

Abundance and breeding distribution of the white-flipped penguin (*Eudyptula minor albosignata*) on Banks Peninsula, New Zealand

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Abstract A survey of the white-flipped penguin (*Eudyptula minor albosignata*) nesting colonies on Banks Peninsula, New Zealand was made during the 2000/01 and 2001/02 breeding seasons. Sixty-eight colonies were found of which 51 contained 5-20 nests, 12 21-50 nests, and 5 >50 nests. Altogether there were 2112 nests which equates to a population of c. 5870 birds. Adding the estimated 1650 nests on Motunau Island gave a total population for the subspecies of c. 10,460 birds. The colonies were distributed right around the peninsula with their occurrence increasing from west to east. Most were situated either on the peripheral coast (47%) or inside bays within 1 km of their entrance (38%). All but three of the colonies were on debris slopes below coastal bluffs with the nests concentrated mainly in rock piles. One colony was on an islet, and the other two were on farmland around the heads of bays. Thirty-four of the colonies were considered accessible to introduced mammalian predators, and 14 contained evidence predators had been present. If predator numbers remain high it seems inevitable that many of the surviving penguin colonies will be lost and others reduced in size.

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INTRODUCTION

The white-flipped penguin (*Eudyptula minor albosignata*) is endemic to Canterbury, New Zealand breeding in significant numbers only on Banks Peninsula and Motunau Island 65 km north of Christchurch. It is considered an endangered subspecies by the International Union for the Conservation of Nature (IUCN) (Ellis *et al.* 1998), and has been assigned a nationally vulnerable threat classification by the Department of Conservation (Hitchmough 2002). The IUCN classification was based on evidence provided by Challies (1998) that penguin numbers had declined at an alarming rate on Banks Peninsula over the last few decades; that their range had reduced and fragmented as a result; and that this trend was continuing. The deterioration in their conservation status had been caused mainly by the predation of adult penguins in their colonies by ferrets (*Mustela furo*), feral cats (*Felis catus*) and possibly stoats (*Mustela erminea*). Predation has not been a problem on Motunau Island, which is free of introduced mammals.

All of the information used in the IUCN review was from colonies that were easily accessible. As much of the coastline of Banks Peninsula is not accessible from the land and not previously surveyed, there remained an element of doubt about the penguin's true status. To rectify this, the Department of Conservation undertook a survey of the whole coastline of Banks Peninsula during the 2000/01 and 2001/02 breeding seasons. The objective was to locate all penguin colonies on the peninsula and record their positions, size, site characteristics, and whether they were accessible to mammalian predators or not. This paper presents the results of that survey.

Banks Peninsula is a roughly elliptical area of deeply dissected hill country of volcanic origin extending eastward from the edge of the Canterbury Plains. It has a shoreline of 300 km of which 60 km (20%) is peripheral and the rest the sides and heads of a radial series of elongated embayments. These range in length from 14 and 16 km respectively for Lyttelton and Akaroa Harbours to 1-2 km for the smaller bays. The coast has been extensively eroded by marine processes and is predominantly rocky and backed by bluffs. These are commonly 25-150 m high on the

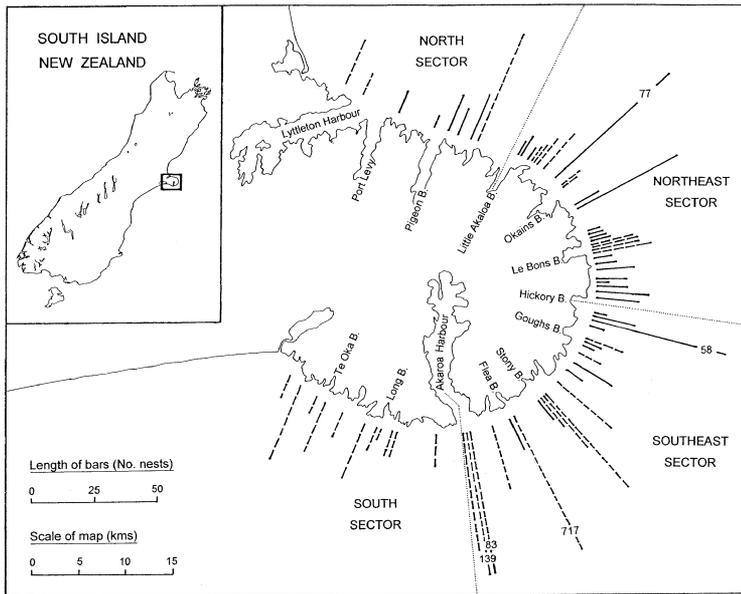


Figure 1 Map of Banks Peninsula with the locations and relative sizes of the 68 penguin colonies represented by radial bars. The bars are positioned directly offshore from their respective sites, and are proportional in length to the number of nests they contained (see scale). Those for the five colonies that contained >50 nests are truncated with the number of nests shown in numerals. Colonies on the peripheral coast are represented by continuous bars and those inside the bays by discontinuous bars.

peripheral coast but progressively reduce in height up the bays. Around the heads of the bays there are stony and sandy beaches and, in the two harbours, mudflats.

METHODS

General methods

Most of the survey was necessarily made from a boat; only a few colonies that could be reached overland were accessed this way. A 6.7 m Naiad rigid-hulled inflatable boat was used throughout, operating from slipways at the heads of Akaroa Harbour and Pigeon Bay. The typical boat crew comprised two Department of Conservation staff, one being the driver, and two others employed for the survey. Landings were made where possible by nosing the bow of the boat into a suitable rock so the landing party could step off; pickups were made the same way. Where this was not possible, a two-person kayak was used to get ashore. Boat landings were made at 174 sites and a further 16 sites were reached overland.

The survey was conducted in two parts – an initial search of the shoreline to locate the nesting sites, and a return visit to document the colonies found. The first was done during October and early November 2000 when laying was still in progress, and the second from mid-November to mid-January 2000/01 and during November and December 2001 after laying had been completed. The parts of the shoreline searched and the locations of nesting sites were marked on enlargements of parts of NZMS 260 maps N36, N37, M36 and M37. Colonies were defined as

groupings of five or more nests separated from other nests by impassable terrain or 100 m. A standard form was completed for each colony, and lesser information was recorded for sites with fewer than five nests. A compilation of these records is held in the North Canterbury Area Office of the Department of Conservation (Challies 2002), and the locations and sizes of the colonies are given in Appendix 1.

Assessment of colonies

The methods and criteria used to describe colonies were:

Location

Each colony was assigned New Zealand Map Grid Coordinates to the nearest 10 m. These were calculated from the positions marked on the field maps and checked against GPS readings made on the support boat offshore from the site.

Size

Colony size was defined as the number of 'active nests', which approximates the number of breeding pairs. This was the sum of the number of nests containing eggs or chicks when surveyed, and the number of nests that had been used earlier in the season but were by then empty. The latter could have been abandoned at the egg or chick stage or the chicks may have already fledged. The ease with which nests could be counted varied depending on the nature of the site. Parts of about 30% of the colonies could not be reached because they were underground in lava tubes, narrow

crevices, or deep in rock piles. In these cases an estimate of the number of nests involved was added to the count for the site.

Physical characteristics

Colonies were either in accessible coastal areas or on debris slopes below coastal bluffs. The latter varied greatly in composition and were commonly eroded to some extent by the sea. The nesting places on these slopes were assigned to one of three site categories; rock pile, boulder beach or debris slope. These were, respectively, piles of rocks larger than 1 m in diameter and commonly larger, the eroded seaward edge with some exposed boulders larger than 1 m in diameter, and the remainder. Caverns in the bluffs were classed as caves if their horizontal depth was greater than their height at the entrance; and pieces of land separated from the mainland at low tide were classed as islands/islets.

Exposure to predation

The surrounds of each colony were viewed from the boat to see if it was physically possible for predators to reach the site without swimming. This could be either from above or around the shoreline. A check was also made at each site for obvious sign of the presence of predators including the remains of birds that had been preyed on. Colonies were considered accessible to predators if either applied.

Partitioning of data

For analytical purposes Banks Peninsula was divided into four parts along the mid-lines of Little Akaloa Bay, Hickory Bay and Akaroa Harbour (Fig. 1). These are referred to as the north (N), northeast (NE), southeast (SE) and south (S) sectors respectively. The coastline was further divided into three classes on the basis of its proximity to the open sea. These are the peripheral coast (the sections facing the open sea), and the shoreline of the embayments that are <1 km and >1 km from the headlands at their entrance.

RESULTS

Abundance and distribution

A total of 68 colonies was recorded of which 51 (75%) contained 5-20 nests, 12 (18%) 21-50 nests, and 5 (7%) >50 nests. Groups of less than five nests were found at 40 other sites. Altogether they contained 2112 nests; a total of 2012 nests in the 68 colonies and an allowance of 100 for the 40 small groups (40 × 2.5). The five largest colonies ranged in size from 58 to 717 nests and contributed 51% of the total.

The colonies were distributed right around the peninsula with their occurrence increasing from

west to east (Fig. 1). The eastern half of the peninsula (ie. sectors NE and SE combined) contained 72% of the colonies including all of those with >50 nests (Table 1). Most were situated either on the peripheral coast (47%) or inside bays within 1 km of their entrance (38%) (Table 2). Of the remainder, five were within 1-2 km of the bay entrance and five were within 2-3.2 km. The four colonies furthest from the open sea were in the outer parts of Lyttelton (1) and Akaroa (3) Harbours. Most of the colonies on the peripheral coast were on sections of coastline facing directly out to sea. This general pattern did not apply on the south coast where all the colonies were in relatively sheltered places inside bays (Table 2).

There was a tendency for the colonies on the more sheltered sites to be larger than those on the open coast. The median sizes of colonies on the peripheral coast and inside bays were 10 and 17 nests respectively. Of the 17 colonies containing >20 nests 76% were inside bays.

Nesting habitat

All but three of the colonies were between the base of coastal bluffs and the sea; the exceptions are treated separately. These sites were composed mainly of debris that had eroded from the bluff and slipped from the adjacent hillside. Typically they included a mix of nest sites ranging from holes in rock piles to burrows in fine debris, as well as caves and lava tubes in the bluffs. The main concentrations of nests were in rock piles where there were usually ample sites under and between the rocks. Elsewhere on these slopes there were fewer suitable places and nests tended to be scattered (Table 3). The nests in caves were amongst rocks or in hollows around the base of the walls, and occasionally in the open on the floors of darker caves.

Of the eight islands and larger islets around the peninsula that were possibly suitable, only Crown Island contained a colony. The 58 nests were amongst boulders on horizontal ledges. Five nests were found at three sites on Quail Island which is at the head of Lyttelton Harbour.

Two colonies in adjacent Flea and Stony Bays were in the valleys at the heads of the bays and on the surrounding hillsides. The Flea Bay colony was by far the largest on the peninsula containing 717 nests, 34% of the total. It extended up to 500 m inland from the head of the bay, and across part of the south slope and all of the north slope up to an altitude of 200 m; an area of 85 ha. Most of this is hilly grazing land with farm buildings, stockyards and holding paddocks in the main valleys. The north slope steepens and becomes increasingly rocky towards the entrance to the bay and is mostly scrub-covered. The nests were mainly in

Table 1 Numbers of colonies in each of three size groupings by sectors.

Sector	Number of nests			Total
	5 – 20	21 – 50	>50	
N	7	1	-	8
NE	24	3	1	28
SE	12	5	4	21
S	8	3	-	11
Combined	51	12	5	68

Table 2 Numbers of colonies in each of three coastline classes by sectors.

Sector	Peripheral coast	Distance inside the entrance of bay		Total
		<1 km	>1 km	
N	4	3	1	8
NE	18	6	4	28
SE	10	6	5	21
S	-	11	-	11
Combined	32	26	10	68

Table 3 Number of nests in each of four site categories by sector.

Sector	Rock pile	Boulder beach	Debris slope	Cave /lava tube
N	49	45	25	15
NE	273	56	61	28
SE	394	20	42	63
S	56	15	25	55
Total	772	136	153	161

Table 4 Numbers of colonies in each of three size groupings that were accessible and inaccessible to predators.

Exposure to predators	Number of nests			Total
	5 – 20	21 – 50	>50	
Accessible	22	10	2	34
Inaccessible	29	2	3	34

holes in the ground and amongst rocks, in rock crevices, and under buildings and other man-made structures. The Stony Bay colony contained 15 nests in and around farm buildings inland from the head of the bay.

Exposure to predation

Thirty-four (50%) of the colonies, including 12 (71%) of those containing >20 nests, were considered to be accessible to mammalian

predators (Table 4). Together they contained 1345 (69%) of the nests. Seven of the 12 larger accessible colonies contained the remains of penguins that had been preyed on or other evidence predators had been there. Of the five larger colonies considered inaccessible four were protected by bluffs and the other was on Crown Island. All five were in the southeast sector. Fewer of the smaller colonies on the peripheral coast were considered accessible (38%; $n = 29$) than were those inside the bays (50%; $n = 22$).

DISCUSSION

Little penguins (*E. minor*) have disappeared from most of their range on the New Zealand mainland since European settlement, and are in much reduced numbers where they have survived. The largest colonies are now either on inshore islands free of predators, or in places on the mainland that are inaccessible or where predators are being controlled (Tennyson 1992; Dann 1994). The situation on Banks Peninsula and in Canterbury generally fits this pattern.

It is clear from contemporary writings that white-flippered penguins were very common around Banks Peninsula in the late 1800s (e.g. Potts 1882). Since then mammalian predators have had a major impact on their overall numbers and the sizes and distribution of colonies. In the 1950s penguins were still nesting around the heads of most of the bays on the peninsula, albeit usually in small numbers (C.N. Challies unpubl. data). These colonies disappeared soon after except for those in Flea and Stony Bays that still exist. During the last 25 years predators have overrun many of the remaining colonies on the sides of the bays. Of four colonies containing >50 nests monitored over this period one was destroyed and the others were reduced by 72 - 77%. The aggregate number of nests in these colonies declined from 489 to 85 between 1981 and 2000, an overall loss of 83% (C.N. Challies unpubl. data).

What is known of the history of predation on the peninsula suggests it was progressive with the most accessible colonies being destroyed first followed by those on less and less accessible sites. In general, this progression has been from the heads of the bays towards the open coast along the gradient of increasing coastal erosion. The surviving colonies, with a few exceptions, are either inside the bays close to the headlands at their entrances or on the peripheral coast. All of these sites are rocky and backed by bluffs, and most of those on the peripheral coast face directly out to sea. While the penguins seem able to access their nests on rocky shorelines in moderate to rough seas it is unlikely that the more exposed sites are preferred habitat. The fact that, historically,

most of the larger colonies have been inside the bays, seems to support this conclusion. It could also explain why the colonies on the peripheral coast are smaller on average than those inside the bays despite fewer of them being directly accessible to predators.

The colonies in Flea and Stony Bays are relics, representative of what conditions were probably like elsewhere on the peninsula in the early and mid-1900s, respectively. The reasons why they have survived when other easily accessible colonies have not are not known but are obviously historic. Since at least the mid-1980s both colonies have been subject to predation, mainly by ferrets. Predator trapping undertaken by local farmers has largely mitigated the effects of this. Trapping was started in Stony Bay in 1988 and in Flea Bay in 1991, and is continuing. There appears to have been some reduction in the size and extent of both colonies over this period despite the trapping but this has not been measured (J.M. Armstrong & F.W. Helps pers. comm.).

Without relevant baseline information it is not possible to estimate with any certainty the overall impact that predators have had on penguin numbers. The present colony in Flea Bay provides the best evidence there is of what penguin numbers and habitat use might have been like in the other bays. If this was the case, as seems probable, the peninsula-wide population must have comprised tens of thousands of pairs at the time of European settlement. The present population is <10% of that.

The survey results generally support IUCN's assessment of the penguin's conservation status (Ellis *et al.* 1998). The only major discrepancy was in the size of the population, which was much larger than previously thought. The survey estimate of 2112 nests was nearly four times the earlier estimate of ≥ 550 pairs made in 1998 (Challies 1998). This was a minimum figure based on known colonies. A further 57 previously unknown, mainly small, colonies were found during the survey, and better information was obtained on the extent of some of those included in the 1998 estimate. When juveniles are included, the 2112 nests equate to a peninsula-wide population of *c.* 5870 birds (assuming a juvenile to adult ratio of 0.39 : 1.0 at the commencement of breeding; C.N. Challies unpubl. data). Together with the estimated 1650 nests on Motunau Island (Challies 1998), the equivalent figure for the total population is *c.* 10,460 birds.

Judging by the number of existing colonies that contained evidence of the presence of predators the historic decline in penguin numbers must be continuing. While half the colonies were considered accessible to predators this is

undoubtedly an underestimate of the number actually at risk. Three of the 14 colonies that contained convincing evidence of predation were not thought to be accessible over land. No account was taken of the possibility that predators might reach colonies by swimming around the coast. There is some evidence that stoats, which are good swimmers (Taylor & Tilley 1984), are reaching parts of the shoreline this way. An example was the sighting of one, and subsequent trapping of two stoats in one of the larger colonies near the entrance to Akaroa Harbour in 1999 (A.C. Hutt & G.A. Tunnicliffe pers. comm.). The colony is ringed by vertical bluffs that drop straight into the sea on both sides.

Predators not only pose a direct threat to most of the surviving colonies but birds that move from these colonies and attempt to breed elsewhere are also at risk. An ongoing study of the penguin's recruitment behaviour has shown that 50% or more of adults nest outside their natal colony, usually within 1 km but sometimes up to several km away (C.N. Challies unpubl. data). Previously these movements would have been mainly reciprocal between colonies but with their breeding range now fragmented this is no longer the case. A parallel study has shown that these birds commonly move to more accessible areas and are eventually killed by predators (C.N. Challies unpubl. data). Colonies that suffer net losses this way will predictably reduce in size regardless of whether predators reach the site or not.

If the numbers of predators on Banks Peninsula continue at the levels experienced during the 1980s and 1990s it seems inevitable that many of the surviving penguin colonies will be lost and others reduced in size. A well-planned and supported management programme will be needed if representative groups of colonies are to be saved. The survey provides some of the background information that will be needed for this purpose along with a reliable baseline from which to measure the effectiveness of future management.

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Appendix 1

Locations and sizes of the 68 colonies listed in order of occurrence clockwise around banks Peninsula from Sumner Head to Bridlings Flat

No.	Date surveyed d-m-y	Location / NZ Map Grid Coordinates			No.	Date surveyed d-m-y	Location / NZ Map Grid Coordinates		
		East	North	No. nests			East	North	No. nests
North sector:									
1	23-11-01	249336	573605	19	35	06-11-01	252015	571545	21
2	11-01-01	249333	573249	9	36	06-11-01	252021	571471	17
3	11-01-01	249900	573336	10	Southeast sector				
4	11-01-01	250278	573128	5	37	06-11-01	251895	571308	5
5	23-11-00	250458	573163	15	38	06-11-01	251898	571276	18
6	23-11-00	250561	573089	11	39	07-12-00	251916	571247	58
7	23-11-00	250686	573041	19	40	07-11-01	251894	571172	6
8	23-11-00	250810	573045	46	41	08-11-01	251834	571041	16
Northeast sector:									
9	23-11-00	251221	572817	6	42	08-11-01	251852	571026	7
10	23-11-00	251230	572807	9	43	08-11-01	251860	571018	5
11	23-11-00	251388	572828	5	44	19-12-00	251796	570956	10
12	23-11-00	251360	572811	7	45	24-11-00	251721	570831	18
13	30-11-00	251321	572787	9	46	24-11-00	251681	570753	8
14	30-11-00	251320	572771	13	47	19-11-01	251555	570687	29
15	30-11-00	251398	572689	19	48	24-11-00	251424	570589	50
16	30-11-00	251542	572605	77	49	07-12-00	251358	570576	27
17	30-11-00	251527	572459	9	50	07-12-00	251322	570579	15
18	30-11-00	251532	572454	7	51	24-11-00	251370	570522	10
19	30-11-00	251820	572361	11	52	— 12-00	251053	570435	717
20	30-11-00	251831	572339	45	53	04-12-01	251128	570279	14
21	01-12-00	251927	572059	5	54	24-11-00	250928	570340	27
22	01-12-00	251940	572050	6	55	06-12-00	250662	570430	83
23	01-12-00	251972	572013	7	56	18-12-00	250621	570452	139
24	01-12-00	251950	571991	8	57	06-12-00	250568	570475	47
25	01-12-00	251770	571913	17	South sector:				
26	01-12-00	251890	571875	19	58	06-12-00	250377	570114	13
27	01-12-00	251910	571880	19	59	06-12-00	249945	570160	10
28	01-12-00	251971	571892	23	60	06-12-00	249950	570185	10
29	07-11-01	252010	571879	7	61	06-12-00	249806	570247	5
30	21-11-01	252023	571831	8	62	05-12-00	249793	570223	10
31	04-12-01	252049	571794	15	63	05-12-00	249612	570240	24
32	21-11-01	252047	571682	12	64	05-12-00	249397	570404	10
33	07-11-01	252052	571654	5	65	28-12-01	249224	570510	21
34	07-11-01	252056	571599	12	66	28-12-01	249162	570556	7
					67	05-12-00	248958	570612	32
					68	05-12-00	248902	570786	9