

Near-shore distribution and seasonal abundance of White-flipped Penguins (*Eudyptula minor albosignata*) at Banks Peninsula, New Zealand

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ABSTRACT

Knowledge of the abundance of White-flipped Penguins and on the distribution of penguins without attached instruments at sea in general is scarce. Sightings of individual penguins in the neritic waters of southern Banks Peninsula were recorded between November 1993 and March 1997 to document their near-shore distribution and changes in seasonal abundance. White-flipped Penguins were not evenly distributed but appeared to concentrate in several bays. Abundance in Akaroa Harbour, the largest bay in the study area, peaked in April and November after recorded lows in March and September (probably due to moult and incubation), respectively.

KEYWORDS: abundance, distribution at sea, *Eudyptula minor albosignata*, Blue Penguin, New Zealand

INTRODUCTION

Penguins (Spheniscidae) are pelagic birds whose sole source of food comes from the sea. Although these birds rely on land for nesting, breeding and moulting, they spend most of the daylight hours foraging at sea. Because penguins are difficult to observe at sea, most of the studies have been conducted in the breeding colonies. In the studies that have investigated foraging at sea, almost all employed the use of externally attached devices (Wilson *et al.* 1989, Wilson & Wilson 1990, Weavers 1992, Wilson *et al.* 1995, Bost *et al.* 1997, Culik & Luna-Jorquera 1997, Guinet *et al.* 1997, Hull *et al.* 1997, Culik *et al.* 1998, Wilson *et al.* 1998). However, bulky instruments have the potential to alter drastically a bird's behaviour. Wilson *et al.* (1986), Gales *et al.* (1990), Bannasch *et al.* (1994) and Hull (1997) found drag to have the most influence on behaviour reducing swimming speed, diving depth, foraging range, and number of prey encountered. Blue Penguins *Eudyptula minor* generally tend to stay closer to shore than the larger species. Previously they were studied extensively at sea only in southern Victoria, Australia, using ship-borne transect counts (Norman 1992) and radio transmitters (Weavers 1992).

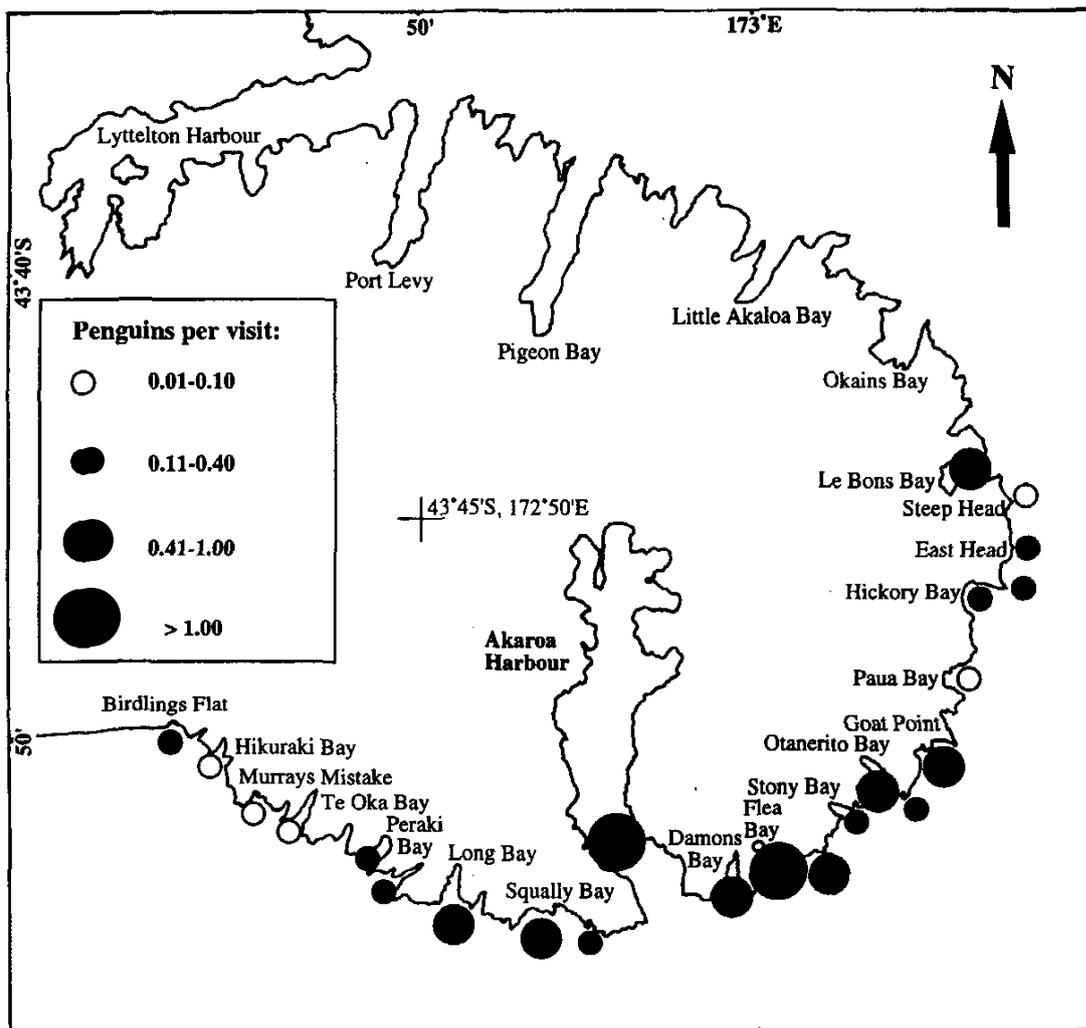


FIGURE 1 - Map of Banks Peninsula with mean encounter rates of White-flipped Penguins per survey.

Among the six subspecies of the Blue Penguin, the most distinct form is the White-flipped Penguin *E. m. albosignata* which occurs only on Banks Peninsula and Motunau Island (Williams 1995, Heather & Robertson 1996). Little has been published on this subspecies, but there is evidence of a strong decline in the population on Banks Peninsula in the recent past (C. N. Challies pers. comm.). This decline is apparently due to predation by introduced mammals. In order to ensure the long-term existence of this population it is important to assess its distribution and abundance at sea as well as on land. The aim of this paper is to describe the distribution and abundance of *E. m. albosignata* from near-shore sightings around the southern side of Banks Peninsula.

METHODS

Between 9 November 1993 and 28 March 1997, the neritic waters around the southern side of Banks Peninsula were surveyed for about 800 hours (on 192 days). Surveys in the study area (Fig. 1) were conducted during all seasons, most frequently, however, between October and March. Usually they commenced early in the morning

and lasted for 2-11 hours at a time. The sites outside Akaroa Harbour were visited 11-55 times during the 41-month period, whereas the sheltered waters of Akaroa Harbour were surveyed more frequently (182 days in total, $\bar{x} = 15.2 \pm 3.76$ SE times per month). An additional 17 days were spent exclusively along the northern shores of Banks Peninsula. However, penguin sightings from these northern surveys were too sparse to warrant a quantitative analysis here.

Data on penguin distribution and abundance were collected opportunistically while studying Hector's dolphins (*Cephalorhynchus hectori*) in the same habitat (Bräger 1998a). Most of the time was spent within 1 km from shore searching for dolphins and penguins from a 4.5 m open research vessel equipped with a outboard motor. Surveys were undertaken at an average speed of 10-15 knots (= 5.1-7.7 m/s) under good sea and weather conditions (slight sea of 0-3 Beaufort and neither fog nor rain). The survey design, however, did not attempt to emulate systematic transects (i.e., distance sampling) or complete coverage of the study area. To avoid repeat recordings of the same individuals on the same day, penguins (observed by eye) were counted on either outbound or homebound movement (usually parallel to the coastline). On different days, however, the same individuals are likely to have been recorded repeatedly which is unavoidable without marking individuals.

For each sighting the total number of individuals and their geographic location were recorded. However, since all surveys originated at the Akaroa boat ramp, only Akaroa Harbour was covered repeatedly during all times of the day. The survey design may have biased sightings outside this bay, because farther areas usually were visited closer to midday when penguins are likely to feed further offshore. Furthermore, since White-flipped Penguins are easy to overlook, all sightings should be treated as minimum numbers. Therefore, the geographical distribution outside Akaroa Harbour (Fig. 1) depicts encounter rates of White-flipped Penguins rather than true densities. For the same reason, the data do not allow testing for any temporal effects (e.g., time of day or difference between years).

STUDY AREA

The study area (Fig. 1) consists of the neritic waters on the southern side of Banks Peninsula (centre at 43° 45' S, 172° 50' E), Canterbury, East Coast of the South Island of New Zealand. Banks Peninsula is a large peninsula of volcanic origin (extinct for 8 million years) with many bays along its approximately 150 km of coastline. The largest bay of Banks Peninsula is Akaroa Harbour which is one of two flooded craters. It extends 14.5 km in north-south direction with 42-43 km² surface area and opens to the Pacific Ocean in the south.

Banks Peninsula has long been known to be the breeding site of White-flipped Penguins (summarised in Marchant & Higgins 1990). Its coastal waters also sustain growing numbers of other piscivores, such as reproducing New Zealand fur seals (*Arctocephalus forsteri*) (Ryan *et al.* 1997), Spotted Shags (*Stictocarbo punctatus*) (Doherty & Bräger 1997), and White-fronted Terns (*Sterna striata*) (Bräger 1998b). See Ryan *et al.* (1997) for a more detailed description of the physical features of the coastline.

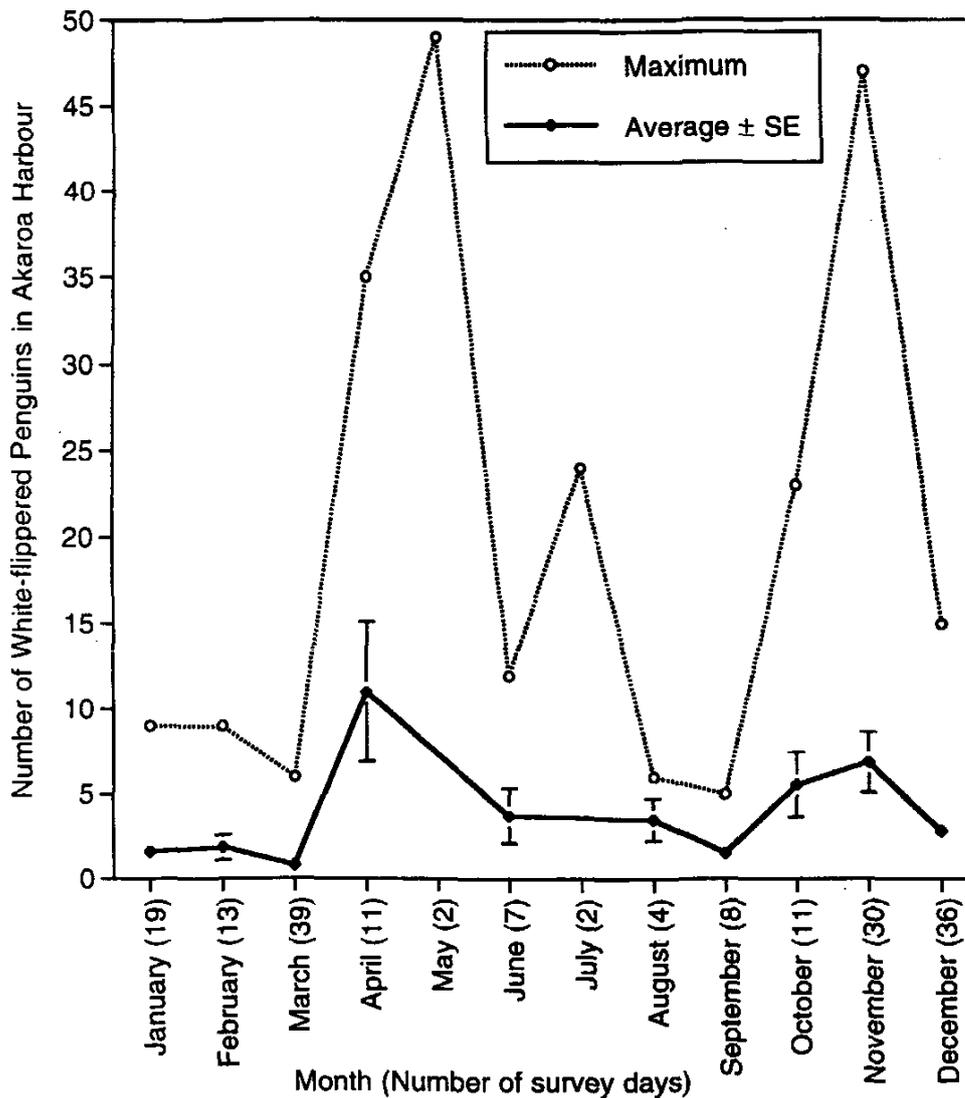


FIGURE 2 - Monthly maximum and mean (\pm SE) numbers of White-flipped Penguins sighted in Akaroa Harbour between November 1993 and March 1997 (sample sizes of survey days in parentheses). No standard errors were calculated for the months of May and July because of small sample sizes.

RESULTS

Near-shore distribution around southern Banks Peninsula

A total of 1270 White-flipped Penguins was observed during 192 survey days (Table 1). On 167 days (87%), White-flipped Penguins were sighted along the southern side of Banks Peninsula between Le Bons Bay and Birdlings Flat. In most areas, penguins were encountered only during 3-38% of the visits with an average number of <1 penguin per visit. Only two areas, Flea Bay and Akaroa Harbour, had encounter rates of over 50% and a mean of >1 penguin per visit (Table 1). In these two areas combined, 1094 of the 1270 penguins were sighted (86.1%, uncorrected for effort). Other areas along the southern shores of Banks Peninsula with high penguin numbers per visit were Le Bons Bay, Shell Bay to Damons Bay, and Squally Bay to Long Bay (Fig. 1).

TABLE 1 - Survey effort, encounter rates, and average abundances of White-flipped Penguins along the southern shores of Banks Peninsula.

Site	Number of visits	Proportion of visits with penguins	Total number of penguins encountered	Average number of penguins per visit	Average number of penguins per successful visit
LeBons Bay	11	18%	9	0.8	4.5
Steep Head	11	9%	1	0.1	1.0
East Head	13	15%	3	0.2	1.5
Putakolo Head	15	13%	2	0.1	1.0
Hickory Bay	14	14%	2	0.1	1.0
Paua Bay	15	7%	1	0.1	1.0
Shell Bay	16	38%	8	0.5	1.3
Pompey's Pillar	22	14%	4	0.2	1.3
Otanerito Bay	23	26%	11	0.5	1.8
Stony Bay	25	20%	6	0.2	1.2
East Island - Redcliffe Pt.	28	29%	20	0.7	2.5
Flea Bay	36	81%	343	9.5	11.8
Flea Bay (<i>without 16 1 ind. of 4 Nov. 95</i>)	35	80%	182	5.2	6.5
Damons Bay	39	23%	18	0.5	2.0
Akaroa Harbour	182	64%	751	4.1	6.4
Scenery Nook	55	11%	11	0.2	1.8
Squally Bay	44	30%	33	0.8	2.5
Island Bay - Long Bay	41	27%	28	0.7	2.5
Horseshoe Bay	36	14%	5	0.1	1.0
Peraki Bay	35	11%	4	0.1	1.0
Te Oka Bay	34	6%	2	0.1	1.0
Murrays Mistake	32	6%	2	0.1	1.0
Hikuraki Bay	31	3%	2	0.1	2.0
Birdlings Flat	30	7%	4	0.1	2.0
Total:	192 days		1,270		

The geographical distribution depicted in Fig. 1 only reflects the number of penguins encountered within 1 km from shore. However, single sightings confirmed the distribution of White-flipped Penguins to at least 12 km out to sea (e.g., on 6 September 1996 off Akaroa Harbour). The highest number of White-flipped Penguins ever encountered together was 161 individuals rafting in Flea Bay on 4 November 1995. The average group size, however, was much smaller ($\bar{x} = 4.9 \pm 0.72$ SE individuals at the same site [$n = 262$ groups], frequently with several hundred meters between individuals).

Seasonality of sightings in Akaroa Harbour

The relative abundance of White-flipped Penguins in Akaroa Harbour varies considerably between different times of the year (Fig. 2). Monthly averages ranged from 0.8 to 11.0 individuals with single counts as high as 49 individuals. The bimodal distribution shows peak numbers in April and November and relatively few sightings from December to March and from August to September. For the months of May and July only two counts each were available, and so no means were calculated (Fig. 2).

Within Akaroa Harbour, White-flipped Penguins almost exclusively used only the southern (outer) half of the bay. Therefore, the maximum encounter rate in southern Akaroa Harbour was about 2-2.5 penguins/km² of bay area.

DISCUSSION

White-flipped Penguins were observed frequently in the near-shore waters around Banks Peninsula, especially in Akaroa Harbour and the smaller bays between Otanerito Bay and Long Bay. Sightings peaked in April/May and October/November which appears to coincide with post-moulting and breeding periods as follows. The lowest mean number of penguins sighted in Akaroa Harbour ($\bar{x} = 0.8 \pm 0.2$ penguins sighted per survey day in March [n=39]; daily max. = 6 individuals) coincided with the time of the complete body moult between January and March. After moulting the birds are likely to forage extensively after weeks of fasting. The second peak in October and November (5.5 and 6.9 penguins sighted per survey day, respectively; Fig. 1) followed a low in September (1.5 penguins sighted per survey day). This pattern appears to be congruent with increased foraging while feeding the newly hatched young (after incubation in September) (Marchant & Higgins 1990).

Other subspecies of Blue Penguin are often seen in shallow inshore waters and harbours close to their breeding grounds and show a high degree of site-fidelity (Dann *et al.* 1992, Williams 1995). They forage diurnally, predominantly within 5m of the surface (Heather & Robertson 1996, Bethge *et al.* 1997) on a diet commonly consisting of small fish such as anchovy *Engraulis australis* and pilchard *Sardinops neopilchardus* (Montague & Cullen 1988). On short-term trips, penguins tend to stay within 5-10 km of the coast and within a radius of 15 km of the burrow (Gales *et al.* 1990, Weavers 1992). On Banks Peninsula, however, very little is known about the distribution of penguin burrows. C. N. Challies (unpublished data) studied three breeding colonies of over 100 pairs (at Onawe Peninsula in Akaroa Harbour, Otanerito Cave, and Te Oka Bay) which suffered declines of 32-99% apparently due to predation by mustelids. The monitoring of seven colonies on Banks Peninsula led him to conclude that predation has resulted in a 60-70% overall reduction in the numbers of breeding White-flipped Penguins between 1980 and 1993. Besides the proximity of the burrow, prey availability is assumed to drive the geographical distribution of White-flipped Penguins in the study area. However, currently no information on prey distribution and abundance is available.

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