foraging and travelling routines, McClung et al. 2004; Burger &Gochfeld 2007; and avoidance behaviour, Kerbiriou et al. 2009), and physiological changes, such as; increases in heart rate (Ellenberg et al. 2009), internal body temperature (Regel & Putz 1997), and hormonal secretions (Fowler 1999; Walker et al. 2005; Ellenberg et al. 2007; Bertin_ et al. 2008). The effects of ecotourism have been studied in a wide range of species, including the majority of penguin species, which appear to be highly susceptible to human disturbance and show limited ability to habituate to our presence (Fowler 1999; McClung et al. 2004; Carlini et al. 2007; Ellenberg et al. 2009).

1.2 The Yellow-Eyed Penguin (Megadyptes antipodes)

The Yellow-eyed penguin (YEP), or Hoiho, (Megadyptes antipodes) is endemic to New Zealand and breeding sites can be found from as far north as Banks Peninsula on the South Island, stretching across the lower half of the South Island's east coast, and on Stewart Island, as well as the Auckland Islands and Campbell Islands in the Subantarctics (Department of Conservation, 2001)The YEP is classified as nationally vulnerable (Hitchmough 2002); with a population of roughly 2000 breeding pairs it is thought to be the rarest penguin species in the world (Department of Conservation, 2001). The most significant population on mainland New Zealand can be found around the Otago Peninsula, near Dunedin, where several breeding areas have became vital to the ecotourism industry of coastal Otago (McClung et al. 2004).

Populations monitored around the Peninsula fluctuate rapidly due to frequent years of poor breeding success and population decline, which have been a major cause for concern for conservation authorities (Moore 2001; McClung et al. 2004). It is generally unknown what causes these bad years for YEP breeding; disease and predator outbreaks, anthropogenic disturbance, inexperienced parents, and environmental changes have all been put forward as causes (Peacock et al. 2000; Moore 2001; McClung et al. 2004; Ratz et al. 2004; Ellenberg et al. 2007), however, it is likely that it is a combination all of these factors.

1.3 Boulder Beach Closure

A study performed by McClung et al. (2004) found that chicks from Sandfly Bay, an area of the Peninsula which experiences high levels of tourism, had significantly lower fledging weights, and lower numbers of chicks fledged per adult breeding pair than chicks from the Highcliff region of Boulder Beach, an adjacent site on the Peninsula, which experiences very low levels of tourism exposure. The Department of Conservation (DOC)

found a similar trend occurring for the chicks from the Midsection area of Boulder Beach, which is the area that tourists walk through to access the beach. This was concerning as chick weight at the time of fledge is positively associated with survival probability, and chicks fledged per pair is an effective measure of productivity for penguin species (McClung et al. 2004).

As a result of these findings a proposal was put forward by DOC to close the entire Boulder Beach site to public access for three months of the YEP breeding season (from 1st December to 28th February) each year (Department of Conservation 2006 (unpublished)). The proposal was accepted and Boulder Beach was closed for a five year trial period beginning in the summer of 2006/07and ending at the conclusion of the 2010/11 summer.

1.4 Aims of this study

Following the end of the 2010/11 breeding season, and subsequently the trial closure of Boulder Beach, analysis is now needed in order to investigate whether excluding tourists from the area during the three months of YEP's breeding season has had an effect on the number of chicks fledged per pair and on chick weights at the time of fledging. The Study also aims to investigate whether changes in other variables such as sea surface temperatures could account for any changes noted in chicks fledged per pair, or weights.

2.0 Methods

2.1 Study Site

The Boulder Beach complex (45º53'S, 170º37'E) on the Otago Peninsula, South Island, New Zealand is made up of four different YEP breeding areas; Double Bay (DB), Midsection (MS), A1 and Highcliff (HC) . Before the closure MS was thought to receive relatively high levels of human disturbance (>10 people per day), DB and A1 received

moderate (<10 people per day) levels, and HC had negligible levels (less than 1 visitor per day - usually only researchers accessed this site) (McClung et al. 2004). Since the closure human disturbance is thought to have been negligible across the entire BB site, however actual numbers are unknown and it is known that some members of the public, such as surfers, still chose to access the beach infrequently.

2.2 Data Collection

Chicks were weighed during late January to early February each year, roughly 4 weeks before they fledge from the nest. The chicks were captured close to their nests and placed in restraining bags, they were then weighed using Pesola spring scales (0.1 kg accuracy) and foot and head lengths were measured for sexing. They were then banded with a stainless steel flipper band containing a unique code and released.

Data from the four Boulder Beach sites was also compared against other YEP breeding sites around the peninsula including Sandfly Bay (SFB), Okia, and Otapahi. Data from BB and SFB was collected by the Department of Conservation, while Okia and Otapahi sites are monitored by The Yellow-Eyed Penguin Trust. Sea surface temperature (SST) data was obtained from measurements taken by the Portobello Marine Lab.

2.3 Data Analysis

Data on chicks fledged per pair (CFPP) and chick fledging weight were analysed using general linear model ANOVAs, in Minitab 15, in order to account for differences in sample sizes. Analysis was split into two parts; part 1 investigated the effect of human disturbance level and restriction type (i.e. whether a site was closed to the public or not) for the trial period years (2006-2010). Part 2 investigated the effect of human disturbance level and time period (pre-BB closure years; i.e. 2001-2005, or the years during the trial closure;

2006-10). Tukey's post-hoc tests were than performed on any findings in order to identify which results were giving significance.

Human disturbance level was ranked, similar to McClung et a1. 2004, as either none (HC and Otapahi), Moderate (A1, DB, and Okia), or High (MS and SFB). The Okia site was excluded from chick weight analysis as no weights were recorded at this site during 2001-2005. Correlation was used to search for a possible relationship between annual CFPP and chick weights and average summer SST's.

3.0 Results

3.1 Chicks fledged per breeding pair (CFPP)

Figure 1 displays the reproductive traits of yellow-eyed penguins at each of the seven breeding areas split into two time periods; 2001-05 (pre-BB closure years) and 2006-10 (during the trial closure). The overall effect of human disturbance (HD) on CFPP for the trial closure period was not quite significant at the 95% level ($F = 2.99$, $df = 2$, $P=0.051$). However, a Tukey's post-hoc test did identify that HD level 1 (negligible) sites did differ significantly from HD level 3 (high) sites (CI -0.4659 - -0.0096, $P= 0.039$). Restriction type (closed versus non-closed sites) had no effect on CFPP, there was, however, a significant interaction effect between HD and restriction type ($F = 6.37$, $df = 2$, $P= 0.002$). The Tukey's test identified that it was SFB causing this result, as CFPP at this site significantly differed from HC (CI -0.9400 - -0.0686, $P= 0.013$), Otapahi (CI -0.8826 - -0.0463, $P= 0.019$), Okia (CI -0.9277 - -0.0330, $P= 0.027$), and MS (CI -0.9289 - -0.0575, $P= 0.016$).

For the total sample (2001-10) there was a significant effect of human disturbance on CFPP ($F = 5.40$, $df = 2$, $P= 0.005$), the Tukey's test identified that HD level 1 sites differed from both level 2 (CI -0.3247 - -0.0455, $P= 0.005$) and level 3 sites (CI -0.3135 - -

0.0042, P= 0.043), but that level 2 and 3 sites did not differ significantly. Total CFPP did not differ significantly across the two time periods (’01-’05 versus ’06-’10), and there was no interaction effect between disturbance level and time period.

3.2 Chick fledging weights

Table 1 shows summary statistics for mean chick fledging weights at breeding sites which experience different levels of human disturbance for the pre-closure and trial periods separately. During the trial closure period chick fledging weight did not differ between sites experiencing different levels of human disturbance, nor did it differ between closed and non-closed sites. However, there was a significant interaction effect between disturbance level and restriction type (F = 6.04, df = 2, P= 0.003). The Tukey’s test identified a significant difference in chick weights between Otapahi and SFB (CI 0.0470 - 0.7403, P= 0.015).

For the total sample (2001-10) there was no difference in weights between sites with different disturbance levels. Weight did differ significantly across the two time periods (F = 23.65, df = 1, P<0.001), and there was a significant interaction effect between time period and disturbance level (F = 4.36, df = 2, P=0.013). The Tukey’s test found that weights for both HD level 1 and HD level 2 sites differed significantly between the two time periods, with CI -0.3547 - -0.0035, P= 0.043 and CI -0.5954 - -0.1530, P<0.001 respectively.

3.3 Boulder Beach analysis

Due to the influence of SFB on the results, the four Boulder Beach sites were analysed separate of the other sites in order to investigate whether Midsection was differing from the other three BB sites. There is a significant difference in CFPP between sites with different levels of disturbance (F = 4.12, df = 2, P=0.017), however the Tukey’s test identified that this difference was only between HC (negligible disturbance) and A1/DB

(moderate disturbance) (CI -0.3884 - -0.0084, P=0.039), MS did not differ from either. There was no difference in CFPP between the two time periods for any of the BB sites.

Table 2 displays summary statistics for mean chick fledging weights at Boulder Beach breeding sites which experience different levels of human disturbance for the pre-closure and trial periods. There was a significant difference in chick fledging weights between different disturbance sites (F = 5.16, df = 2, P= 0.006), and the Tukey's test found that this difference was only between HC and MS (CI -0.3205 - -0.0485, P= 0.004). There was also a difference in weights between time periods (F = 46.91, df = 1, P<0.001). A Tukey's test on the interaction effect of disturbance and time period found that HC chick weights differed significantly between the two time periods (CI -0.6237 - -0.1469, P<0.001), and that HC weights differed significantly from MS weights for 2001-05 (CI -0.5384 - -0.0540, P=0.006), but not for 2006-10 (CI -0.2986 - 0.1528, P=0.941). A1 & DB weights also differed significantly between time periods (CI -0.5675 - -0.1809, P<0.001).

3.4 *SST's* and reproductive success

There was no correlation between either SST and CFPP (r = 0.432, n = 10, P=0.246) or SST and chick fledging weight (r = -0.313, n = 10, P=0.413).

4.0 Discussion

4.1 Chicks fledged per pair

CFPP was significantly higher at sites with negligible levels of human disturbance (Otapahi and HC) than sites with high levels of disturbance (SFB and MS) during the trial closure period. However, it appears that SFB was dragging this group down as a post-hoc test on the interaction effect of disturbance level and restriction type showed that, while SFB differed significantly from both Otapahi and HC, MS did not. In fact, SFB and MS differed

from one another with MS fledging significantly more chicks per breeding pair than SFB. It is hard to say whether the difference in CFPP between SFB and MS is due to the closure of Boulder Beach, in order to answer this question more analysis would need to be done on CFPP at either site for the years prior to the BB closure.

From the results of the total sample period (2001-10) it would appear that levels of human disturbance at or above one person per day does affect rates of CFPP in yellow-eyed penguins, as sites with negligible levels differed significantly from both sites with moderate and high levels of human disturbance. However, time period had no effect on CFPP, yet, if it was solely human disturbance affecting fledging success, one might expect to see a difference in CFPP at the Boulder Beach sites between time periods as the closure would have kept the majority of tourists out meaning human disturbance levels at BB would be closer to negligible during the 2006-10 time period. These results show no such difference, which means that either disturbance levels have remained constant between the two time periods or there are other factors at these sites affecting rates of CFPP.

When the four BB sites were analysed separately from the other monitored sites, in order to remove the effect SFB was having on the results, there was a significant difference in CFPP between sites, however, this difference was only between negligibly and moderately disturbed sites (i.e. between HC and A1/DB), MS did not differ from any of the other BB sites, therefore, here it is more likely that some other factor is affecting CFFP. There was also no difference between time periods for any of the BB sites. This means that rates of CFPP at MS have not changed significantly over the last 10 years, and do not differ from the other sites at BB regardless of suspected level of human disturbance.

4.2 Chick fledging weights

As was seen in CFPP, when all sites were analysed, chick weights only differed significantly between Otapahi and SFB. Sites with negligible and moderate levels of human disturbance differed significantly in mean chick weights between the two time periods, however, this was a significant decline in chick weights at these sites as the average weights for 2001-05 were higher than for 2006-10.

Some interesting results were observed when chick weights were analysed amongst the BB sites only. Chick fledging weights differed significantly between HC and MS for the pre-closure years (2001-05); however, for the five trial closure years there is no difference in chick weights. This means that, in the years prior to the BB closure, yellow-eyed penguins at HC (which received <1 visitor per day) were producing significantly heavier chicks at time of fledge than penguins at MS (which received >10 visitors per day). Since the closure began, and the level of human disturbance to MS is assumed to have dropped, there has been no difference in chick weights between the two sites. This seems like a positive finding, however, chick weights at both sites have declined during the trial closure years compared to the five years prior to the closure. Therefore, while excluding tourists may have been enough to allow MS to fledge chicks at weights similar to HC, again, some other factor is having a greater affect on YEPs causing the decline in weights. This is important as the weight of a chick at time of fledge is related to its survival probability (McClung et a1. 2004).

4.3 Environmental influence

Changes in the environment are the most likely cause for the fluctuation in reproductive success of YEPs. Changes to factors such as El nino-Southern Oscillation events, which can affect ocean and terrestrial temperatures, water salinity, rainfall, etc. are likely to influence offspring survival either directly through extreme weather events, or indirectly through

changes to food supply (Peacock et al. 2000). There appeared to be no correlation between average summer SST's and CFPP or chick fledging weights, however this was not a powerful statistical test. Further research into different environmental conditions could offer some insight into why YEP populations fluctuate so wildly.

4.4 Summary

As the ecotourism industry continues to grow, the need to fully understand the influence human presence is having on wildlife populations does too. From the results it appears that, so far, the closure of Boulder Beach has had no significant benefit for YEPs, with the population at Boulder Beach continuing to fluctuate in a similar pattern to pre-closure years. It seems more likely that environmental factors such as climate and food availability would have a greater effect on reproductive success than human disturbance, however this needs further testing to prove.

Although human presence is known to prevent adult penguins from coming ashore to feed their chicks (Wright 1998) this does not seem to be significantly influencing the population at Boulder Beach. A lack of consistency in human disturbance analysis suggests that there are other factors affecting yellow-eyed penguin reproductive success at Boulder Beach. However, human disturbance does seem to be a significant problem at nearby SFB and one would suggest that, with Boulder Beach containing a much larger breeding population of YEPs, should the breeding season closure no longer continue, levels of ecotourism would need to be closely monitored in order to prevent the BB sites going the same way as SFB.

Other wildlife, such as New Zealand Sea Lions (Phocarctos hookeri), may also add weight to the argument for a continued closure at Boulder Beach, as NZ Sea Lions continue to re-establish themselves on the peninsula they have begun to give birth to pups on Boulder

Beach. One pup was found there during the 2009/10 summer, and two pups were found during the 2010/11 summer, but the presence of humans may deter future females from birthing on Boulder Beach. Furthermore, with the close proximity of Sandfly Bay, a major ecotourism beach, to Boulder Beach, perhaps having a human-excluded breeding area for Otago's ever-important wildlife could be used as conservation insurance for future generations.

In conclusion, the five year trial closure of Boulder Beach does not appear to have had any relevant effect on YEP reproductive success. However, chick weights at MS were much closer to HC during the closure than they were pre-closure and this could be because adult penguins from MS are free to walk up the beach to their nests now that tourists are banned from the beach. Regardless of whether human exclusion has allowed MS to catch up to the less frequented sites, it appears that other, unknown, factors are much more influential on YEP reproductive success.

5.0 Acknowledgements

I would first like to thank Mel Young for all her help; for sharing data, statistical advice, comments, and information that made this report possible. Thanks also to the Department of Conservation, the Yellow-Eyed Penguin Trust, Ursula Ellenberg, Melanie Massaro, Alvin Setiawan, Dean Nelson, Mike Hazel, and Aviva Stein for sharing their YEP data and knowledge. Finally, thanks to Craig Stewart of NIWA and the Portobello Marine lab for supplying SST data.

6.0 References

Acevedo-Gutierrez, A., Acevedo, L., Boren, L. (2011). Effects of the presence of official-looking volunteers on harassment of New Zealand Fur Seals. Conservation Biology. **25**, 1-5.

Bertin, A., Richard-Yris, M.A., Houdelier, C., Lumineau, S., Mostl, E., Kuchar, A., Hirschenhauser, K., Kotrschal, K. (2008). Habituation to humans affects yolk steroid levels and offspring phenotype in Quail. Hormones & Behaviour. **54**, 396-402.

Bouton, S.N., Frederick, P.C., Dosualdo Rocha, C., Barbosa Dos Santos, A.T., Bouton, T.C. (2005). Effects of tourist disturbance on Wood Stork nesting success and breeding behaviour in the Brazilian Pantanal. Waterbirds. **28**(4), 487-497.

Burger, J., Gochfeld, M. (2007). Responses of Emperor penguins (Aptenodytes forsteri) to encounters with ecotourists while commuting to and from their breeding colony. Polar Biology. **30**, 1303-1313.

Carlini, A.R., Coria, N.R., Santos, M.M., Libertelli, M.M., Donini, G. (2007). Breeding success and population trends in Adelie penguins in areas with low and high levels of human disturbance. Polar Biology. **30**, 917-924.

Department of Conservation (2001). Hoiho (Megadyptes antipodes) recovery plan 2000-2025. Threatened Species Recovery Plan 35. Department of Conservation, Wellington, New Zealand.

Department of Conservation (2006) (Unpublished). Subject closure of conservation are: Boulder Beach. Internal DOC files (docdm-48527).

Ellenberg, U., Setiawan, A.N., Cree, A., Houston, D.M., Seddon, P.J. (2007). Elevated hormonal stress response and reduced reproductive output in Yellow-eyed penguins exposed to unregulated tourism. General & Comparative Endocrinology. **152**, 54-63.

Ellenberg, U., Mattern, T., Seddon, P.J. (2009). Habituation potential of Yellow-eyed penguins depends on sex, character and previous experience with humans. Animal Behaviour. **77**, 289-296.

Fowler, G.S. (1999). Behavioural and hormonal responses of Magellanic penguins (Spheniscus magellanicus) to tourism and nest site visitation. Biological Conservation. **90**, 143-149.

Hitchmough, R.A. (2002). New Zealand threat classification systems list 2002. Department of Conservation. Threatened Species Occasional Publication 23, Wellington.

Kerbiriou, C., Le Viol, I., Robert, A., Porcher, E., Gourmelon, F., Julliard, R. (2009). Tourism in protected areas can threaten wild populations: From individual response to population viability of the Chough Pyrrhocorax pyrrhocorax. Journal of Applied Ecology. **46**, 657-665.

Kruger, O. (2005). The role of ecotourism in conservation: Panacea or Pandora's Box?. Biodiversity & Conservation **14**, 579-600.

McClung, M.R., Seddon, P.J., Massaro, M., Setiawan, A.N. (2004). Nature-based tourism impacts on Yellow-eyed penguins Megadyptes antipodes: Does unregulated visitor access affect fledging weight and juvenile survival?. Biological Consevation. **119**, 279-285.

Moore, P.J. (2001). Historical records of Yellow-eyed penguin (Megadyptes antipodes) in southern New Zealand. Notornis. **48**,145-156

Otley, H.M. (2005). Nature-based tourism: Experiences at the Volunteer Point penguin colony in the Falkland Islands. Marine Ornithology. **33**, 181-187.

Peacock, I., Paulin, M., Darby, J. (2000). Investigations into climate influence on population dynamics of Yellow- eyed penguins Megadyptes antipodes. New Zealand Journal of Zoology. **27**, 317-325.

Phillips, G.E., Alldredge, A.W. (2000). Reproductive success of Elk following disturbance by humans during calving season. Journal of Wildlife Management. **64**(2), 521-530.

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.

Ratz, H., Darby, J.T., Edge, K.A., Thompson, C. (2004). Survival and breeding of Yellow-eyed penguins (Megadyptes antipodes), at two locations on Otago Peninsula, South Island, New Zealand, 1991-96. New Zealand Journal of Zoology. **31**, 133-147.

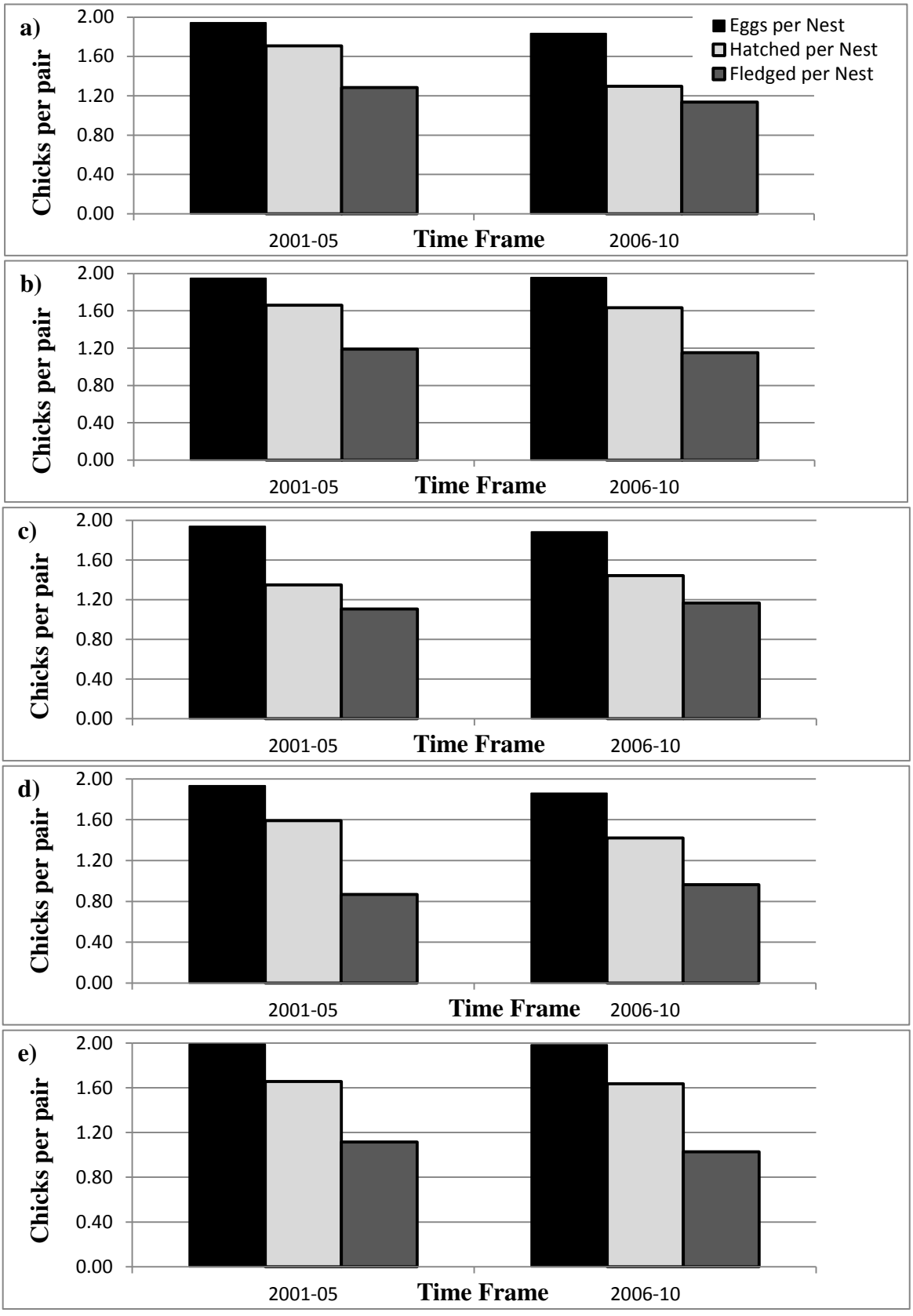
Regel, J., Putz, K. (1997). Effect of human disturbance on body temperature and energy expenditure in penguins. Polar Biology. **18**, 246-253.

Stronza, A. (2007). The economic promise of ecotourism for conservation. Journal of Ecotourism. **6**(3), 210-230.

Tisdell, C., Wilson, C. (2005). Perceived impacts of ecotourism on environmental learning and conservation: Turtle watching as a case study. Environment, Development, & Sustainability. **7**, 291-302.

Walker, B.G., Dee Boersma, P., Wingfield, J.C. (2005). Physiological and behavioural differences in Magellanic penguin chicks in undisturbed and tourist-visited locations of a colony. Conservation Biology. **19**(5), 1571-1577.

Wright, M. (1998). Ecotourism on Otago Peninsula: Preliminary studies of Hoihos (Megadyptes antipodes) and Hookers Sealion (Phocarctos hookeri). Science for Conservation 68. Department of Conservation, Wellington, New Zealand.


a)
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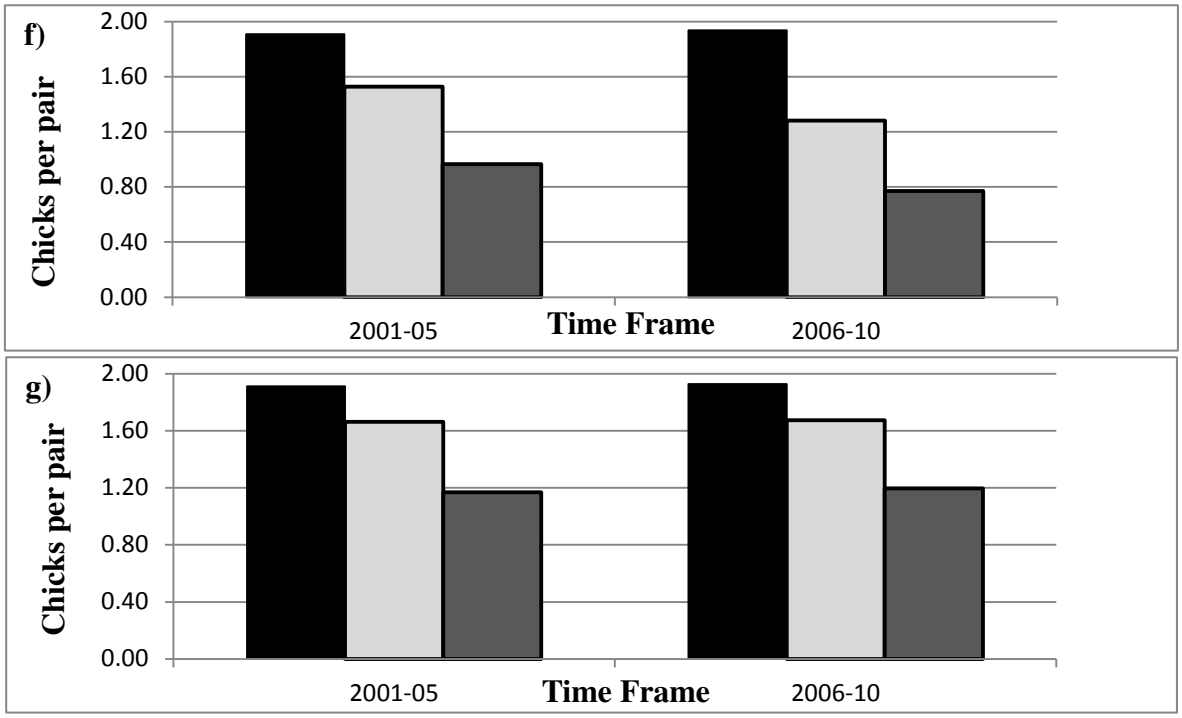
Chicks per pair
2.00
1.60
1.20
0.80
0.40
0.00
Eggs per Nest
Hatched per Nest
Fledged per Nest
2001-05
Time Frame
2006-10



2001-2005					
Disturbance Level	**Sites**	**n**	**Mean**	**SD**	**Range**
1	Otapahi, HC	211	5.27	0.75	2.5-7.2
2	A1, DB	144	5.45	0.59	3.5-7.1
3	SFB, MS	157	5.24	0.67	2.3-7.1
2006-2010					
1	Otapahi, HC	236	5.09	0.65	2.5-6.5
2	A1, DB	137	5.07	0.61	2.0-6.3
3	SFB, MS	134	5.18	0.56	3.5-6.7

Disturbance Level: 1 = negligible levels (<1 person/day), 2 = low (<10 people/day), 3 = high (>10 people/day). Sample size (n) is the number of chicks counted in each type of nest. Mean weights, SDs, and Ranges are in kilograms.

2001-2005					
Disturbance Level	**Sites**	**n**	**Mean**	**SD**	**Range**
1	HC	83	5.56	0.63	3.3-7.2
2	A1, DB	144	5.45	0.59	3.5-7.1
3	MS	97	5.27	0.58	3.4-7.1
2006-2010					
1	HC	104	5.18	0.43	3.6-6.1
2	A1, DB	137	5.07	0.61	2.0-6.3
3	MS	102	5.11	0.55	3.5-6.7

Disturbance Level: 1 = negligible levels (<1 person/day), 2 = low (<10 people/day), 3 = high (>10 people/day). Sample size (n) is the number of chicks counted in each type of nest. Mean weights, SDs, and Ranges are in kilograms.

Figure 1: Comparison of reproductive performance of yellow-eyed penguins at each of the monitored sites for non-BB closure years (2001-05) and closure years (2006-10). Each graph represents a different breeding site with a) through f): Otapahi, HC, Okia, A1, DB, SFB, and MS

Table 1: Summary statistics for yellow-eyed penguin chick fledging weights at breeding areas on the Otago Peninsula, South Island, New Zealand, which experience differing levels of daily human disturbance between non-BB closure years (2001-05) and closure years (2006-10).

Table 2: Summary statistics for yellow-eyed penguin chick fledging weights at breeding areas on the Otago Peninsula, South Island, New Zealand, which experience differing levels of daily human disturbance between non-BB closure years (2001-05) and closure years (2006-10).