The Third Montagu Island Penguin Survey
November 1998

N.R. Trezise, N.I. Klomp, P.J. Fullagar and P.C. Heyligers

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M I Partners is a small, non-profit making company formed by naturalists in 1991. Its purpose is to contribute to species and habitat conservation through research to provide baseline data for decision makers and managers. Its name, short for Montagu Island Partners, alludes to a special interest in island and seashore ecosystems.

The partnership has at present the following members.

Michael A. Crowley, BSc., Dip.Ed., Regional Ecologist, State Forests of New South Wales. His main interests are in the vertebrate fauna of the coastal zone with an emphasis on birds, bats and frogs.

Peter J. Fullagar, PhD., retired CSIRO research scientist and curator of the sound archive of the Australian National Wildlife Collection. His main interests are in waterfowl and seabird ecology, and in bird vocalization.

Petrus C. Heyligers, PhD., retired CSIRO research scientist. His main interest is in coastal natural history, especially in the dispersal ecology of strand plants and in the role played by vegetation in dune formation.

Copies of this report are available from M I Partners,
5 d'Arcy Place, Chifley ACT 2606.
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Preface

This report is the first M I Partners Report that reflects the increased co-operation between M I Partners and the School of Environmental and Information Sciences, Charles Sturt University, in the monitoring of seabird populations on Montagu Island. The survey formed part of the fulfillment of the requirements for a B.Sc.(Hons) degree for the senior author. In addition to ascertaining the size of the Little Penguin breeding population, the influence of distance between transects on the estimates of population size was evaluated and is discussed in the report.

For working out the results of the third survey, a somewhat more stringent definition of areas unsuitable for nesting was applied. This, together with using a more appropriate method for calculating standard errors of population estimates, resulted in revised population estimates for the 1992 and 1994 Little Penguins surveys.

M I Partners
Chifley ACT, 6 June 2000

Summary

After surveying Montagu Island from 18 to 30 November 1998, the breeding population of the Little Penguin *Eudyptula minor* was calculated to be 4007 ± 127 pairs. This is significantly lower than the number estimated breeding in 1994, but is similar to the number found in 1992. Nest site statistics were also similar to those recorded for 1992. A larger proportion of nests with two chicks rather than one chick may have been indicative of a period of abundant food supply.

The 1998 and 1992 seasons differed from the situation encountered in 1994. In the survey of that year most chicks were found to be at an advanced stage of growth while many of the remaining nests contained eggs. These data suggested that a second breeding attempt was in progress. The age distribution of chicks in 1992 and 1998 was such that eggs found during those years were assumed to be from late first clutches or replacement broods.

On North Island an extra set of transects offset from the basic set by half the 100 m transect distance, was surveyed to assess the consistency of the survey results. Each set yielded a similar estimate for the breeding population on North Island, namely 908 ± 134 pairs and 953 ± 95 pairs, thus showing that transects at the usual spacing of 100 m is an economical survey technique for assessing the size of penguin breeding populations on larger islands.

Acknowledgments

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We are grateful to the team of volunteers, namely Jack Trezise, Ben Holloway, Julie Makings, Ash Deans, Cameron Tiller, Scott Mathieson and Greg Robertson for participating in the work, often in uncomfortable conditions. We would also like to thank a number of people at the School of Environmental & Information Science, Charles Sturt University (CSU) for providing logistical support, including Mark Schultz, Brooke Ryan, Leslie Montfort, Liz Chubb and Angela Gibbs. Wayne Robinson kindly provided statistical advice. The NSW National Parks & Wildlife Service and the Animal Care and Ethics Committee (CSU) provided the necessary licensing and approval for this project

INTRODUCTION

Montagu Island (36° 15' S, 150° 14' E) is situated about 10 km east of Narooma on the NSW coast. It has an area of approximately 80 ha, of which 75% (58.8 ha) is covered by low coastal vegetation that appears to be suitable for penguin nesting. The island is divided into two, a smaller North Island and a larger South Island (Figure 1), although in practice they are rarely separated because they join above the high-water mark. Much of the vegetation is dominated by Spiny-headed Mat-rush *Lomandra longifolia,* locally mixed with Bracken *Pteridium esculentum.* Some areas, especially in the southwest of South Island, are covered by Kikuyu Grass *Pennisetum clandestinum.* This species has spread a great deal since its distribution was mapped in 1990 (Heyligers 1993, Trezise 1999). Soil depth varies considerably, with shallow sand and exposed granitic rock covering much of the island, but with soil deeper than 1 m in some parts.

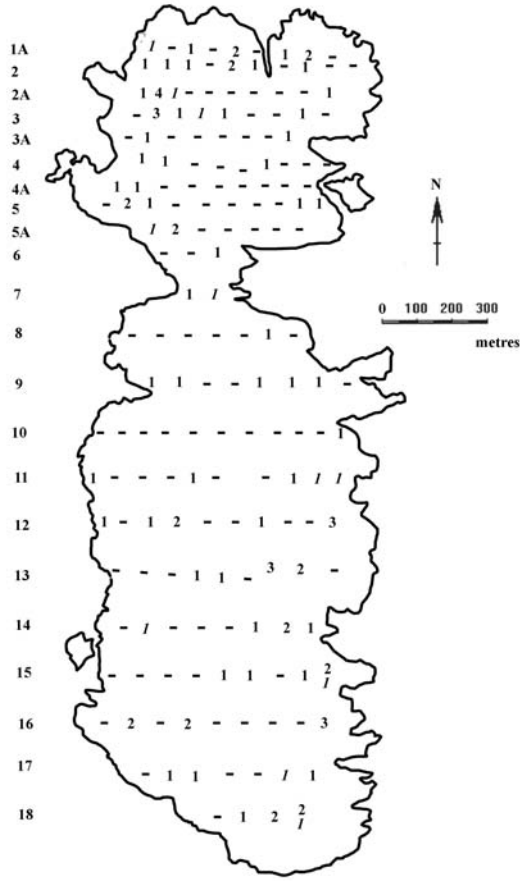

Figure 1. Distribution of nest sites along 50 m sections of the transects examined in 1998. Sites with only an adult present shown in italics. Dashes indicate 50m sections with no nest sites.

The Little Penguin *Eudyptula minor* starts breeding in different colonies around southern Australia anytime between May and October, with timing and success thought to be primarily dependent on food availability (Stahel and Gales 1987). Although usually burrowing into the soil, Little Penguins appear to be content to nest almost anywhere as long as there is adequate shelter. On Montagu Island most

birds nest on the surface under dense vegetation, often under mat-rush tussocks, and rarely underground (Fullagar & Heyligers 1992).

As a rule, a clutch of two eggs is laid. Brooding takes about five weeks and chicks fledge at seven to nine weeks after hatching. If the season is favourable, double brooding occurs with a second clutch laid several weeks after the successful fledging of the first brood (Marchant and Higgins 1990).

The first survey to assess the size of the breeding population of Little Penguins on Montagu Island was conducted from 17 to 26 November 1992 (Fullagar & Heyligers 1992). A second survey of was carried out in 1994 between 21 and 28 November (Heyligers & Fullagar 1995). The present, third, survey was done between 18 and 30 November 1998.

The survey was conducted to serve as a comparison with a concurrent survey on Bowen Island, Jervis Bay (Fullagar *et al.* 1999), similar to the survey in 1994, which was done to provide a comparison for a concurrent survey of Gabo Island (Fullagar *et al.* 1995, Heyligers & Fullagar 1995).

This report presents the results of the survey on Montagu Island in 1998, and compares these results with the two previous penguin population surveys on the island. In addition, the consistency of the transect methodology was assessed.

METHODS

The transect survey method used by Fullagar & Heyligers (1992), Fullagar *et al.* (1995) and Heyligers & Fullagar (1995) was followed. For the present survey transects ran W–E at 50 m intervals on North Island and at 100 m intervals on South Island, starting and ending at the edge of the vegetation (Figure 1). They were located in accordance with the 1992 and 1994 positions, which had been marked on plastic-coated colour aerial photograph enlargements. In some areas, the lack of landmarks made it difficult to ensure exact replication, as was found in 1994 (Heyligers & Fullagar 1995).

A strip 1 m wide was investigated each side of a tape laid out to mark the transect position. Penguin nests and other signs of penguin activity, shearwater burrows, vegetation, topographical features and soil depth were recorded on data sheets (see Appendix).

No rocky areas were counted as part of the transects. Transects started and ended at the edge of the vegetation and any given metre on the transect (ie. 2 m^2) that was filled with rock was not included in the calculation of area searched. Under this definition, the 1992 data remained unchanged, however the 1994 data were revised for consistency. In 1992 the habitable area for penguins on Montagu Island was calculated as 588,000 m^2 and this figure has been used for all analyses.

Work was undertaken by a team of five people, with two positioning the transect line, two searching (one each side of the tape) and one recording. Once a line was suitably positioned, those laying it out joined the searchers. Positioning, searching and recording was rotated between members of the team. Twenty-two transects were searched in fourteen consecutive days, in the following order: 17, 15, 13, 16, 11, 9, 7, 5, 3, 8, 10, 12, 14, 18, 6, 2, 4, 1a, 2a, 3a, 4a, 5a. The number of transects completed each day varied from one to three.

Penguin nesting and resting sites were detected by thorough searching of vegetation and cavities. In occupied nests the eggs, chicks and adults were counted. Chick age was determined using the key of Stahel & Gales (1987). The distinction of chick ages is likely to have differed slightly between members of the survey team, particularly for the first few birds handled. Consultation with other team members and experiences with chicks of different ages kept observer bias to a minimum.

Although the presence of one or two adults at a site might indicate that breeding was imanent, it is also possible that such adults were non-breeders staying ashore. Hence, the term 'sites with adults only present' was used, and therefore 'nest sites' includes both 'sites with adults only present' and nests containing eggs or chicks. It was often difficult to determine the exact status of unoccupied penguin sites, therefore such data were not included in our analyses, as is consistent with previous surveys (Heyligers & Fullagar 1995).

Given the high proportion of the island surveyed, an estimate of standard errors based on the standard sample statistics in which the transects are assumed to be samples of an infinite population, is not appropriate. Hence, a revised method from that used in 1992 and 1994 for estimating the penguin population was used for the present survey. Rather than using the total number of nests found in the total area surveyed, we calculated the mean of the density of nests found on each transect (i.e. the number of nests per m^2). This method provides a more accurate population estimate (less rounding error) and allows standard errors (SE) for population estimates to be calculated using the following formula (after Scheaffer *et al.* 1990):

$$SE = \sqrt{\left(\frac{\frac{s}{n}\left(\frac{N-n}{N}\right)}{n} \right)}$$

where s is the sample variance (using each transect was a separate sample), n is the number of transects in the survey, and N is the total number of transects needed to census the entire island.

As a result of the use of the statistical method outlined above, the population estimates of 1992 and 1994 had to be revised to enable comparisons to be made with the present survey.

The 1998 survey sampled the North Island with more effort (transects closer together) than the South Island. For this reason, the densities for the two areas were calculated separately and summed. Calculations were based on the following areas:

North Island = 175,500 m^2, South Island = 412,500 m^2, total = 588,000 m^2.

Once we had a population estimate for each island, we simply added them together, but we could not do the same for the two standard errors without weighting them first.

RESULTS

Population estimate

The 22 transect lines crossed a total of 8,168 m of land deemed suitable for penguin nesting (rock outcrops were not included because penguins do not nest within rock crevices on Montagu Island). Hence, a total of 16,336 m^2 was searched. This represented 2.8 % of the area of the island regarded as suitable for penguin nesting.

The location of penguin nest sites on each transect are shown in Figure 1. On North Island there was no significant difference between the numbers of nests recorded on each of the two sets of transects (21 nests in Set A compared with 23 nests in Set B; Table 1). Hence, the estimates of the numbers of penguins breeding on North Island did not differ significantly when using either one set, or both sets of data. The population estimate based on all North Island transects was added to the population estimate for South Island to obtain a figure for the total population. The figure thus obtained was 4007 ± 121 pairs of Little Penguins breeding on Montagu Island in November 1998.

Table 1. Penguin population estimates for North and South Island

Sets A and B are alternate transects at 100 m intervals on North Island. These have been combined for estimates of the population on North Island. North and South Island estimates are added to give the breeding population estimate for the entire island.

Transects		Transect length	Number of nest sites	Population estimate (pairs)	Standard error (pairs)
Set A:	1a, 2a, 3a, 4a, 5a	2038	21	908	134
Set B:	2, 3, 4, 5, 6	1997	23	953	95
Sets A + B:	(North Island)	4035	44	930	44
Set C:	7 – 18 (South Island)	4133	58	3077	130
Sets A + B + C:	Entire island (1998)	8168	102	4007	121
	Entire Island (1992)	5880	85	4546	194
	Entire Island (1994)	6114	137	6976	220

Penguin nest sites

The results of the 1998 survey are summarized in Tables 2 – 4, which also contain comparable information from the two previous surveys. It can be seen from Table 2 that 102 nest sites were located during the survey. Two of these nests contained both an egg and a one-day-old chick. These nests have not been included in the 'nests with chicks present' category. Of the 11 sites with adults only present, seven were occupied by one adult and the remaining four by two adults. The numbers of nests containing one or two eggs are tabulated in Table 3, while Table 4 gives the age distribution of chicks. Due to difficulties with the distinction of class 'e' chicks, this class and class 'f' chicks have been treated as a single group.

Table 2. Penguin nest site statistics from 1992, 1994 and 1998 transects

Nest contents	*North Island*			*South Island*			*Totals*		
	1992	1994	1998	1992	1994	1998	1992	1994	1998
Adult(s) only present	1	10	4	10	23	7	11	33	11
Egg(s) present	1	17	7*	16†	37	7*	17	54	14
Chick(s) present	17	14	32	38	30	44	55	44	76
Burrows too deep	2	3	1	-	3	-	2	6	1
Totals	21	44	44	64	93	58	85	137	102

* One of these nests also contained a one-day-old chick.
† Three of these nests also contained a one-day-old chick.

Table 3. Penguin nests with eggs

Nest contents	Number of nests			Number of eggs		
	1992	1994	1998	1992	1994	1998
One egg, no adult	3	2	-	3	2	-
One egg, one adult	1	1	2	1	1	2
One egg, two adults	-	5	-	-	5	-
Two eggs, no adult	1	-	2	2	-	4
Two eggs, one adult	9	45	8	18	90	16
Two eggs, two adults	-	1	-	-	2	-
Egg and day-old chick, one adult	3	-	2	3	-	2
Totals	17	54	14	27	100	24

Table 4. Penguin nests with chicks

Age classification of chicks are described below (after Stahel & Gales 1987).
The numbers of nests in which adults were also present are shown in brackets.

Age class	Nests with one chick			Nests with two chicks			Total chicks		
	1992	1994	1998	1992	1994	1998	1992	1994	1998
a. Head floppy	4*(3)		2**(2)			1 (1)	4		4
b. Eyes not fully open	3 (3)		2 (2)	3 (2)		5 (5)	9		12
c. New down incomplete	1				2 (2)	6 (4)	1	4	12
d. feet dark grey	1			2	2 (1)	2 (2)	5	4	4
e. egg tooth still present	4	4 (2)		3 (1)	5 (4)		10	14	
f. down still complete	11	3 (2)	16 (1)	8	10 (4)	26	27	23	68
g. adult plumage present	12 (1)	11 (4)	5	6 (1)	7 (1)	13	24	25	31
Totals	36	18	25	22	26	53	80	70	131

* Including three nests with an unhatched egg.
** Including two nests with an unhatched egg.

a. head floppy: the chick is not yet able to support its head (day-old);
b. eyes not fully open: the chick is between two and seven days old;
c. new down incomplete: the second down cover has not yet fully replaced the first, not yet 14 days old;
d. feet dark grey, their tops have not yet turned white and the bottoms black; chick is less than 21 days old;
e. egg tooth still present; the egg tooth has only disappeared completely when chick is 28 days old;
f. second down cover still complete, but no adult plumage visible yet: chick is not yet 56 days old;
g. adult plumage present, down may still cover head and neck, chick is older than 56 days; when all down is gone, feathers on flippers are blue and shiny.

DISCUSSION

The size of the breeding population

The 1998 breeding population of Little Penguins on Montagu Island was calculated to be 4007±121 pairs. This estimate was derived from finding 102 nest sites on 22 transects covering an area of 16,336 m^2, representing 2.8% of the area of the island suitable for nesting penguins.

The use of two separate sets of transects (offset 50 m) on the North Island did not result in a significant difference in population estimates for that area. Set A produced an estimate of 908 134 pairs, and Set B gave an estimate of 953 95 pairs. Given the similarity between these estimates and the estimate using all transects on the North Island (930 44 pairs), the use of transects spaced at 100 metres is justified as an economical survey method.

An improved statistical method for calculating population estimates and standard errors was used for this survey and as a consequence the figures obtained previously from surveys in 1992 and 1994 were recalculated.

This improved method treats each transect as an individual sample out of a known finite number of possible samples, rather than combining all transects as one continuous sample. This reduces rounding error in the population estimate and allows for a more realistic determination of standard errors.

Taking into account these revised statistical procedures together with a re-evaluation of the 1994 transects (to allow for the exclusion of smaller rock outcrops), the breeding populations for these years can be recalculated as follows:

1992 from 4250 67 pairs to 4546 194 pairs
1994 from 6358 79 pairs to 6976 220 pairs.

Assessment of the 1998 breeding season

Data from which we might infer the breeding events at the time of each the three surveys are given in Tables 2-4.

The highest proportion of nest sites with chicks (75 %) was found during the 1998 survey compared with 66% found in 1992 and 34% found in 1994. A much higher proportion of nest-sites containing eggs was found in 1994 (41%) than in either 1992 (21%) or 1998 (14%). Similarly, in 1994 the proportion of nest-sites in which adults only were found was higher (25%) than in either 1992 (13%) or 1998 (11%). These figures have been interpreted to indicate a second breeding period in 1994 (Heyligers & Fullagar 1995). The high proportion of chicks found in 1998 suggests that the breeding season up to the time of the survey had been more successful than in either of the other two years. Little Penguins adopt a brood reduction strategy, where one particular chick is always fed first to ensure a greater chance of survival of at least one offspring should food resources be scarce (Stahel & Gales 1987). In the 1998 survey, two chicks were present in 68 % of nests where chicks were found without eggs, compared with only 40 % in 1992 and 41 % in 1994. This may indicate that the 1998 survey followed a period of more abundant food resources.

In 1994 most chicks were well advanced in growth with almost 90% being more than three weeks old and 36% more than two months old. In 1992 and in 1998 proportionally fewer chicks were in the older categories compared with chicks under 3 weeks old. This suggests that the breeding season in 1994 started earlier than in either of the other two years.

Comparison with other penguin colonies

In November 1998 a survey of Bowen Island at the entrance to Jervis Bay, NSW (35˚ 07' S, 150˚ 46' E), resulted in an estimated breeding population of 2450 ± 49 pairs of Little Penguins (Fullagar *et al.* 1999). In November 1994 on Gabo Island, at the eastern entrance to Bass Strait (37˚ 34' S, 149˚ 55' E), the penguin population was estimated 18 244 ± 131 pairs (Fullagar *et al.* 1995). Bowen Island is smaller than Montagu Island and its penguin colony is restricted to a zone of about 12 ha along one side. Gabo Island, with a vegetated area of 126 ha, is considerably larger than Montagu but is similar in that it has penguin breeding sites scattered widely over the whole island. The density of penguin colonies on the three islands was:-

Bowen Island 2.1 nests per 100 m^2
Gabo Island 1.2 nests per 100 m^2
Montagu Island 0.8; 1.1 & 0.7 nests per 100 m^2 for the years 1992; 1994 & 1998.

Information on nest contents on Bowen Island in 1998, which was obtained concurrently with the survey on Montagu Island, indicated that the population on Bowen Island was in a somewhat earlier stage in the breeding cycle. On Bowen Island there was a higher proportion of nests with eggs, suggesting a somewhat later start to the breeding season, although the relative proportion of young to old among chicks was much the same for the two islands (see Table 5).

Table 5. Penguin nest site statistics from the surveys on Bowen Island (data from Fullagar *et al.* 1999) **and Montagu Island in 1998**

Nest contents in 1998	Bowen Island	Montagu Island
Adult(s) only present	5	11
Egg(s) present	14	14
Chick(s) present	30	76*
Totals	49	101

Chick statistics in 1998	Bowen Island	Montagu Island
Nests with one chick	7	25*
Nests with two chicks	23	53
Nest with younger chicks (classes a–d)	6	18
Nests with older chicks (classes e–g)	24	60

* In two nests a one day old chick was present together with an egg; these two nests were classified as nests with eggs in the nest contents summary.

CONCLUSIONS

The Little Penguin breeding population

The survey in 1998 confirmed the broader picture already established for Montagu Island by the two previous breeding population surveys carried out in 1992 and again in 1994.

When maps of the distribution of nest sites from the three surveys are compared, the general location of sites on North Island has remained much the same. However, on South Island there is an apparent shift in the concentration of breeding sites from a largely west coast bias in the 1992 and 1994 surveys to an east coast bias in 1998. This change is shown on so many of the transects on South Island that it seems unlikely to have been entirely due to the sort of aberrations that can be expected when relying on the transect method for determining nest distribution. It is possible that the breeding cycles might not have been synchronous between sub-populations of Little Penguins in different parts of the island. Variation of this type might be expected to show up on closer examination of the nest-site statistics but, unfortunately, the sub-samples become too small to make this exercise worthwhile. It is also possible that the invasion of the western side of South Island by Kikuyu Grass *Pennesetum clandestinum* has in fact already had a significant effect causing a reduction in the density of penguin nesting sites in areas it has recently invaded.

The numbers of Little Penguins breeding on the island have ranged between 4000 and 7000 pairs according to our surveys between 1992 and 1998. The differences between breeding population estimates for the two similar years of 1992 and 1998 and the higher number found in 1994 may only reflect slightly different phases in the breeding cycle rather than be indicative of a real increase in the breeding population that year. In 1992 and again in 1998 there was no indication that egg laying had resumed to initiate second broods as appears to have been the case in 1994.

Refinements to survey methods and analyses

For some time two problems have been of concern to us. First, the need for a biologically sensible measure of variance for our estimates of penguin breeding populations. Second, the need to compare population densities between different islands in a biologically meaningful way.

In the past we have employed methods to calculate the standard errors of our estimates that have not taken into account the fact that with more transects the errors should decrease until they become zero when a census is obtained. Calculating standard errors following the method of Sheaffer *et al*. (1990) is a distinct improvement in our opinion, as this method takes into account the finite size of the population being sampled.

By considering more carefully the areas deemed suitable for penguin nesting we can obtain a more appropriate estimate of nest densities. Except for areas of exposed rock, on both Montagu and Gabo Island most of the land above high water level appears potentially suitable, although nesting densities vary widely between different parts of the islands. In contrast, on Bowen Island we found that a large part of the island was unoccupied by penguins. In order to compare densities more appropriately between these three islands it was essential to make allowance for uninhabited and unsuitable areas.

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APPENDIX . Third Montagu Island Penguin Survey form

MONTAGU ISLAND PENGUIN SURVEY **NOVEMBER 1998**

Transect N°: Sheet N°: Date:

Searchers: N: S: Recorder: Others:

Distance from start of transect: m.

Little Penguins N eggs	N chicks	N adults	S eggs	S chicks	S adults	Rock	Veg. cover (%)	*Lomandra*	*Pteridium*	*Poa*	*Phragmites*	*Imperata*	*Pennisetum*	*Zoysia*	*Isolepis*	Other grasses	*Acetosa*	*Delairea*	*Kennedia*	Other twiners	Other herbs	Shrubs	Shearwaters	Slope: angle	direction	Notes
0																									
5																									
10																									
15																									
20																									
25																									
30																									
35																									
40																									
45																									
50																									

Slope: angle: negligible, gentle, moderate, steep, very steep — dir.: N - NE - E - SE - S - SW - W - NW.

Chick age:
a Head not supported (day 1)
b Eyes not fully open (-day 7)
c Down cover incomplete (-day 14)
d Feet dark grey (-day 21)
e Egg tooth present (-day 28)
f Down cover general (-day 56)
g Absent or head/neck only (57+days)
000 **Empty nest** camp: campsite

Cover scale:
p present
n numerous
c codominant
d dominant

Other grasses:
E *Eragrostis*
P *Polypogon*
A *Sporobolus africanus*
V *Sporobolus virginicus*
B *Stenotaphrum*
S *Stipa*
T *Themeda*
Other:

Other twiners:
D *Dipogon*
I *Ipomoea*
M *Marsdenia*
S *Stephania*
Other:

Other herbs:
C *Commelina*
I *Isotoma*
P *Phytolacca*
N *Solanum nigrum*
U *Urtica*
Other:

Shrubs:
B *Breynia*
V *Solanum vescum*
W *Westringia*
Other:

Shearwater burrows
b : bird(s) present
e : empty

HOW TO USE THE LITTLE PENGUIN SURVEY FORM

Transects are -in principle- 100 m apart, and start -ideally- at the high water mark. The legacy of previous surveys means that on North Island some transects of the second survey are only 50 m from those of the first. For the third survey take your pick of which ones you repeat.

Transects run mostly West to East, but some (**3, 4A and 9**) were done in **East to West** direction. Check the air photo enlargements as well as the forms of the previous surveys for landmarks, especially at the first 50 m of transect, to align the transect as closely as possible to previous one in order to achieve comparability. This is particularly important in the assessment of changes in vegetation, eg. expansion of Kikuyu, *Pennisetum*, and Rambling Dock. *Acetosa*.

Each survey form provides room for recording 50 m of transect. The **distance from the starting point of each 50 m section to the starting point of the transect** has to be recorded in the heading to enable double-checking with the sheet number.

Search width is exactly 1 m at either side of the tape laid out to define the transect. If in doubt whether a burrow is inside or outside the 1 m strip, check with a tape or make-shift measure. If more than half of the entrance is within the boundary, the burrow is counted, if more than half falls outside, the burrow is ignored. (**If we do not stick to this rule, than the results become statistically unreliable**).

For every metre of transect **penguin nest site details** are to be recorded individually and separately for each side, but for shearwater burrows it is only necessary to give the total number of burrows found per metre of transect. Ownership of empty burrows has to be determined by differences in the size of the entrance, the smell, foot prints, faeces or other signs. As an indication of reliability, the numbers for **shearwater burrows** are to be annotated with **'b': bird(s) present, or 'e': empty**. The columns for recording shearwater and penguin data are at opposite sides of the form to make recording in the wrong columns less likely.

Little Penguin data

Penguin sites are either '**nest**' or '**camp**' sites, the latter being sites where (non-breeding?) penguins rest. If the penguins nest in a burrow, measure or estimate **burrow length** in tenths of metres and **write these details down under 'Notes'**. Record number of **eggs, chicks and adults**, indicating **chick age** (see bottom of form) after the chick number, e.g. 0,2c,1. If more information on estimating chick age is required, see photocopy of pp. 72-74 from Stahel and Gales (1987). Additional data can be entered in the column 'Notes', e.g. the status of an empty nest, or whether an observation was made with the burrowscope. Also details about sheltering vegetation can be given here.

Vegetation

The aim of this section is to give a **general impression** of the vegetation crossed by the transects, not to provide metre to metre accurate detail. Hence the notations may have to refer to a swath wider than 2 m. **Draw a line across the vegetation columns where the vegetation changes** noticeably and assess the new situation. Only the major, aspect-determining plants are given in the heading of the form and their common names are given below. Locally common species which you may encounter are given at the bottom of the form. Do not despair: if there is no botanist in the team, ignore them, but make an appropriate annotation in the relevant 'Other .....' column.

The **abundance** of each species should be indicated according to the cover scale. If *Lomandra* and *Pteridium* are about equally common and there are only some tussocks of *Poa*, the annotation would be '**c c p**', but if *Pteridium* is dominant with only scattered *Lomandra* and no *Poa*, the annotation is '**p d -**'. The **minus symbol** makes the reading of the columns easier and avoids misinterpretations.

Common names for predominant species

Lomandra	(Spiny-headed) Mat-rush	*Isolepis(nodosa)*	Knotted Club-rush
Pteridium	Bracken	*Acetosa*	Rambling Dock
Poa	Tussock Grass	*Delairea*	Cape Ivy (a rambling yellow daisy)
Phragmites	Common Reed		
Imperata	Blady Grass	*Kennedia*	Scarlet Runner
Pennisetum	Kikuyu		
Zoysia	Prickly Couch		

Slope

Record the slope **angle** of the transect according to the scale given at the top of the form. Although this scale consists of 'common sense' categories, the boundary between 'steep' and 'very steep' is meant to be about 30°

to 35°, the slip angle of loose sand. The **direction** of the slope is recorded facing **upslope**. Where any one of these parameters changes, draw a line across the column and make a new assessment.