

number of people in each zone was recorded consecutively from Zone A to Zone F at the beginning of each 2 minute interval over the observation period, using the instantaneous scan sampling technique (Altmann 1974).

All times used in this study are New Zealand daylight saving time which is New Zealand standard time plus 1 hour, or GMT plus 13 hours.

2.2.3 Data analysis

To assist in the analysis of the data the 2 minute sampling intervals were combined into 6 minute units, which were then numbered in relation to the conclusion of sampling (i.e., time unit 1 ran from 6 minutes prior to sampling finish until sampling finish, time unit 2 ran from 12 minutes prior to sampling finish until 6 minutes prior to sampling finish etc.).

Penguin landing times were compared using two different analyses. The time until 25%, 50% and 75% of penguins had landed at each beach on each day was calculated. These three measures were then compared separately using univariate two-way analysis of variance, with the days and beaches as the sources of variation. Empirical cumulative distribution functions were also constructed for each beach on each day by calculating the percentage of the total penguins landing to have landed by the end of each successive six minute observation period. The empirical cumulative distributions for each beach were then compared on a pairwise basis for each day using the two-sample Kolmogorov-Smirnov test. All observations were used for this analysis as commencement time was irrelevant because of the pairwise nature of the test.

If penguin landings at Sandfly Bay are unaffected by the presence of people, then the proportion of penguin landings occurring during periods when people were present should be equal to the proportion of time when people were present. Alternately, if the presence of people was affecting penguin landings we hypothesised that penguins would land proportionately less frequently when people were present. To evaluate this hypothesis the proportion of observation time (using the number of six minute observation periods as units) during which people were present in each zone was calculated ($\text{Number time units people present in zone} = \text{Total number of time units}$). The proportion of penguin landings occurring while people were present in each zone was also calculated ($\text{Number of penguin landings with people present} = \text{Total number of penguin landings}$). These two proportions were compared for each zone using a one-tailed z test, based on the normal approximation to the binomial.

All computerised analyses were performed using PROC GLM of SAS Version 6.10, SAS Institute Inc., Cary, North Carolina. Zone B was excluded from all analyses as there were never people present in that zone.

2.3 RESULTS

The univariate two-way analysis of variance showed there was no significant difference in the patterns of penguin landing times between Sandfly Bay and Double Bay, but it did show there was a highly significant difference among days in the three measures of landing time (25%, median and 75% percentiles) (see Table 1 for results). Although landing patterns were the same for the two

TABLE 1. LANDING ANALYSIS SUMMARY. PERIOD OF THE DAY UNTIL 25%, 50% AND 75% OF PENGUINS HAD RETURNED TO LAND FROM SEA. THE TABLE SHOWS IF DIFFERENCES EXISTED FOR THESE THREE MEASURES BETWEEN DAYS OR BETWEEN BEACHES.

TIME UNTIL CUMULATIVE PERCENT LANDED	SOURCE OF VARIATION	f	df	p	SIGNIFICANCE LEVEL
25	Day	6.51	14,14	0.0006	**
	Beach	0.25	1,14	0.6218	ns
50	Day	4.73	14,14	0.0032	**
	Beach	0.001	1,14	0.9091	ns
75	Day	7.98	14,14	0.0002	**
	Beach	0.17	1, 14	0.6860	ns

ns = not significant
 * = significant to 5% level
 ** = significant to 1% level

beaches on any one day, the patterns on different days were significantly different. It must be remembered though that these tests were comparing time intervals as they related to sunset. Therefore, as the days progressed, the actual time of day landing occurred was not being compared by these tests. To allow for this the days were used as blocks so as to make the comparisons pairwise.

The Kolmogorov-Smirnov test compared the trends in landing times between beaches and found that no significant differences existed between the empirical cumulative distribution functions on any specific day ($p > 0.1$ for all days). See Appendix 1 for daily graphs of landing patterns.

The results of the z tests looking at the associations between penguin landings and the presence of people at Sandfly Bay are shown in Table 2. Zone D was the only zone in which fewer than expected (if the hypothesis of no affect of human presence was correct) penguin landings occurred when people were present. All other zones had non-significant differences.

2.4 DISCUSSION

This study showed no major differences in landing patterns between Sandfly Bay and Double Bay during the guard phase of the breeding season, meaning that visitor presence at Sandfly Bay has not caused the penguins there to alter their landing patterns in any major way at this stage of their life cycle. The highly significant difference that did exist in the analysis was between the days sampled. Moore et al. (1995) used radio tracking to monitor the foraging patterns of yellow-eyed penguins from nest sites approximately 4 km from Sandfly Bay along Otago Peninsula (and even closer to Double Bay). They found that the birds forage 16 km on average and up to 57 km from their nesting site. As Sandfly Bay and Double Bay are less than 3 km apart, 'as the penguin swims', it is conceivable that the birds from these two breeding sites use the same areas to feed. Therefore, the distance they travel to find food

TABLE 2. ASSOCIATION BETWEEN PENGUIN LANDING AND PRESENCE OF PEOPLE IN A ZONE. TESTS IF FEWER LANDINGS THAN EXPECTED OCCURRED WHEN PEOPLE WERE PRESENT IN EACH ZONE OF SANDFLY BAY.

ZONE	% INTERVALS WHEN PEOPLE PRESENT	% LANDINGS WHEN PEOPLE PRESENT	z	p	SIGNIFICANCE LEVEL
A	51.26	56.4	1.49	0.9319	ns
C	0.67	0.47	-0.357	0.3605	ns
D	11.85	6.64	-2.347	0.0095	**
E	26.36	22.75	-1.191	0.1168	ns
F	35.42	35.54	0.0365	0.5146	ns

ns = not significant
 * = significant to 5% level
 ** = significant to 1% level

each day would be similar, as would the time spent travelling, providing a theory for the pseudo-synchronisation between landing times at the two beaches.

Edge (1997) observed patterns of brood attendance and therefore foraging time. She discovered that penguins' foraging time was not effected whether they were raising one or two chicks. She argues that trip length is unlikely to correlate with prey availability and that single chick raising adults 'loiter' at sea rather than spending more time on land. Edge also suggests that the reason penguins stay at sea may be related to avoidance of thermal stress or in order to track diurnal prey movements, as has been suggested for other penguin species (Williams *et al.* 1992 and Kooyman *et al.* 1992).

However, whatever reasons are governing penguin foraging time, it would appear that human presence on Sandfly Bay was not a factor causing them to drastically alter the time they returned to their nest site during the period observed.

The analysis did show, however, that there was some effect on penguin landings with the presence of people on a specific area of the beach at Sandfly Bay. If people were present in the area of the beach closest to the penguin habitat and landing site (Zone D), penguins were less likely to come ashore than if people were on other areas of the beach or in the hide. At Sandfly Bay the Department of Conservation has interpretation signs giving information about yellow-eyed penguins and asking people to go from the beach into the viewing hide, as their visible presence will inhibit the landing of the penguins. From the data presented here it would appear that if people follow these instructions and move directly from the beach, up the sandhill path and into the hide, without going onto the area of beach past the hide track (Zone D), the penguins will not change their behaviour when returning from sea.

Van Heexik and Seddon (1990) looked at the effect of human disturbance on beach groups of jackass penguins (*Spheniscus demersus*) and found that

groups of penguins showed the most agitated behaviour when humans were 30 m from them. The border of Zone D is a minimum of 100 m from the penguin landing area and travel routes. They also discovered that medium-term exposure to non-contact human disturbance resulted in habituation, something that could also be a factor at Sandfly Bay and would add weight to the argument for individual assessment of specific visitation sites because of site specificity (Kuss et al. 1990).

Research into human disturbance has been conducted on several other penguin species. Much of the work has been based on population parameters, including reproductive success (Muller-Schwarze 1984, Woehler et al. 1994, Giese 1996), or behavioural effects (Hockey and Hallinan 1981) or on the measurement of heart rate as a stress indicator (Wilson et al. 1991, Nimon et al. 1995). However, it is not easy to make comparisons between these studies and this one of yellow-eyed penguins. The species in these other studies (Adelie: *Pygoscelis adeliae*, chinstrap: *Pygoscelis antarctica*, gentoo: *Pygoscelis papua* and jackass) are colonially breeding, often with large numbers of pairs nesting in close proximity to one another, with no vegetative cover. Yellow-eyed penguins nest in relative seclusion, out of sight of humans and one another (Darby and Seddon 1990). This secluded nesting behaviour, combined with DOC interpretation signs asking people to keep out of nesting areas, should make the occurrence of nest visits by the public infrequent, if they occur at all.

The definition of wildlife harassment adopted by Kuss et al. 1990, p. 164, (from Ream 1979) 'includes events that cause excitement and/or stress, disturbance of essential activities, severe exertion, displacement, and sometimes death.' Temporary behavioural responses caused by wildlife harassment may or may not have lasting effects on the wildlife population (Kuss et al. 1990) and that is the question that remains to be answered in this case: will these short-term changes in landing behaviour at Sandfly Bay have any long-term effect on the penguins and/or their population dynamics. Yorio and Boersma (1992) studied behavioural and reproductive success responses of Magellanic penguins (*Spheniscus magellanicus*) to disturbance. Apart from seasonal attendance at their breeding site in Argentina, these penguins are quite similar to yellow-eyed penguins in that they nest in vegetation (or burrows) and follow approximately the same (if slightly shorter) breeding schedule. The authors found that penguins in a 'tourist' area allowed people to approach a lot closer before using threat and defensive displays than did penguins in a 'non-tourist' area. However, there was no difference in reproductive success or fledging weights between penguins from the two areas.

When the long-term effect of the relatively new phenomenon of tourism at Sandfly Bay is considered, two anecdotal examples are of interest. Firstly, the western end of Sandfly Bay is also home to a small number of penguin nests. This is the end of the beach where the track from the carpark down to the beach is located. All visitors pass through it to get to the hide, unless they make a one hour walk down from Sandymount. In the past, nests have been constructed at the western end and occasionally eggs have been laid, but 1995/96 is the first breeding season that chicks have fledged from this area since regular monitoring began in 1990/91 (three chicks fledged; D. Nelson unpublished data). First time breeders are more likely to be affected by

disturbance than experienced breeders (D. Nelson pers. comm.) and three of the pairs in this area were first time breeders that did not desert their eggs. Secondly, Roberts and Roberts (1973) did a study in which they compared reproductive rates at Sandfly Bay with two other areas and concluded that human activity was responsible for Sandfly Bay having worse rates than Boulder Beach. Their study had a small sample size compared to the nest monitoring carried out now and many other factors, such as habitat quality and predator control, have changed since then. However, the two reproductive rates they measured have both improved markedly from 1971/72 to 1994/95 and 1995/96 (D. Nelson unpublished data), the same time span during which the level of visitation has increased.

Many factors affect reproductive success and survival rates of yellow-eyed penguins. The New Zealand mainland population has experienced several declines and recoveries of varying degrees in recent times (Moore 1994, Moore and Wakelin, in press). Many criteria and potential indicators for population fluctuations have been identified (Moore 1994) but it can still not be stated with certainty why population changes occur. Moore (1994) suggests that population 'crashes' or 'bad seasons' may be natural features of the normal fluctuation of the population. It is clear, though, that many things are affecting the stability of the South Island mainland population of yellow-eyed penguins.

The level of human disturbance, including ecotourism, a population can withstand must be considered alongside the other factors affecting the animals. As Ream, on p. 170 in Kuss et al. 1990 puts it, 'Well-fed, healthy animals with ample refuges from disturbance can withstand more harassment than wildlife already under stress from severe weather, malnutrition, parasite loads, birth or nesting, or inadequate security areas.' Giese (1996) found that hatching success in Adelle penguin colonies was significantly lower in smaller areas where nest checks were performed and in areas exposed to recreational visits it was lower still.

It is important that monitoring of the penguin population continues in order to better assess what factors are contributing to population changes. If it becomes apparent that there is a significant decline in the population or there is some other change in penguin behaviour, then it may be important to reconsider the possible contribution of visitor impacts to such changes. Several avenues could be used to do this. To assess the quantitative effect of penguins delaying their landing time, it would be necessary to measure the added energetic cost to the animals. For example, if a bird is staying at sea for an extra x minutes and using y kilojoules of energy, it must be determined whether this extra energy expenditure is enough to reduce the bird's condition below a critical threshold level. This would involve a complex procedure and require presently unknown information e.g., energy budgets. More realistically, things that could be used as indicators of visitor impact and which are presently being monitored at several Otago Peninsula and Catlins breeding areas, including Sandfly Bay, are reproductive success, recruitment, migration and nest site placement.

Any reduction in reproductive success at sites with high public visitation could indicate impacts. Alternatively, lower success at nests closer to human disturbance compared with nests further from it in the same breeding area could suggest a problem. Birds at the beginning of their breeding life prospect

for mates and nest sites and yellow-eyed penguins usually return to their natal site in their first year of life (Reilly 1994). If recruitment of young birds to natal sites is not occurring, then it may be an indication of a problem with the site (J. Darby pers. comm.). Significant migration is another relatively obvious indicator, as breeding birds seldom move to another breeding site (D. Nelson pers. comm.). Nest site placement is also being monitored on a long-term basis and any pattern of movement away from areas nearer to human use could be interpreted as the penguins trying to distance themselves from disruption. These behavioural changes are not necessarily indicators of visitor impacts and may be the result of other factors. However, awareness of potential effects would allow investigation into causes and solutions.

This monitoring is, of course, of all human visitation, not only that of ecotourism operations, and as this study is essentially about tourism, I feel I should make a qualifying statement. All the commercial ecotourism groups I witnessed at Sandfly Bay never went into Zone D or allowed any of their members to remain outside the viewing hide in Zone A. Therefore, as things stand at the moment, the issue of disturbance of birds on nests or on the beach by ecotourism is less than that relating to impact by the general public at Sandfly Bay.

Yellow-eyed penguin numbers on the Otago Peninsula were at a 16 year high in 1995 (Wallace 1996), after having dropped from 650 breeding pairs in 1985 to 140 pairs in 1991 (Gill and Darby 1993). Through the continued monitoring of breeding sites it may be possible to identify detrimental factors (e.g., visitor impacts, predators, habitat at capacity, etc.) and work towards correcting the problem. It must be remembered, though, that any results of visitor impact studies must be considered in conjunction with the other factors impacting on the species, especially in the case of yellow-eyed penguins where so many variables can potentially have a major effect on their population dynamics.

3. Hooker's sea lion

3.1 INTRODUCTION

The Hooker's or New Zealand sea lion (*Phocarctos hookeri*) is the rarest of the five extant species of sea lion in the world (Woodley and Lavigne 1993) There is a lack of published literature on this species and early population estimates varied widely. Cawthorn et al. (1985) estimated the population to be between 6500 and 7000 from tagging and surveys, but warned that even this estimate was provisional. More up to date calculations estimate the population to be between 11,000 and 15,000 (Cawthorn pers. comm. cited in Woodley and Lavigne 1993) and Gales (pers. comm.) has estimated the population in 1995/96 to be between 9980 and 14,432.

The historical range of Hooker's sea lion on the New Zealand mainland is not known, but remains have been found in coastal middens throughout New Zealand (Smith 1985). Worthy (1994) considers the present Hooker's sea lion distribution to be relict and thinks it likely that, prehistorically, they bred at

suitable mainland locations throughout New Zealand. He backs this up with fossil remains of three pups at Delaware Bay, near the top of New Zealand's South Island, as being proof of a breeding site there.

Since human settlement, the Hooker's sea lion's range has largely been restricted to New Zealand's subantarctic islands, mainly centred on the Auckland Islands (Cawthorn 1993). This range has extended in recent years. King, in Crawley and Cameron 1972, reported them as 'occasional visitors' to southern New Zealand. By 1994 Lalas and McConkey (1994) considered the population on the New Zealand mainland to be 40-50, double that of a decade before. No breeding had been reported from the Snares islands (approximately 105 km south-west of Stewart Island) until Crawley and Cameron's (1972) report of it in 1969. Wilson (1979) reported Stewart Island as the only New Zealand 'mainland' site where Hooker's sea lion regularly hauled out between 1971 and 1974, but 2 pups have been born there, one each in 1989 and 1991 (Gales 1995). Wilson (1979) also saw one and two Hooker's males at Cape Saunders (adjacent to Papanui Beach on Otago Peninsula) on two occasions in 1972. However, by the time Hawke (1986) conducted surveys in 1984 and 1985 there were up to seven sea lions on Papanui Beach year round. Beentjes (1989) also used Papanui Beach as his study site and identified 14 animals, nine of which he determined were resident there. The resident population identified by McConkey (1994) at the same beach was 17, almost twice that found eight years earlier by Beentjes. There is, therefore, evidence of an increasing range for Hooker's sea lion and increased numbers at the limit of that range.

Breeding has also occurred on the Otago Peninsula, with the same female giving birth to a pup at Taieri Mouth (48 km south of Papanui Beach) in December 1993 (Gales 1995) and then another in December 1995 (pers. obs.), both of which she subsequently moved to Victory Beach on Otago Peninsula (the next beach along from Papanui).

This breeding is encouraging for the re-establishment of Hooker's sea lion on the New Zealand mainland, as the first females were only recorded in Otago in surveys between 1984 and 1992 (Hawke 1993). Best (1974) suggested the breeding areas in the subantarctic were nearing capacity, while Hawke (1993) stated that the presence of females and mature males is consistent with re-establishment of the species on the mainland. Lalas (1995) sees the population in Otago as showing the typical dispersal pattern of polygamous mammals, where the young males disperse to new areas, take up residence and the females follow later. Hooker's sea lion are now regularly present on 14 Otago Peninsula beaches (McConkey 1994).

If what is presently being experienced on the New Zealand mainland is a recolonisation of the species, then it is important that we monitor its progress and determine any factors having detrimental impacts on it. Papanui Beach is presently the only site on Otago Peninsula that is regularly visited by commercial tourist operations. It is also the most important Otago Peninsula haul out site for sea lions (Hawke 1986, Beentjes 1989) It is therefore important that this site is monitored for any indications of tourism impacts.

3.2 METHODS

3.2.1 Study Site

Papanui Beach is situated on the Otago Peninsula, South Island, New Zealand (45° 52'S 170° 44'E, Figure 1). This beach was chosen as the study site for several reasons. During his population data collection McConkey (1994) found that of the Otago beaches he surveyed, Papanui Beach most frequently had the largest number of animals present. The beach is easily accessible from the centre of Dunedin City by a 30 minute drive followed by a 10 minute walk. It is also the beach to which two ecotourism operators take their tour groups to view Hooker's sea lions and is, therefore, the place on the peninsula where the animals are actually being subjected to organised tourist visits.

The beach is approximately 350 m long, easterly facing and has steep rocky bluffs at each end. It is surrounded by pastoral farmland and the sand dunes which run the length of the beach are privately owned, as no Queen's Chain exists on this land. Two streams run from the farmland to the sea at each end of the beach. Beach access is by an unformed legal road through private land to its southern end. The stream at the northern end is designated as the farthest point that tour groups may go along the beach. This is to protect yellow-eyed penguins which nest on the farmland behind the north end of the beach and cross that section of beach to come ashore. Therefore only sea lions hauled out south of the beach's northern stream were observed.

3.2.2 Procedure

Sea lion behaviour was observed before, during and after the approach of two people (hereafter called approachers) to a sample animal which was either solitary or the member of a group. The sample animal was approached to 5, 10 or 20 m, giving six experimental treatments i.e., solitary animal to 5, 10 and 20 m and group member to 5, 10 and 20 m. An animal was considered a member of a group if it was within 4 m of another individual.

Observations were carried out on 8 days between 14 February 1996 and 29 February 1996 inclusive. The minimum number of samples recorded on any observation day was two and the maximum was five. The study area was observed from the farmland behind the beach. Sea lion behaviour was recorded using the categories listed in Tables 3 and 4. Two types of behaviours were recorded: the state the animal was in and the event behaviours the animal performed. The subject was always in one of the three mutually exclusive states during which time it could also be performing any or none of the 10 events.

Each sample consisted of 5 stages as follows:

Stage 1 = Pre-control: a 5 minute control period during which no humans were present on the beach;

Stage 2 = Approach: two people approaching the sample animal to the designated distance;

Stage 3 = Stand: 5 minutes of observations with the 2 approachers present at the designated approach distance;

Stage 4 = Retreat: the retreat of the approachers and

Stage 5 = Post-control: another 5 minute period after the people had left the beach.

TABLE 3. ETHOGRAM SHOWING SEA LION STATES.

Lie	No body weight supported by the foreflippers
sit	Supporting the body using the foreflippers
Move	Walking or running

TABLE 4. ETHOGRAM SHOWING SEA LION EVENTS.

Composition change	when an animal (either the subject or another sea lion) left or entered the group that the subject animal was a member of
Flipper move	movement of a flipper (fore or hind) while the rest of the body is motionless
Flipper wave	lifting the flipper (fore or hind) so that it is no longer in contact with another surface (either the surface of the animal's body or the sand)
Groom	using one part of the body (usually flippers or snout) to scratch or rub another part of the body
Head lift	vertical movement of the animal's head
Head turn	horizontal or tilting movement of the animal's head
Interact*	when one animal touches or is touched by another animal
Mouth open	opening of the mouth either silently or during vocalisation
Position change	body movement of the animal when in a lying state
Sandflip	the movement of the fore or hind flippers in a sweeping motion to collect sand and flip it onto the animal's back

*This event could only occur when the sample was a group observation

There was a 30 minute recovery period between each observation period, during which there was no human presence on the beach or at the observation point. This was to allow the animals to return to an undisturbed state. All observations were between 1100 hrs and 1600 hrs (New Zealand daylight saving time, i.e., GMT plus 13 hours) and were not conducted on days with constant or heavy rain as Marlow (1975) stated that heavy rain caused sea lions to evacuate the beach.

The walking speed of the approachers was kept constant rather than the approach time, as it was felt this would more closely approximate to the situation during the visit of a tour group; therefore stages 2 and 4 of each sample varied in length according to the distance the sample animal was away from the entry point of the approachers onto the beach.

One animal was observed during each sample using the focal animal technique (Altmann 1974). A randomised design was used with 6 replicates of each of the 6 experimental treatments being sampled (n=36).

Immediately before the end of stage 3, while the approachers were standing at the designated distance away from the study subject, ambient and black bulb temperature readings were taken. Ambient temperature was recorded using a Biolab Scientific -10 - 110°C 76 mm Immersion thermometer held in the shade by one of the approachers. The black bulb thermometer was placed on the

sand directly in front of the approachers and consisted of a Biolab Scientific - 10 - 110°C 76 mm Immersion thermometer with the alcohol bulb sealed inside a ping-pong ball painted matt black. Black bulb temperature is linearly related to solar radiation (Campagna and Le Boeuf 1988) and therefore gives an approximation of the effect of solar radiation and substrate temperature experienced by the sea lions. The black bulb was always placed on the same substrate consistency that the study animal was on.

Data Analysis

A preliminary analysis of variance was used to investigate whether temperature variables recorded correlated with any behavioural differences between samples. Control behaviours (Stage 1) were analysed with group type as the factor in the model (one-way ANOVA), with each temperature variable as a covariate. This enabled any variation due to black bulb or ambient temperature, without the effect of any of the treatments, to be investigated before the main analysis was conducted. Temperatures were only recorded once per sample because they did not change between stages and therefore could not be used as a covariate in the main analysis.

State and event data were analysed separately. A univariate repeated measures model of analysis of variance was used to assess whether there was any difference in sea lion behaviour with approach distances, group size or sample stage. Because the stages (especially 2 and 4) differed in length, states were compared using proportions of time spent lying during each stage. Because of the small proportion of time the animals spent sitting or moving, these two states were combined. Analysis was only performed on proportion of time spent lying, as any significant difference in this proportion would constitute a corresponding difference in the alternate sitting/moving state.

For the purpose of analysis event types were combined into categories. Sandflip and flipper wave were grouped together, into a new category called flip, as they are both behaviours the sea lions use to thermoregulate. Position change and flipper move were grouped together as they are both body movement events and this category was named position. Head turn, head lift and mouth open were made into another category for analysis called *head* as these three behaviours involved movement of the animal's head. To correct for variation in the stage lengths events were analysed with stage length incorporated into the model as a covariate.

Event data was transformed before analysis using the equation $\text{SQRT}(X+1)$. This helped to stabilise the error variance and therefore better satisfy the assumptions of analysis of variance.

The composition change, interact and groom behaviours were not included in the analysis because they were very infrequently performed and trying to calculate any differences between treatments would have been impractical. They were also not performed frequently enough to satisfy the assumptions of the ANOVA model.

All analyses were performed using PROC GLM of SAS Version 6.10, SAS Institute Inc., Cary, North Carolina.

3.3 RESULTS

Analysis of the four environmental variables

The proportion of time the animals spent lying during either Stage 1 or Stage 3 was not correlated with either of the two temperature variables recorded for each sample.

The two temperature variables did, however, correlate with the event behaviours. Black bulb temperature had a statistically significant affect on the *flip* behaviour category during stage 1 ($f=11.23$, $df=1,33$, $p=0.002$), as did ambient temperature in the analysis of stage 1 behaviours ($f=5.68$, $df=1,33$, $p=0.023$). These were all positive correlations, meaning that as the temperatures increased so too did the frequency of the *flip* behaviours.

However, as these variables were essentially the same during each sample and because of the randomisation of sampling order they do not appear to be confounded with the six experimental treatments.

Analysis of the proportion of time in states

The analysis of time spent lying showed a significant 3 way interaction between approach, group and stage ($f=2.29$, $df=8,120$, $p=0.026$). However, when the data was re-examined it was discovered that during sample 2 the tide height had risen enough that a wave engulfed the sample animal and caused it to sit up and move. Because of the unusual behaviour this outlier (stage 4, sample 2) was removed from the analysis. Without it, no significant difference in the proportion of time spent lying existed with any experimental treatment or within any combination of treatments or treatment stages.

Analysis of events performed

A significant stage effect existed in the behaviour category *head* ($f=2.83$, $df=4$, 119 , $p=0.028$). The category *position* also showed a significant stage effect ($f=2.50$, $df=4$, 119 , $p=0.046$). However, no significant difference existed between either of the different group sizes or between any of the approach distances.

3.4 DISCUSSION

This study found no difference in the behaviour of sea lions on Papanui Beach when approached to 5, 10 or 20 m, regardless of whether they were the member of a group or a solitary animal. This included no difference in the proportion of time the animals spent lying in any of the experimental treatments. Any decrease in time spent lying could potentially have the greatest impact on the animals. As *P. hookers* spend a large amount of their time ashore resting (Marlow 1975, Beentjes 1989, Heinrich 1995) and are not known to sleep at sea as other seal species may do (Marlow 1975), it is important that this resting and therefore energy-conserving behaviour is not significantly disturbed. Time allocation is the ultimate measure of an animal's survival ability (Seddon 1988), an animal that can optimally allocate time to vital

activities, resting, breeding, feeding, etc., will be the best able to survive. Time spent consuming energy instead of conserving it may leave less energy available for growth or reproduction, therefore reducing an animal's fitness. Presumably a threshold level of impact upon activity budgets exists for Hooker's sea lion but what that threshold is has not yet been discovered. Beentjes (1989) however did find a seasonal variation in activity budgets between summer and winter, with more time spent lying in summer.

In this study (conducted in the Southern Hemisphere summer) there was a positive correlation between temperature (both ambient and black bulb) and the occurrence of the behaviour category called *flip*, which included sandflipping and flipper waving. Both of these events are thermoregulatory and aid in cooling the animal (Marlow 1975, Beentjes 1989). Sandflipping does this by covering the body with deeper sand to cool it and the flippers by contact with damper sand and by shading the darker sea lion body with lighter coloured sand. The 'waving' or extending of the flippers in the air is to allow cooling by the breeze. Beentjes (1989) also found an increase in these behaviours with increased temperature. The nature of animals that divide their time between sea and land is that they are well insulated to contend with cold sea temperatures and must therefore compensate to prevent thermal stress when temperatures are warm ashore (Marlow 1975, Campagna and Le Boeuf 1988, Gales 1995). Animals disturbed too frequently from their lying state in warmer temperatures may be unable to perform these life sustaining thermoregulatory behaviours. For this reason it is important that human impacts are, and must continue to be, monitored.

Beentjes (1989, p. 82) reported that the Hooker's sea lions he observed on the same beach as this study would 'not tolerate observer presence much closer than 10 m'. However, the approachers in this study went as close as 5 m with no distance related effect being detected, and researchers individually identifying animals on this beach for the 18 months previous to this study have regularly gone right up to the sea lions and have at times lifted flippers in order to see distinguishing marks (S. McConkey pers. comm.). This appears to indicate increased tolerance by the sea lions on Papanui Beach to the presence of humans. Heinrich (pers. comm.) has also found evidence of habituation in the Catlins, South Otago.

This study used people approaching sea lions to imitate tourist behaviour, whereas Heinrich (pers. comm.) has been monitoring reactions to actual visitor encounters at Roaring Bay, which is a public beach and people encountering the sea lions there are often in small groups. In comparison, access to Papanui Beach is over private land and is primarily by organised tour groups of approximately 6-10 people. This study only used two people approaching the animals, a fact that could be argued gives the study little extrinsic (or real life) validity. However, Kovacs and Innes (1990), in their study of tourism impacts on harp seals (*Phoca groenlandica*), looked at the significance of tour group size and discovered it was of little consequence. Kuss *et al.* (1990) consider there to be a threshold level of visitation but also consider the times, frequency of visits and the visitor behaviour to be more important than actual numbers. Because of the site specific nature of impacts this may or may not be the case at Papanui Beach but presumably there is a threshold above which the number of people in a group has negligible effect on the animals' behaviour. If

this threshold is one and it is merely presence or absence of people which is the crucial factor, then the results discussed here stand firm. If, however, the critical threshold is greater than two then these results are invalid. This is an area requiring further research.

At Roaring Bay in the Catlins, Heinrich (1995) found 5% of sea lion/visitor encounters caused 'long term effects' (defined as lasting longer than 5 minutes), including biting, chest to chest pushing and alterations in group composition. These effects were never observed in conjunction with human approaches in this study. The animals sampled in this study were males 3 years and older, including mature males. Heinrich's study animals were juvenile males 2-5 years old (10 were 2 year olds), 1 subadult male and 1 female, no adult animals were present. There are no data on behavioural changes with age but it appears that the younger males are more aggressive (S. McConkey pers. comm.) and Beentjes (1989) reported that animals that had spent less time using Papanui Beach were initially more intolerant but within a short time they appeared untroubled by his presence. Younger animals could also be less used to humans if all animals migrated from their natal area at approximately the same age. The difference between Papanui Beach and Roaring Bay could therefore be explained by the age of the animals and the degree of habituation.

As emphasised by Kuss *et al.* (1990), all tourism areas must be considered separately as many contributing factors make each site a specific and unique case. Stirling *et al.* (1993) agree that behaviour can differ within a species according to variation in factors between sites, including latitude and substrate type for example. Substrate type at Roaring Bay is sand and pebble beach backed by grass whereas at Papanui Beach it is sand beach backed by marram covered dunes. Regardless of the cause it would appear these two sites show differing sea lion responses and Heinrich has extended her research to look more closely at human impacts at Roaring Bay (pers. comm.). This would appear to be an example of site specific variation within a species.

The monitoring of the two main Hooker's sea lion tourism sites on mainland New Zealand - at Papanui Beach and Roaring Bay - is encouraging and these studies add to the currently sparse pool of research into these animals, especially from a behavioural perspective. In the future it must be remembered that these studies look almost exclusively at male sea lions not engaged in breeding. If recolonisation of the mainland does occur and the number of females present increases, it is most important to consider that the females may not behave or react to humans in the same way as males. Therefore, the monitoring of impacts may have to be designed differently. Also, the establishment of regular breeding or even the practising of holding territories here by males could result in different reactions to people. Hooker's sea lion bulls are considered to defend a territory which is a space around themselves rather than a defined area of ground (Marlow 1975, King 1983). This would have implications for visitor approach distances.

Continued monitoring of the number and frequency of sea lions and humans using beaches could provide useful indications of Hooker's sea lion tolerance to varying levels of human visitation. Also, any change in the preferred haul out areas on a beach (something which Beentjes 1989 studied on Papanui Beach) could indicate preference of areas with differing levels of human use.

Increased use of areas with lower human impact is a possibility and has occurred at The Taiaroa Head Royal Albatross Colony where the birds have begun nesting further away from the observation building (Robertson 1993).

Any change in aggressive behaviour towards people could indicate a dislike of visitation. For example, scientific research in the Galapagos has not detected any noticeable tourism impacts; however the long-term residents and naturalist guides have reported that the sea lions there have become increasingly nervous and aggressive towards tourists which they now sometimes chase (Boo 1990). On the other hand, Seal Bay (Kangaroo Island, Australia) is a major tourist attraction with over 100,000 people per annum taking guided tours around the Australian sea lion (*Neophoca cinerea*) colony. No formal studies other than peak visitation time counts have been conducted there, but the sea lions appear to be totally habituated to human presence and the only reaction to the increasing number of human visitors is that they are 'ignored in greater numbers' (T. Dennis, District Ranger pers. comm.).

Animals are likely to be more vulnerable to impact at certain times of the year or breeding cycle (Kuss *et al.* 1990) and wildlife breeding areas have been identified as areas with a low range of tolerance to disturbance (Ward and Beanland 1994). It will be important to investigate these factors at Papanui Beach, and other sites where human impact may become an issue, as the dynamics of the Hooker's sea lion population change. As Ream states (p. 177 in Kuss *et al.* 1990) 'Time and effort spent alleviating harassment in other situations is wasted if habitat loss and wildlife mortality occur at critical times and places'.

Hooker's sea lion is perhaps a very special case. Woodley and Lavigne (1993) studied the population dynamics of Hooker's sea lion in relation to their ability to sustain incidental mortalities from commercial fishing bycatch. They considered the Hooker's sea lion population to have demonstrated a limited capacity for increase, meaning incidental deaths could tip the balance between population growth and decline. Because of this bycatch the Southern Ocean squid fishery for the 1996 season was closed early. The precarious nature of this rare marine mammal means we must be especially cautious about any additional impacts, as a population already at risk is much more vulnerable than a healthy one (Kuss *et al.* 1990). Also, a significant impact of bycatch in the subantarctic region, where 90% of the population reside (Lalas and McConkey 1994), may place greater emphasis on the ability of the mainland population to contribute to the overall population.

Hooker's sea lion will continue to represent a prime opportunity for people to view a sea lion species in its natural environment, as it is considered the least aggressive of the five sea lion species (Marlow 1975). In fact, Marlow reported that they would allow approach to 3 m with 'considerable tolerance' (Marlow 1975 p. 162). The overall growth of tourism in New Zealand and the growing demand for ecotourism, coupled with the suitability and accessibility of this species on Otago Peninsula makes the need for continued monitoring essential in order to protect the population and its well being.

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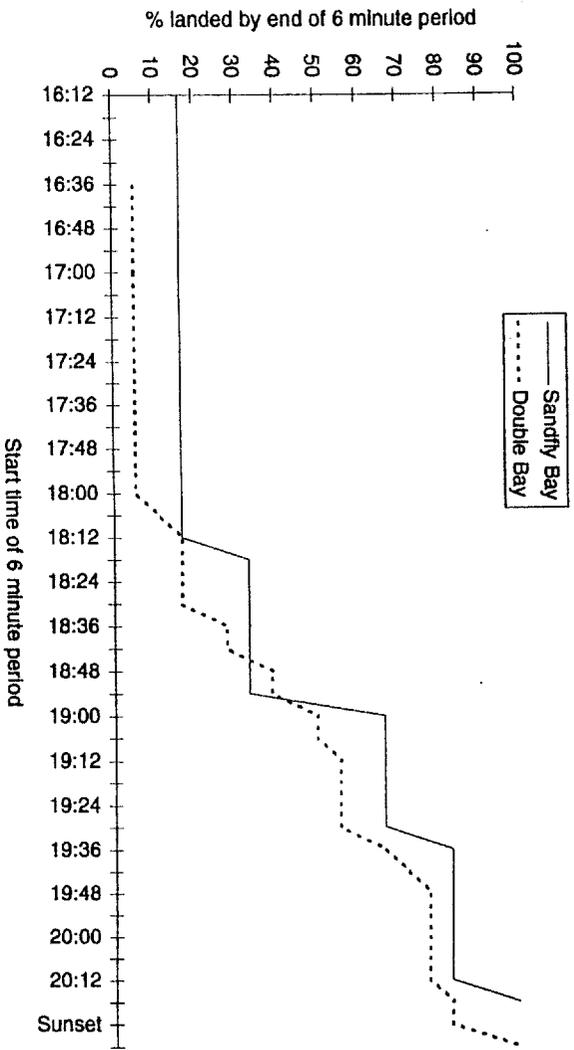
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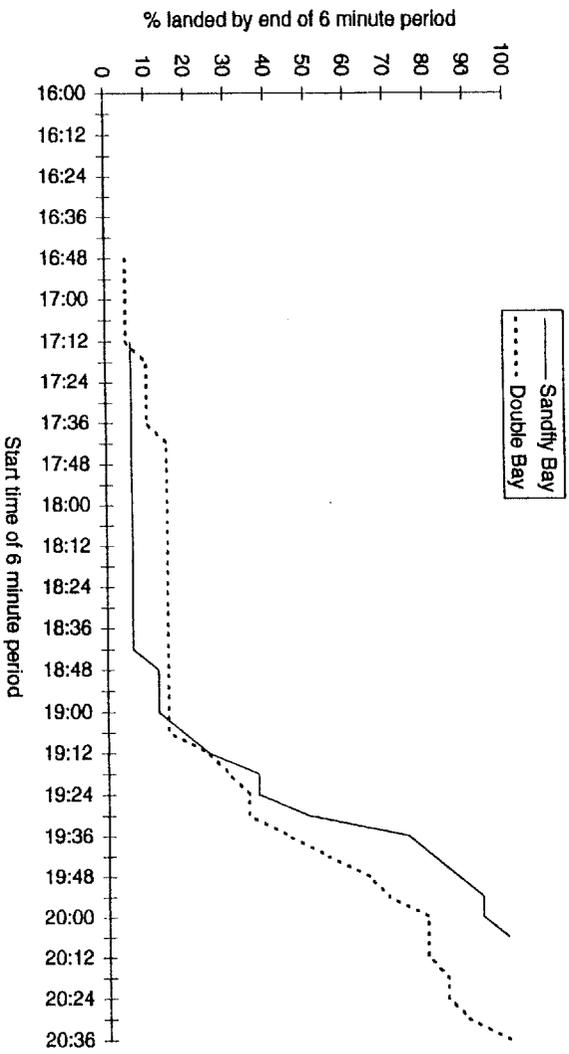
Appendix 1

Graphs showing comparison of daily yellow-eyed penguin landing times between Sandfly Bay and Double Bay.

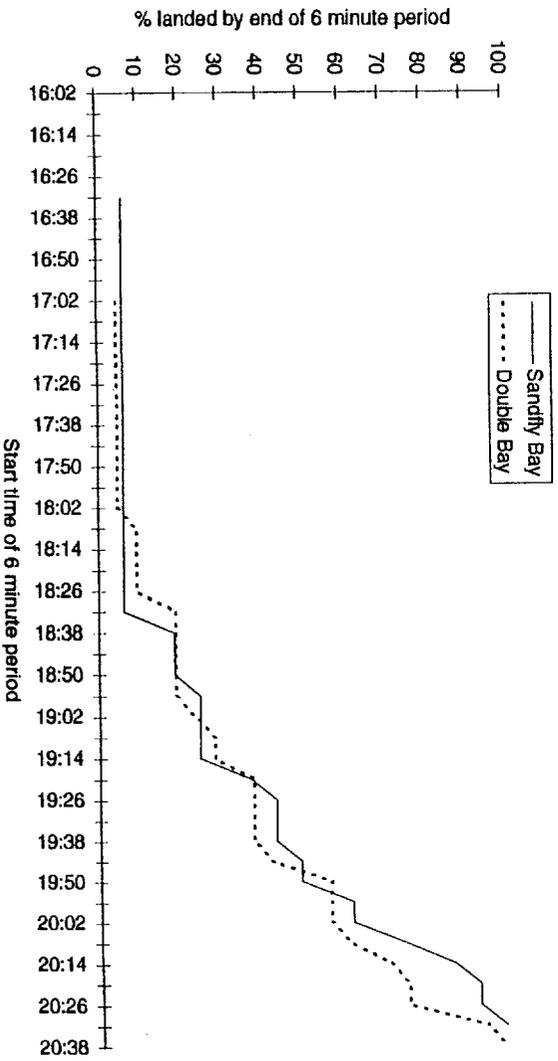
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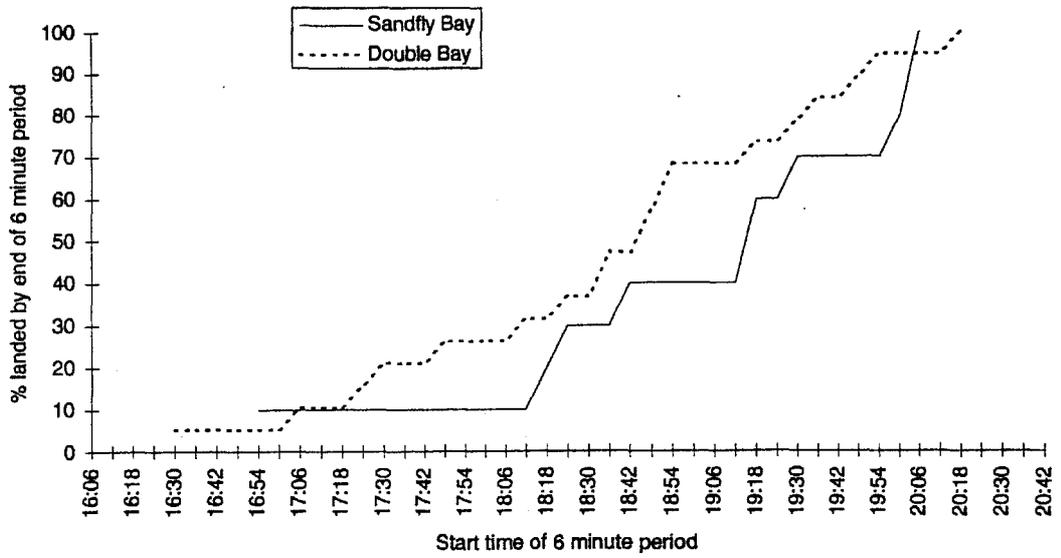
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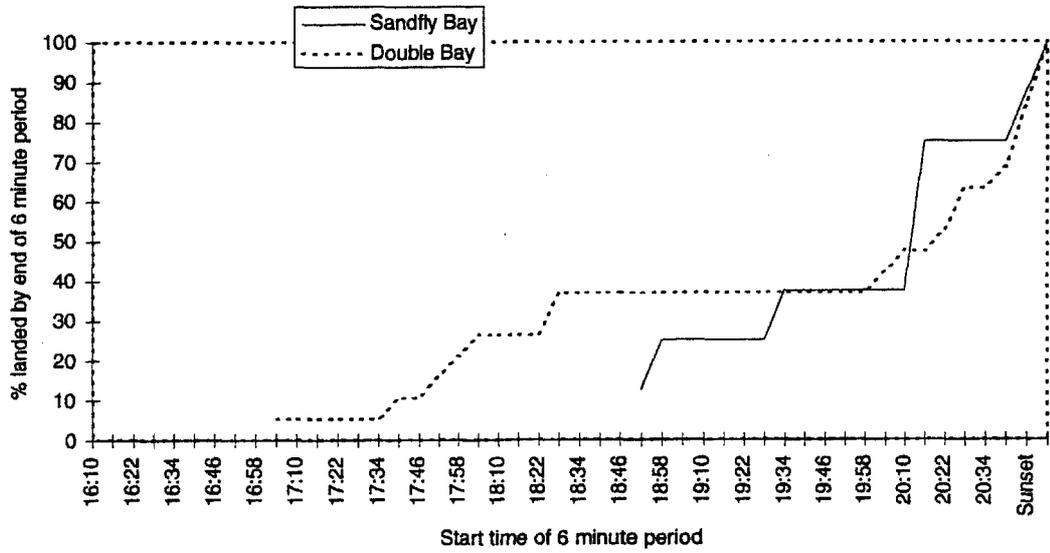
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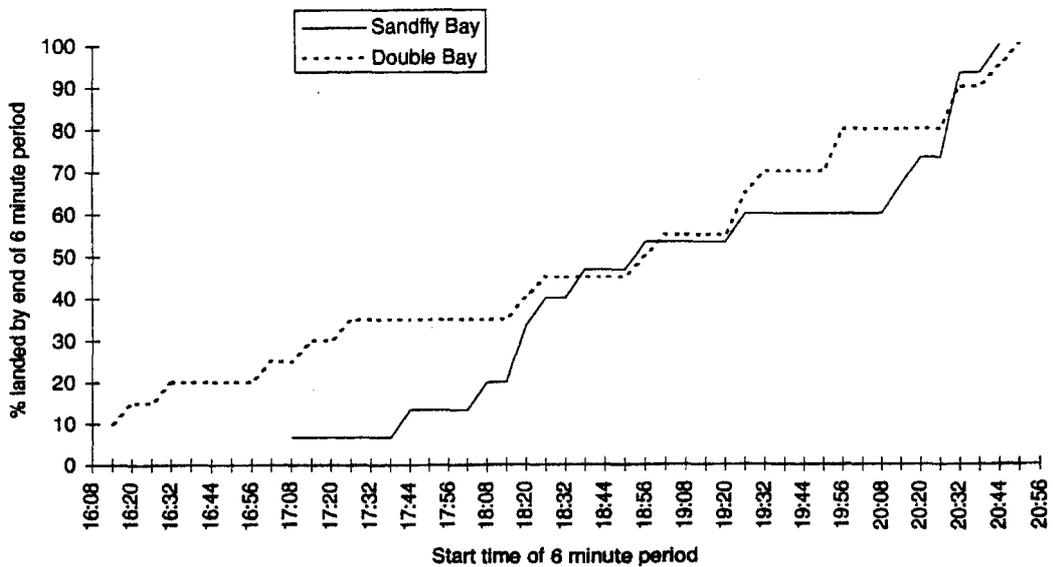
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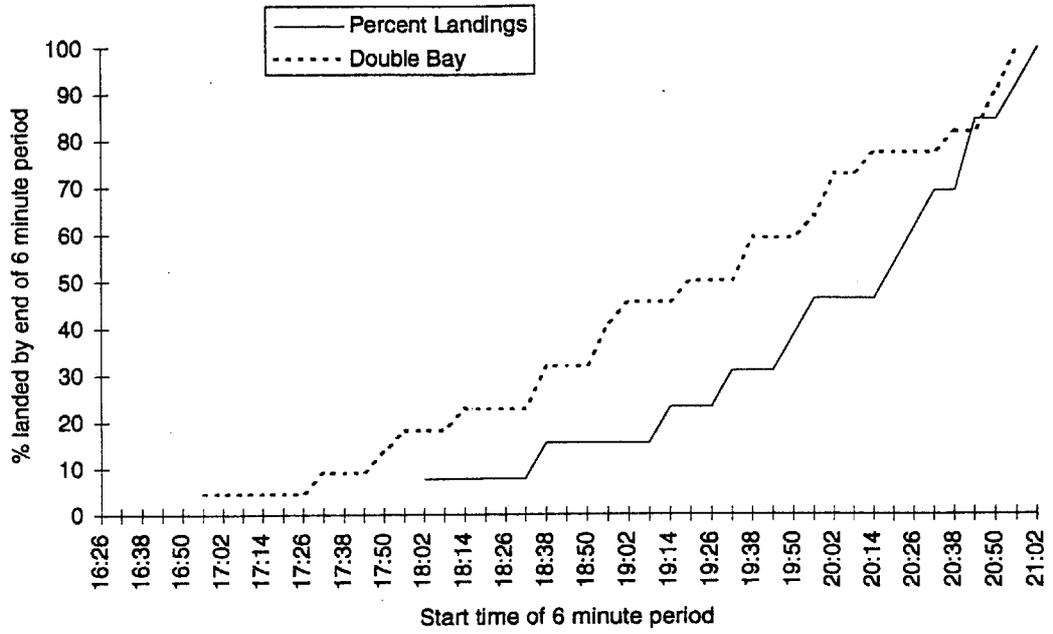
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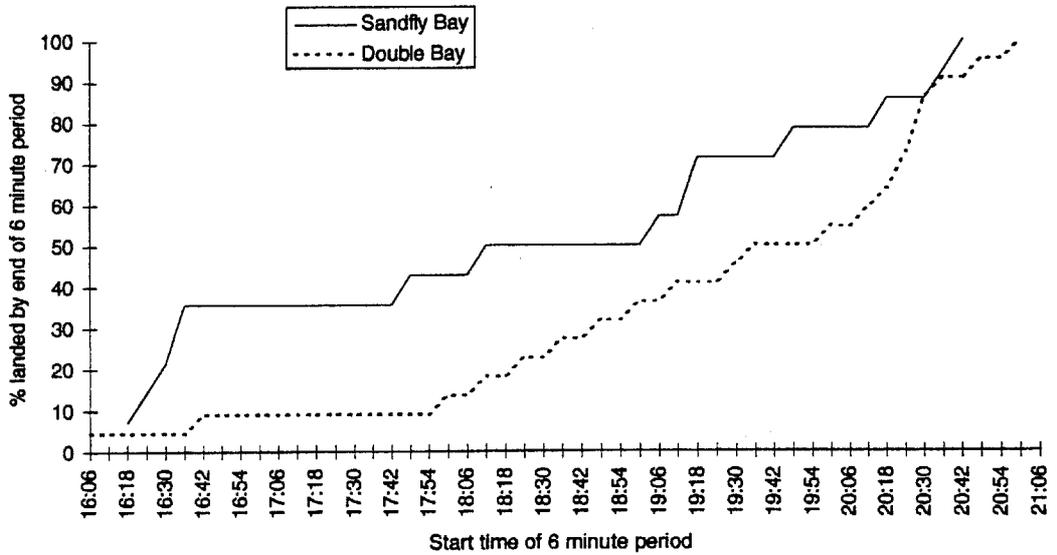
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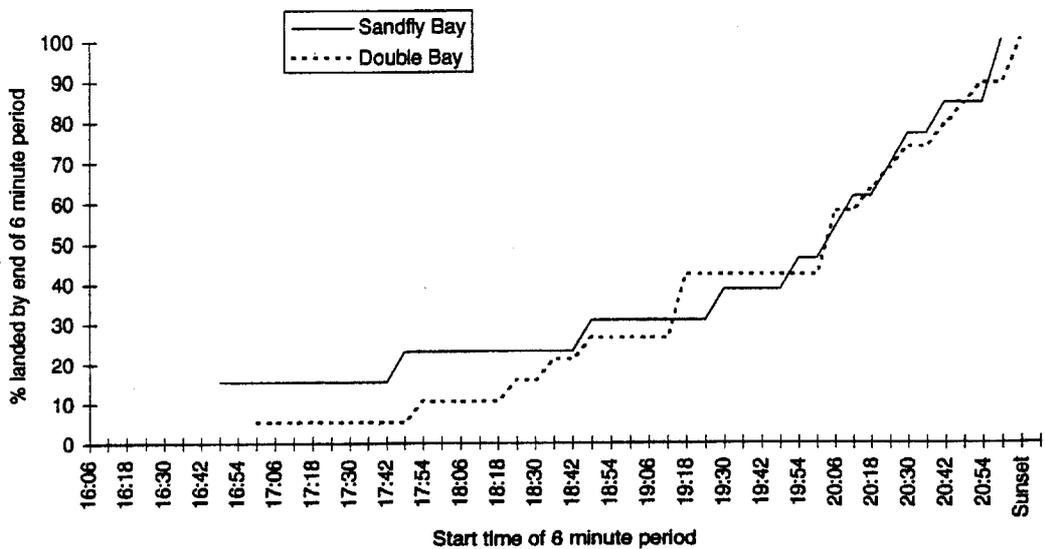
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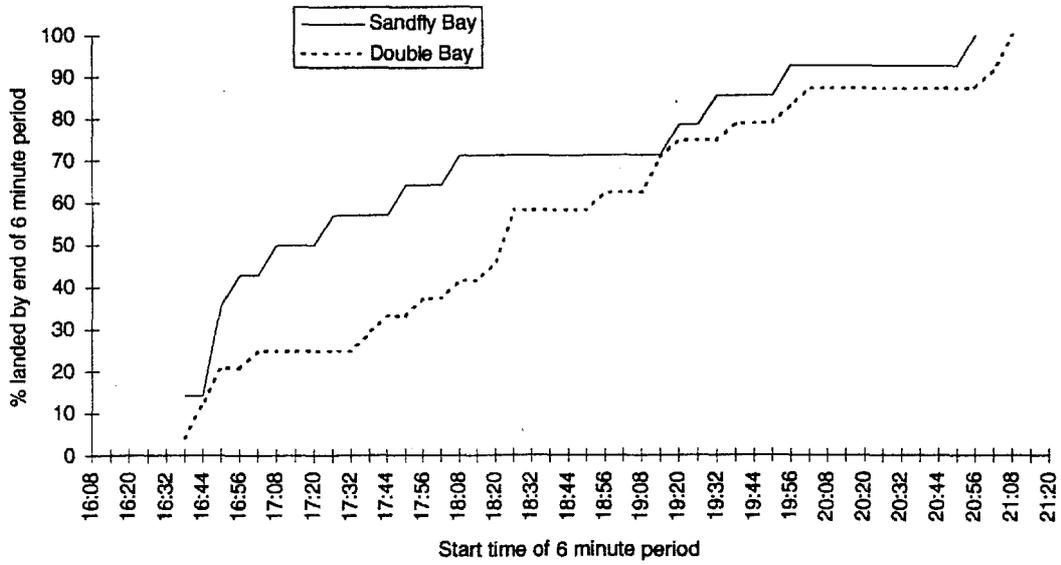
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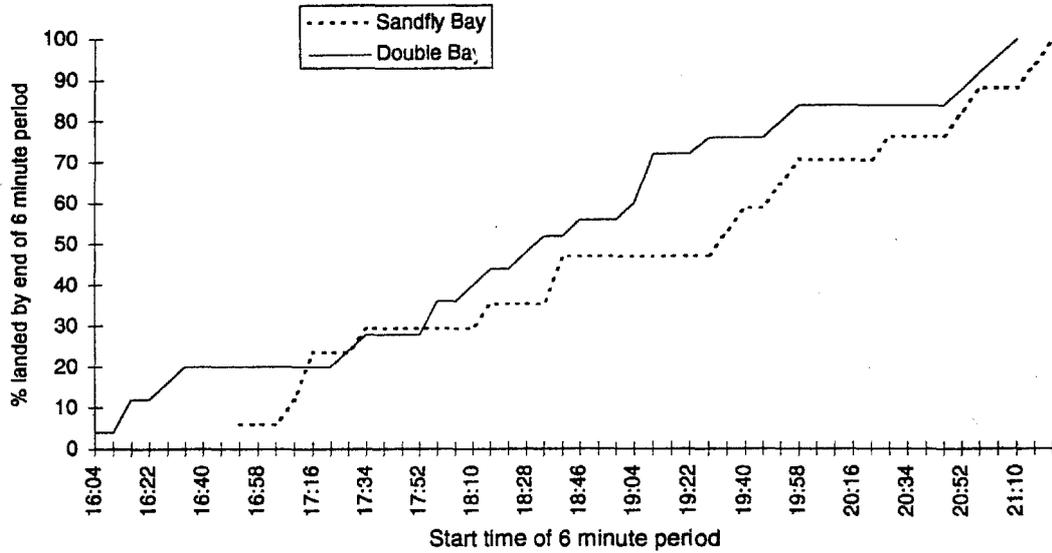
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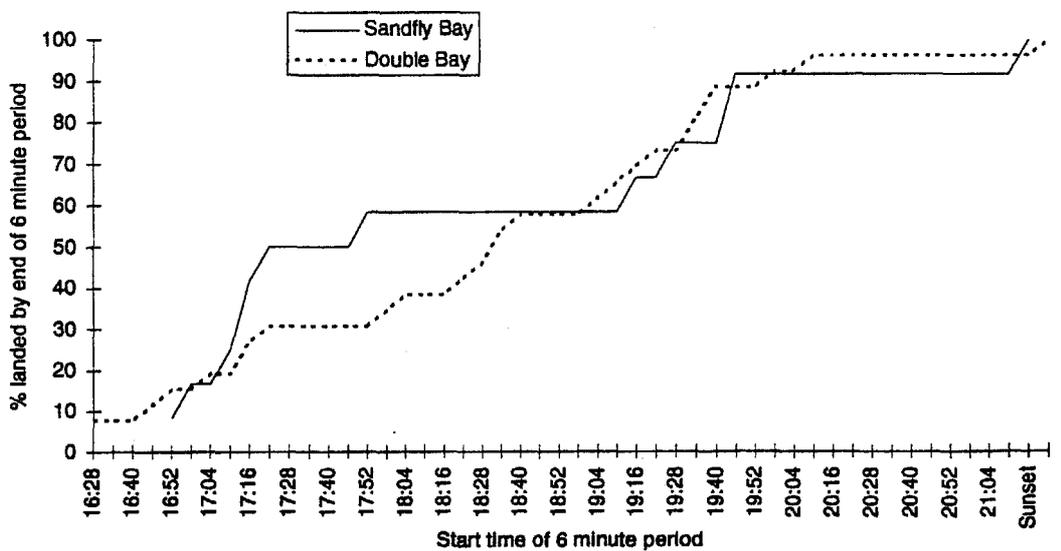
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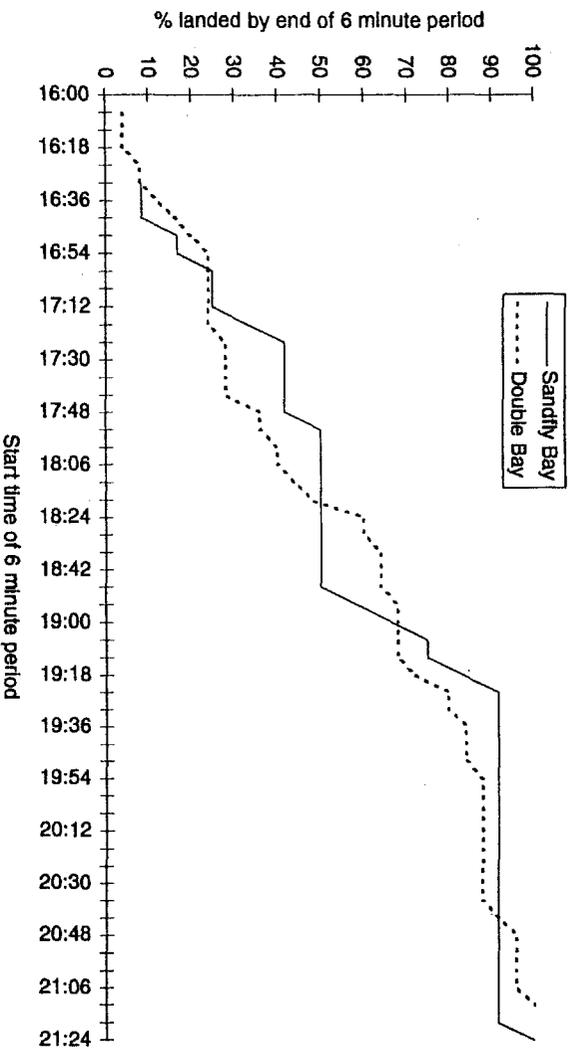
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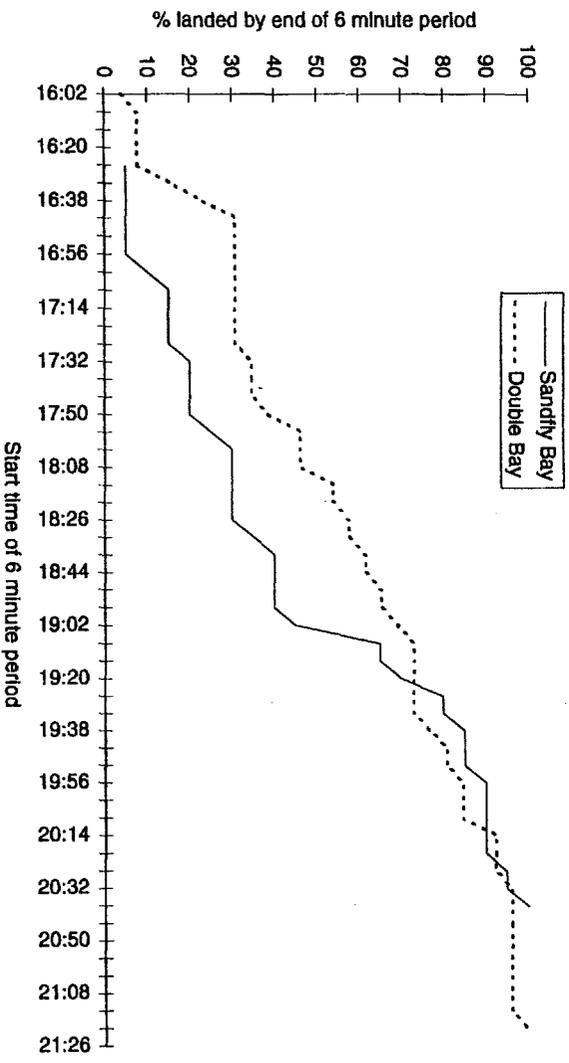
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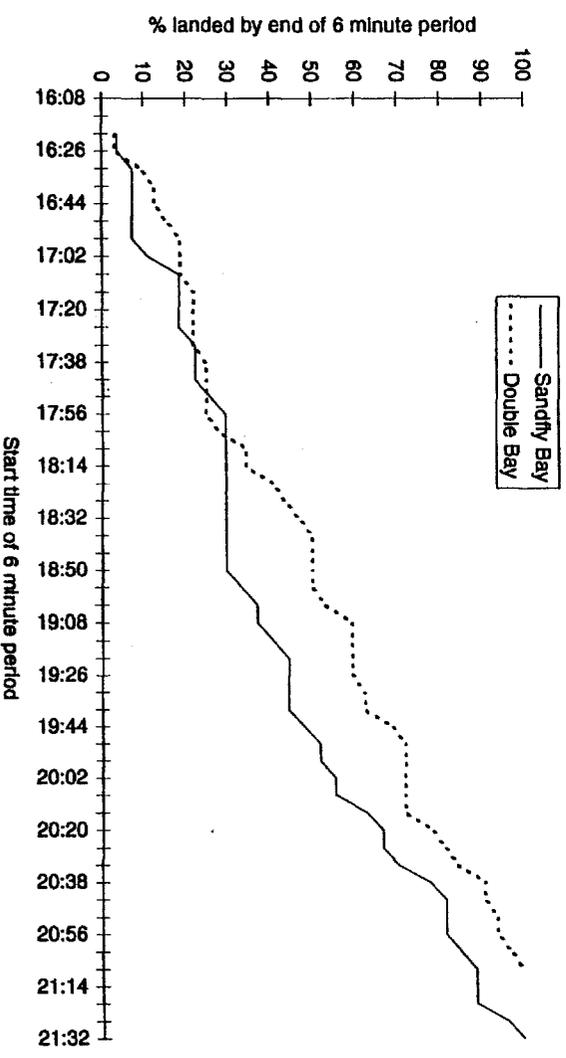
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Yellow-eyed Penguin Landings - 10/12/95



Yellow-eyed Penguin Landings - 18/12/95



Appendix 2

RESEARCH AVENUES INVESTIGATED

Before these studies were embarked upon, many possible methods for investigating tourism impacts on the species were investigated. Some are mentioned briefly here in order to assist others who may be looking at conducting similar studies.

Apart from the possible indicators mentioned in the yellow-eyed penguin discussion, such as recruitment rate and nest site placement, a behavioural approach was also mooted to gauge penguin responses to humans. The possibility of measuring the amount of time penguins spent performing various behaviours (such as walking, preening, standing, etc.) from the time they landed on the beach until they entered the nesting habitat was considered. Several obstacles arose with this, the main one being the difficulty in finding a beach to use as a control which was similar in size from water to habitat. This problem, coupled with the differing size of any one beach with the rise and fall of the tide, proved to be logistically and statistically impractical for the resources of this study. Another option for investigating the effect people on the beach have on penguins would have been to measure whether the amount of time the penguins spend at sea within a certain distance of the shore (say 100 m) is affected by the presence of people on the beach. This would require expensive tracking devices and was therefore not a practical option for this study but is something that may be useful to look at in the future.

For the Hooker's sea lion monitoring it was originally intended to monitor the behaviour of the animals during approaches of actual ecotourism groups. To do this time lapse video equipment was installed on top of the bluffs overlooking the beach. Unfortunately, because the sea lions do not haul out in the same places on the beach each day, it was necessary to record the entire beach. This meant that the animals were too small in the recorded view to distinguish their behaviour in any detail. Different camera positions were tried, as was using a smaller field of view to increase the size of objects viewed but these changes were not enough to make a noticeable difference. With remote viewing at the time of recording and the ability to zoom in on areas of activity this could be a viable research method, but it would need more development, which was not possible for this study because of time and financial constraints.

To investigate the question of habituation more fully it would have been desirable to conduct the same sampling regime on a non-visited beach as was conducted on Papanui Beach. No control site was found for the sea lion study because all beaches in the Otago region which sea lions haul out on are either regularly visited by humans or do not have more than one or two animals regularly present.