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POPULATION SURVEY OF YELOW-EYED PENGUINS ON THE AUCKLAND ISLANDS, NOV-DEC 1989.

by

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SUMMARY

1. A survey of the population of yellow-eyed penguins on the Auckland Islands was conducted in November-December 1989. A total of 934 individuals was counted at 15 landing sites in the northern islands and harbours, and part of Carnley Harbour in the south. Most of Port Ross, the eastern harbours and Carnley Harbour were not surveyed because of time constraints.

2. It was estimated that there were about 420-580 pairs in the surveyed area.

3. Allowing for a possible sparse population along the remaining coastline, there may be at least 520-680 pairs present on the islands. This is on par with, if not higher than, the Campbell Island population. The previous estimate for the Auckland Islands was 250-350 pairs.

4. The Auckland Island total may represent about 27-32% of the world population of 2300 breeding pairs (or 5600-6900 individuals).

5. A large proportion of the birds counted, 593 individuals (or an estimated 260-360 pairs), were found on Enderby Island.

6. The northern harbours of Auckland Island had populations that were denser than previously thought. This indicates that cat and pig predation may not be at high levels.

7. Chicks were first seen hatching on 27-28 November. This is one or two weeks later than occurs on the New Zealand mainland, but is a very similar hatching date to that on Campbell Island.

CHAPTER ONE: INTRODUCTION

1.1 General

The yellow-eyed penguin (*Megadyptes antipodes*), or hoiho, is endemic to the New Zealand region and is one of the rarest species of penguin in the world. The breeding distribution ranges from the south-east coast of the South Island to Stewart Island (and outliers), Auckland Islands and Campbell Island.

Yellow-eyed penguins inhabit coastline within close proximity of a reliable year-round food source. This relates to the width of the continental shelf and the level of primary productivity of the ocean. They are also restricted to areas where mean summer temperatures on land are less than 16.5°C (Smith 1987).

Unlike many species of penguin which nest in densely populated colonies, the yellow-eyed penguin is the only species where each pair nests separately, avoiding visual contact with their neighbours (Jouventin 1982, Darby 1985). Hence, they nest in scattered aggregations in coastal forest and scrub. Another unusual feature is that adult yellow-eyed penguins remain at or near their breeding grounds throughout the year.

Darby (pers. comm.) believes there were once 2000-3000 pairs of yellow-eyed penguins on the South Island, and they were probably in their thousands on the Otago Peninsula (Richdale 1942). With the gradual clearance of the coastal forest breeding habitat, predation by feral cats, ferrets and dogs, disturbance by stock and people, and occasional crashes of the food supply, there has been a population decline. Darby (1985) estimated that in areas of the Catlins, Southland, 60% of birds had disappeared since the 1940s.

Based on the categories designated by the Survival Commission of IUCN (King 1981), Bell (1986) defined the yellow-eyed penguin as rare (having a small world population that is at risk) and regionally threatened (likely to become endangered). Robertson and Bell (1984) identified the species as a top priority for population surveys and development of census methods. Similarly, Warham *et al* (1986) stressed the need for base-line monitoring of penguins in the New Zealand region to understand the population trends and breeding ecology of each species.

In 1985-86, Darby (in N.Z. Wildlife 1986) put the total world population at 1500-2100 breeding pairs, 600 of which were on the South Island. Based on Richdale's (1957) figure of 40% non-breeding birds this put the overall population at 5100-7100 birds, and was considered at the time to be the world's rarest penguin. Updated information in the late 1980s put the overall population at closer to 5000 individuals (DOC 1989, Moore and Moffat 1990, Darby and Seddon in press, Darby in Marchant in press).

A major collapse in the food chain in 1987 is believed to have been caused by the El Nino southern oscillation weather pattern (Darby pers. comm.), and resulted in a further reduction in the breeding population of yellow-eyed penguins on the South Island to 220 breeding pairs (Darby and Seddon, in press).

By 1989 accurate assessments of the yellow-eyed penguin population had only been made on the mainland and at Campbell Island. Population trends had been monitored closely on the mainland by J. Darby, who developed a censusing technique based on counts of penguins at landing sites during October (incubation period) and December (chick guard stage). In winter 1988 Campbell Island was surveyed for yellow-eyed penguins, and selected penguin landing sites monitored throughout the year (Moore and Moffat 1990).

1.2 Auckland Islands

The Auckland Islands lie at 50° south latitude, 459 km south of Bluff and 290 km northwest of Campbell Island (Penniket *et al.* 1987). They were first discovered in 1806 by the British whaling vessel "Ocean" under the command of Captain Abraham Bristow. The year 1840 was important for exploration in the antarctic and subantarctic, and three major expeditions visited the Auckland Islands. The United States Exploring Expedition, under the command of Captain Wilkes, visited from 7-10 March 1840 and made the first "discovery" of yellow-eyed penguins in the New Zealand region (Richdale 1941). Specimens were collected and "Penguins were numerous and of a variety of colours" (Wilkes 1845). Yellow-eyed penguins were also collected one week later by the French expedition under Admiral D'Urville. The French naturalists of this expedition, Hombron and Jacquinot (1841) were first to name and describe the species *Catarrhactes antipodes.* Later in that year, the British Antarctic Expedition, under Sir James Clark Ross, collected yellow-eyed penguins, and Gray (1843, 1844) listed the species as being present on the Auckland Islands.

Various other expeditions recorded the presence of yellow-eyed penguins, mainly by collecting specimens for museums, rather than assessing their abundance. For example Wilson (1904) mentioned that three yellow-eyed penguins were caught during the 1904 expedition. He also noted a rookery along the south-eastern shore of Ewing Island, although this is actually the present site of an Auckland Island shag colony.

During the Second World War, members of the "Cape Expedition" coast-watching parties noted that "yellow-crested penguins are also common in the Aucklands" (Aerodrome Services -Public Works Department 1946). Eden (1945) stated that "no large penguin colony has been discovered, but small colonies and individual penguins are fairly numerous, particularly on Adams and Disappointment Islands, and on the small islands in the vicinity of Port Ross." This description includes both yellow-eyed and rockhopper penguins, as the latter have a colony on Disappointment Island. In a later book Eden (1955) noted in passing that penguins were present on Ewing and Adams Island. He also noted that there was no sign of penguins in Chambres Inlet on the main Auckland Island. Oliver (unpublished) records a nest found by "C.M." on Ocean Island in November 1941. Oliver also photographed penguins there in March 1927.

Most recent expeditions have noted that the yellow-eyed penguin was most abundant in the northern islands of the group, particularly Enderby Island. For example casual field observations on Enderby and Rose Islands in 1954 and 1966 showed that yellow-eyed penguins bred in "large numbers", and that this was a most notable feature compared with other islands of the group (Taylor 1971). Other important localities were Ewing and Ocean Islands, with a few pairs also found on Adams Island (Darby 1984, N.Z.

Wildlife 1986). Cats and pigs are absent from these islands, although cattle, rabbits and mice are present on Enderby Island, and rabbits are on Rose Island.

In a reference to yellow-eyed penguin distribution in 1972-73, Challies (1975) stated that "they now nest on Port Ross Islands and on the lower slopes of Adams Island, but are rarely seen above the shoreline on Auckland Island." This was attributed to their vulnerability to cats and pigs on Auckland Island. One of the pigs that was sampled contained most of a yellow-eyed penguin, most likely from predation rather than scavanging (Challies 1975, B. Bell pers. comm.). This suggested that penguins had almost disappeared from the main island, with very small groups still present at Terror Cove, Norman Inlet and Waterfall Inlet (Darby 1984, N.Z. Wildlife Service 1986).

There is some evidence which contradicts Challies' (1975) assessment of the situation on the main island. For example, during the 1962-63 expedition "yellow-eyed penguins were nesting under coastal scrub and other cover throughout Port Ross" (Yaldwyn 1964). In October 1971 penguins were "frequently seen in small groups swimming and fishing" at Waterfall Inlet (Ritchie 1971). Bartle and Paulin (1986) saw yellow-eyed penguins on headlands along the eastern coast and "these were fairly abundant." In 1988 A. Cox (pers. comm.) heard frequent penguin calls from the scrub in Waterfall Inlet. Furthermore, Taylor (1988) also saw penguins going ashore in several locations on the western side of North Harbour but the population at Port Ross "appears very sparse."

Expedition reports from the mid-1970s to included notes on yellow-eyed penguin numbers which confirmed the prominence of Enderby Island as a major centre for the species in the Auckland Islands, although the assessments were very subjective or vague. Bartle and Paulin (1986) found in December 1976 that penguins were "widespread" on Enderby and "there must be many thousands" there. In January 1980 they were "numerous" (Mitchell and Ensor 1986) and in April 1980 they were "throughout" the island (Pierce 1986). In May 1981 it was noted that there were "about 100 yellow-eyed penguins moving between the inland areas and the beach, with a further 20+ on the beach just south of Derry Castle Reef on the east coast" (Robertson and Jenkins 1986). In March 1982 there were “500+ juveniles in moult" (Thomson 1986) presumably referring to nearly fledged chicks. In February 1988 penguins were "very common" (Taylor 1988) and in the same month, G. Lind (pers. comm. to J. Darby) counted 170, 194 and 200 penguins during three counts at Sandy Bay. The other islands received fewer comments in expedition reports. On Ewing Island penguins were "common" (Thomson 1986) and "frequently encountered" (Taylor 1988). Surprisingly, on Ocean Island, "none was seen or heard on this apparently suitable nesting island" (Taylor 1988).

During the expedition to the islands in 1972 R. Nilsson and R. Russ of the N.Z. Wildlife individually estimated the total yellow-eyed penguin population to be 80-100 pairs and 80-150 pairs respectively (Nilsson, Russ pers. comm. to J. Darby). These formed the basis for population estimates in the mid 1980s (Darby 1984, N.Z. Wildlife 1986). This order of magnitude was confirmed during a visit by Darby and Seddon in February 1986, and they estimated that there were 140 pairs breeding on Enderby Island (Darby 1986) based on extrapolation of nesting density data (Darby pers. comm.). Thus, there were probably 150-225 pairs on the Auckland Islands (Darby in N.Z. Wildlife Service 1986). In 1988 this figure was adjusted to 200-250 pairs, while acknowledging that most sites had

yet to be visited (Darby in DOC 1989, Darby and Seddon, in press) and further adjusted to 250-350 pairs (Darby in Marchant, in press). These changes were made because there was evidence from visits to Enderby and Auckland Islands that there were greater numbers of penguins than previously thought.

Thus, in 1989 it was apparent that a reliable assessment of the Auckland Island yellow-eyed penguin population was required. This was essential to an understanding of the overall status of the species, especially as the mainland population had been suffering a continued decline. The collection of base-line data would also allow future monitoring studies to detect changes in the population.

1.3 Aims

In October-December 1989 the Department of Conservation Southland Conservancy conducted a six week expedition to the Auckland Islands. One of the aims was to survey some of the coastline for yellow-eyed penguins, in order to assess the status of the species on the islands.

CHAPTER TWO: METHODS

The Auckland Islands were visited between 31 October and 8 December 1989. A survey of yellow-eyed penguin landing sites was conducted on the islands and harbours at the northern end of the island group. Usually two, and occasionally three, expedition personnel were involved in the survey. A fourth observer collected additional information from Adams Island.

Most of the shoreline which appeared to be accessible to penguins was surveyed in these areas. Counts were conducted by choosing suitable vantage points on the shoreline to record the penguins as they left for sea in the morning, or arrived back from sea in the evening. The duration of counts was chosen to coincide with the peak of departures or arrivals, usually the first three hours after dawn and the last five hours before dusk. The numbers of adults and juveniles were recorded as going out to sea or coming in from sea. Additional birds were noted which arrived at landing sites but did not go to sea. Sixty-seven counts and 314 hours of observation were conducted.

To assist with the interpretation of results, two counts were conducted throughout the daylight hours of 10 November and 3 December 1989 at Sandy Bay, Island. Results of the study on Campbell Island in 1987-88 (Moore and Moffat 1990) were also used to assist interpretation of the Auckland Island results.

Incidental observations, such as timing of the nesting cycle, were recorded.

CHAPTER THREE: RESULTS

3.1 Yellow-eyed penguin population

The results of the population survey of yellow-eyed penguins at the northern and southern ends of the Auckland Islands are summarised in Fig. 1, Table 1 and Appendix 1. Only 2.1% of birds at the landing sites were juveniles. The landing sites were spread along coastline that allowed access to breeding habitat, and varied from rocky shores (64%) to boulder beaches (32%) and sandy beaches (4%).

Table 1 also attempts to interpret the counts in terms of the number of breeding pairs, to compare the population with other parts of the species' range. Because counts were made during the incubation and hatching periods, one partner of each breeding pair would have been at the nest each day. Thus, roughly half the breeding birds and most of the non-breeders would be expected to be counted at the landing sites. However, the counts will be underestimates as some birds stay ashore (particularly juveniles and non-breeding adults), and others stay away for longer than a day[1]. Estimate "d" (Table 1) corrects for this to some extent on the basis of Campbell Island data for November, but the adjustment is probably a conservative one. Another reason for probable underestimation in Table 1 is that there was evidence for high variation in counts. At Enderby Island, the counts at Sandy Bay in early December were about twice the totals counted 3.5 weeks earlier (when the whole island was surveyed, Appendix 8). Although some of this variation is explained by the stage of the breeding cycle (Moore and Moffat 1990), it is higher than expected.

The overall estimate for the surveyed area was approximately 420-580 pairs (Table 1). The unsurveyed coastline is extensive, with at least 13 major bays and harbours likely to accommodate penguins. Even allowing for a very sparse population, at least 100 further pairs would be a conservative expectation. Therefore, a minimum estimate for the island group would be about 520-680 pairs.

The centre of the yellow-eyed penguin population is at Enderby Island (Appendix 2), as 63% of the total was counted there, or an estimated 260-360 pairs. Birds landing on the north-eastern shore, and many at Sandy Bay, had to walk at least 500m across the coastal sward before reaching suitable nesting habitat in coastal southern rata (*Metrosideros umbellata*) forest and scrub vegetation (e.g. *Myrcine divaricata*) on the coast or in higher altitude gullies. Nesting density for the 688 ha island was about 0.5 pairs/ha. Localised nesting density would be much higher, because at least half the island area consists of short vegetation which is unsuitable for nesting.

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[1] Mainland studies show that incubation spells range from 1-5 days (Richdale 1951) or 1-7 days (Seddon 1989), although most are only 1-2 days long. Campbell Island (1987-88) incubation spells may have been even closer to daily ones, as visits to nests on consecutive days showed that 83% of birds had been relieved at the nest by the partner. Even if birds spend longer than one day away from the nest, some may still be counted at the landing site (e.g. one nest on Campbell Island had the same bird incubating when visited on three consecutive days, yet the partner was seen returning to the landing site on the second evening).

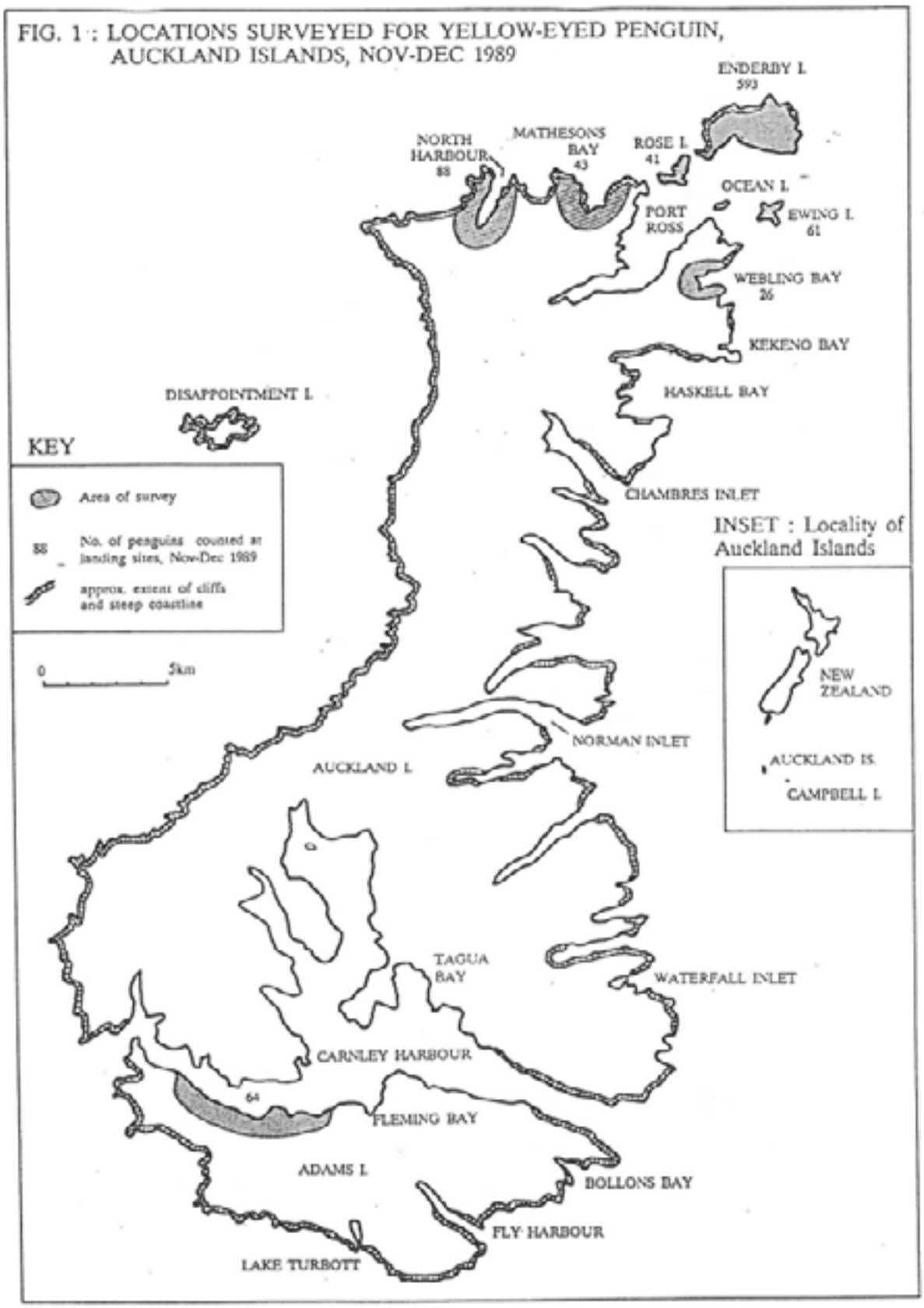


FIG. 1 : LOCATIONS SURVEYED FOR YELLOW-EYED PENGUIN, AUCKLAND ISLANDS, NOV-DEC 1989
ENDERBY I.
593
NORTH HARBOUR
88
MATHESONS BAY
43
ROSE I.
41
OCEAN I.
PORT ROSS
EWING I.
61
WEBLING BAY
26
KEKENO BAY
HASKELL BAY
DISAPPOINTMENT I.
CHAMBRES INLET
KEY
Area of survey
88
No. of penguins counted at landing sites, Nov-Dec 1989
approx. extent of cliffs and steep coastline
0
5km
INSET : Locality of Auckland Islands
NEW ZEALAND
AUCKLAND IS.
CAMPBELL I.
NORMAN INLET
AUCKLAND I.
TAGUA BAY
WATERFALL INLET
CARNLEY HARBOUR
64
FLEMING BAY
ADAMS I.
BOLLONS BAY
FLY HARBOUR
LAKE TURBOTT

TABLE 1: Yellow-eyed penguin counts at the Islands 1989

Locality	Total[a] Count	Time[a] Adjusted	Grouping	Sub-Total	Minimum Pair Estimate[c]	Maximum Pair Estimate[c]
Enderby Is.	593	616	Enderby Is.	616	260-320	290-360
Ewing Is.	61	68				
Rose Is.	41	44	Northern			
Ocean Is.	2+	2+	Islands	144+	50-60	55-70
North Harbour	88	103				
Matheson Bay	43	46	Northern			
Port Ross (north)	13+	13+	Harbours			
Webling Bay	26	33		195+	80-100	90-110
Tagua Bay	3+	3+	Carnley			
Adams Island	64	72	Harbour	75+	30-40	35-40
	934	1000		1000	420-520	470-580

KEY :

a : total count of yellow-eyed penguin adults and juveniles leaving the landing sites in the morning or arriving from sea in the evening;

b : total count adjusted to allow for birds assumed to be moving outside the survey hours. Based on whole-day counts at Sandy Bay, Enderby Island (Appendix 8);

c : estimate of breeding pairs on the basis that 60%. (Richdale 1957) to 70% (Moore and Moffat 1990) of will be breeding pairs and 94% of these breeding pairs will be still incubating eggs at the late incubation stage;

d : adjustment to breeding pair estimate to allow for assumption that 89% of birds will be counted at the landing site (Nov data, Campbell Island, Moore and Moffat 1990; 31-32 pairs had been banded at nests and 24-31 banded birds were counted at the landing site, i.e. 89% (75-100%)). This is because not all non-breeding birds travel to sea every day, and not all breeders alternate on a strict day-on, day-off basis at the nest. During some of the non-breeding months the figure was closer to 80%.

+: minimum number seen or estimates but area not fully surveyed.

Ewing Island (Appendix 3), at approximately 50 ha in area, probably had a similar density of nests to Enderby, at about 0.7 pairs/ha. The whole island was presumably suitable for nesting, as there is a coastal zone of *Olearia lyalli* surrounding rata forest. Of the northern islands, Rose Island (Appendix 3) probably had the most sparse population. South-eastern landing sites allowed access to rata forest, while north-eastern landing sites were adjacent to *Poa litorosa* grassland. A reconnaissance of Ocean Island revealed little sign of penguins, apart from a minor track from a landing site on the south-eastern shore (Appendix 6). There was no apparent lack of suitable nesting habitat on this small island.

North Harbour landing sites (Appendix 4) were along the shores of the inner harbour, as the remaining shore was steep or inaccessible. Similarly, Bay penguins were concentrated on the few rocky ramps accessible to them (Appendix 5). Both these areas appeared to have a higher density than the other northern harbours, with more than twice the average count per landing site at Webling Bay (Appendix 1). The large

harbour of Port Ross was not surveyed, but some incidental observations were collected by other expedition members working in the vicinity of Dewiest Head (Appendix 6). During a reconnaissance visit, no obvious sign of penguins was found in the Tucker Point-Ranui Cove area (Appendix 6), suggesting a sparse population there.

Minor tracks are easily overlooked during brief searches of shorelines, as evidenced by a visit to Webling Bay prior to conducting the counts there.

The Webling Bay population was well dispersed (Appendix 5). A quick reconnaissance of small stretches of shoreline on the east coast of Island, between Kekeno Bay and Chambres Inlet (Fig. 1), revealed little penguin sign apart from a set of claw marks on the south-eastern shore of Chambres Inlet. This suggests a small well-dispersed population, perhaps of similar (or lower) density to Webling Bay.

A survey along part of the Carnley Harbour shoreline of Adams Island (Appendix 7) indicated a well-dispersed population. Individuals were also seen at Fleming Bay on the north coast, and at Bollons Bay, Fly Harbour and the outlet of Lake Turbott on the south coast (Fig. 1). A few birds were also seen at Tagua Bay on the northern side of Carnley Harbour.

3.2 Daily movement pattern at landing sites

The results of counts conducted throughout two full days at Sandy Bay on Enderby Island are illustrated in Fig. 2 and Appendix 8. The pattern for November shows that most birds departed between0500-0800 hours (NZST) and returned from sea between 1700-2000 hours. This is a similar pattern to that found on Campbell Island in November 1987 (Moore and Moffat 1990). The count was during the incubation phase, when breeding birds alternate between incubating the eggs and travelling to sea to feed.

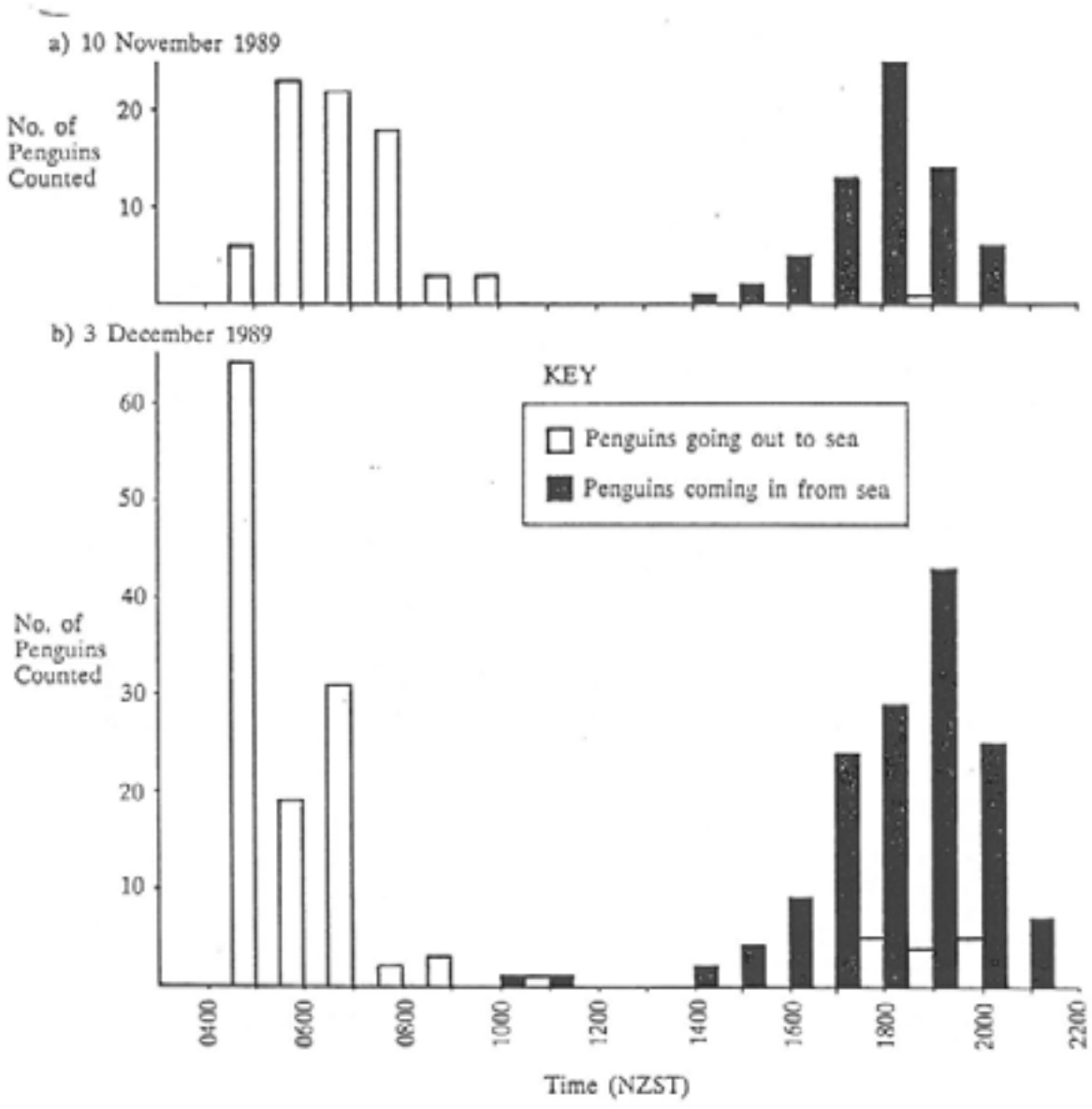
By early December daylight hours had increased, and the departure and arrival peaks were correspondingly further apart. At most nests chicks would just have hatched and therefore the movement pattern of adults was similar to that at the incubation stage. Later in December arrivals and departures should spread throughout the day as breeding partners take alternate trips to sea during the same day (Moore and Moffat 1990). This was beginning to happen by early December, as evidenced in Fig. 2 by the few birds going out between 1700-2000 hours.

3.3 Nesting habitat and breeding cycle

Nests were found at most localities that were surveyed. Twenty-one nests were found by the penguin survey team and several others reported by expedition members. All that were checked had two eggs. Nests were isolated from each other and ranged from the edge of the shoreline vegetation to about 1km inland (Enderby Island). They were backed and sheltered by dense vegetation, tree trunks, logs, gully hollows and, in one case, a cave. Canopy vegetation included rata, *Olearia, Myrsine, Poa litorosa, Stilbocarpa polaris,* and *Blechnum* and *Histiopteris* ferns.

The first pipping of eggs was observed on Rose Island on 27 November 1989, and the first chicks were seen a day later. Pipping was also observed on 30 November on Ewing Island.

FIG. 2: HOURLY COUNTS OF YELLOW-EYED PENGUINS AT SANDY BAY, ENDERBY ISLAND



CHAPTER FOUR: DISCUSSION

A rough estimate of the number of breeding pairs of yellow-eyed penguins on the Auckland Islands can be used to assess the status of the species in relation to the other population centres (Table 2). It appears that the subantarctic islands may have about 60% of the total population. As the South Island population continues to decline, these areas assume increased importance.

TABLE 2: Yellow-eyed penguin population estimate

	70% Breeders[5]		60% Breeders[6]	
	Population Estimate	% Total	Population Estimate	% Total
BREEDING PAIRS on				
South Island[1]	300-320	15-14	300-320	17-15
Stewart Island[2]	470-600	24-26	470-600	26-29
Auckland Islands[3]	620-680	32-30	520-560	29-27
Campbell Island[4]	570-700	29-30	490-600	28-29
TOTAL	**1960-2300**		**1780-2080**	
BREEDERS	3920-4600		3560-4160	
NON-BREEDERS	1680-1970		2370-2770	
TOTAL INDIVIDUALS	**5600-6570**		**5930-6930**	

1. Oct-Dec1989 (Darby in Merchant, in press). A dramatic decline in the number of breeding adults occurred on the Otago Peninsula late in the season, with 30-40% of adults dying (J. Darby, pers. comm.). Therefore, the population level in 1990-1991 can be expected to be much lower.
2. Dec. 1988 (Darby and Seddon, in press). Based on anticipated densities, but some counts have been made, particularly on Codfish Island (estimated 120-150 pairs, J. Darby, pers. comm.). Recent evidence suggests that this estimate may be too high (J. Darby, pers. comm.) and 300-400 pairs may be more realistic (Darby in Marchant, in press). An accurate census is required.
3. Nov-Dec 1989 (this study) approximate estimates. Further counts are needed to refine these.
4. May-July 1988 (Moore and Moffat 1990). There is some evidence for population fluctuation. Although numbers appeared very stable in 1987 and 1988, two landing sites had 73-84% fewer birds using them in 1990 than in 1988 (Moffat pers. comm.). One of these sites has been disturbed by sea lion activity. To what extent this is a local effect and is offset by movement to nearby sites, is uncertain. There was little change in penguin numbers at two other landing sites. Further counts are necessary.
5. A figure of 70% breeding birds has been used to obtain the total population estimate. This is based on Campbell Island data (Moore and Moffat 1990) and recent evidence from the mainland (Darby pers. comm.).
6. A figure of 60% breeding birds has been used to obtain the estimates, based on (1957).

It is difficult to accurately assess the status of the yellow-eyed penguin population on the Auckland Islands on the basis of a brief and incomplete survey of the coastline. Ideally, a more thorough survey would allow seasonal and daily variations in penguin numbers at landing sites to be assessed. Although some allowance for under-estimation has been made, largely on the basis of experience gained on Campbell Island, the estimates are deliberately cautious.

It is probable, therefore, that the Auckland Islands estimate of 500-700 pairs is conservative, despite being more than double the previous estimate of 200-250 pairs (Darby, in DOC 1989, Darby and Seddon, in press) or 250-350 pairs (Darby in Marchant, in press). A full survey of the eastern coastline would probably reveal more than the 100 pairs allowed for in Table 2. If this was the case, the islands would be the largest centre of the world population.

The Campbell Island and Auckland Islands populations are genetically distinct from each other (i.e. there is little migration), and in turn, distinct from the mainland population (Triggs and Darby 1989). The large Auckland Island population is an important finding, as some concern had been expressed at the loss of genetic variation in the smaller sub-populations (Triggs and Darby 1989). The South Island population remains of paramount concern as numbers continue to decline there.

This study confirmed the prominence of Enderby Island as a major centre of the Auckland Islands population. The estimate of 260-360 pairs was much higher than the 140 pairs estimated by Darby (1986). Either he under-estimated or there has been a large increase in numbers of penguins there. The main Auckland Island population was greater than suggested by Challies (1975) and Darby (1984). This indicates that, in some areas at least, predation by pigs and cats may not be significant.

The timing of the breeding cycle appeared to be very similar to that found in on Campbell Island, where the mean hatch date was 26 November (Moore and Moffat 1990). This is later than occurs further north on the mainland, where most eggs have hatched by the first two weeks of November (Darby 1985).

CHAPTER FIVE: RECOMMENDATIONS

Surveys should be conducted for yellow-eyed penguins in areas of the Auckland Islands not covered in this study. A few harbours could be chosen for survey, including some where there have been frequent reports of penguins (e.g. Waterfall Inlet) and others where the population is believed to be sparse (e.g. Haskell Bay).

Index counts at Sandy Bay on Enderby Island by capable visitors (e.g. biologists, management staff) would indicate any major changes to the population level. These should be conducted as frequently as possible. See Appendix 9 for guide to counting penguins. Repeats of counts at other major landing sites would also be very useful.

More detailed studies of yellow-eyed penguin population dynamics and breeding success on the islands would assist in determining the status of the species there.

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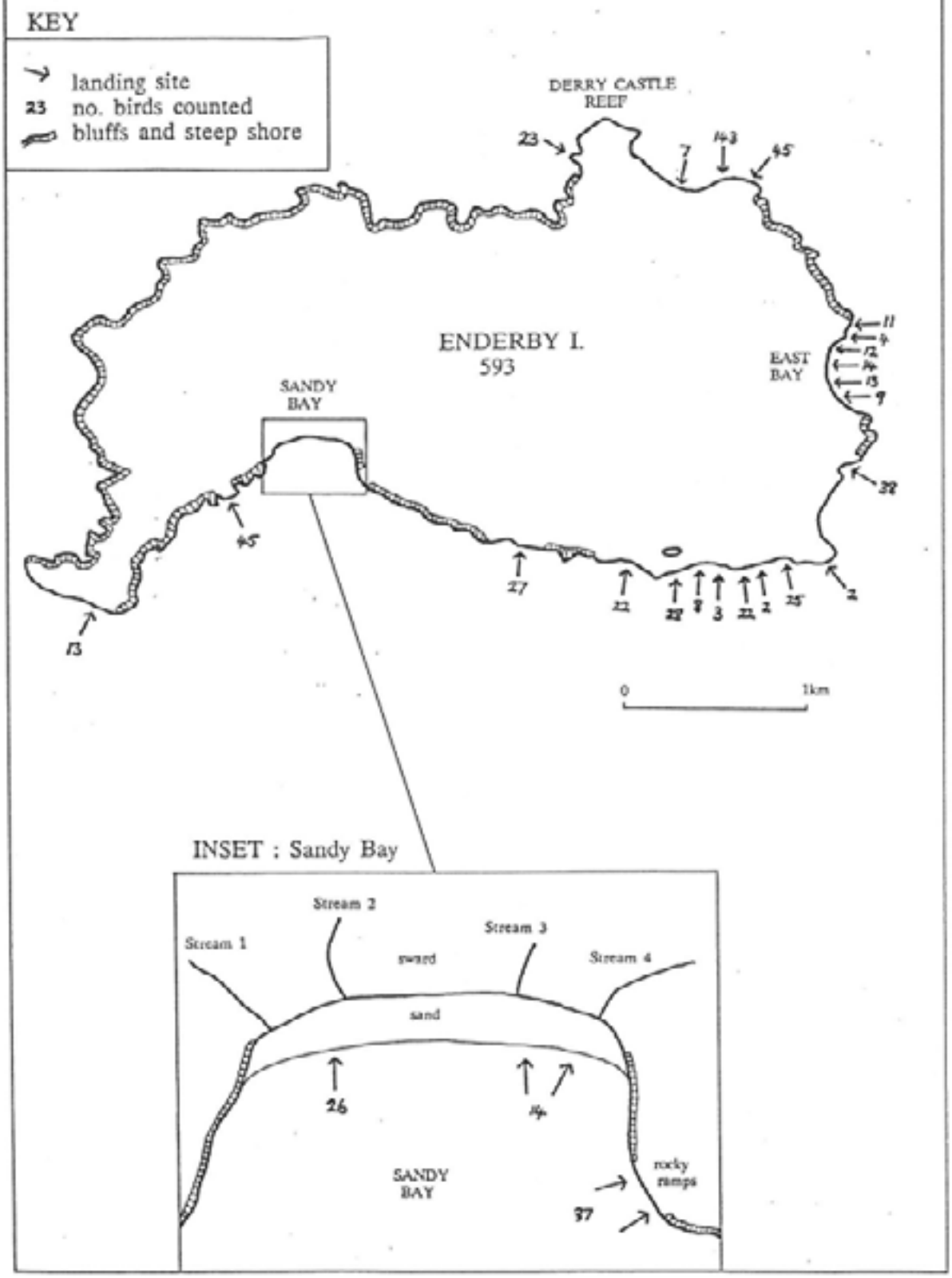
APPENDICES

APPENDIX 1: Yellow-eyed penguin counts at the Auckland Islands Nov-Dec 1989

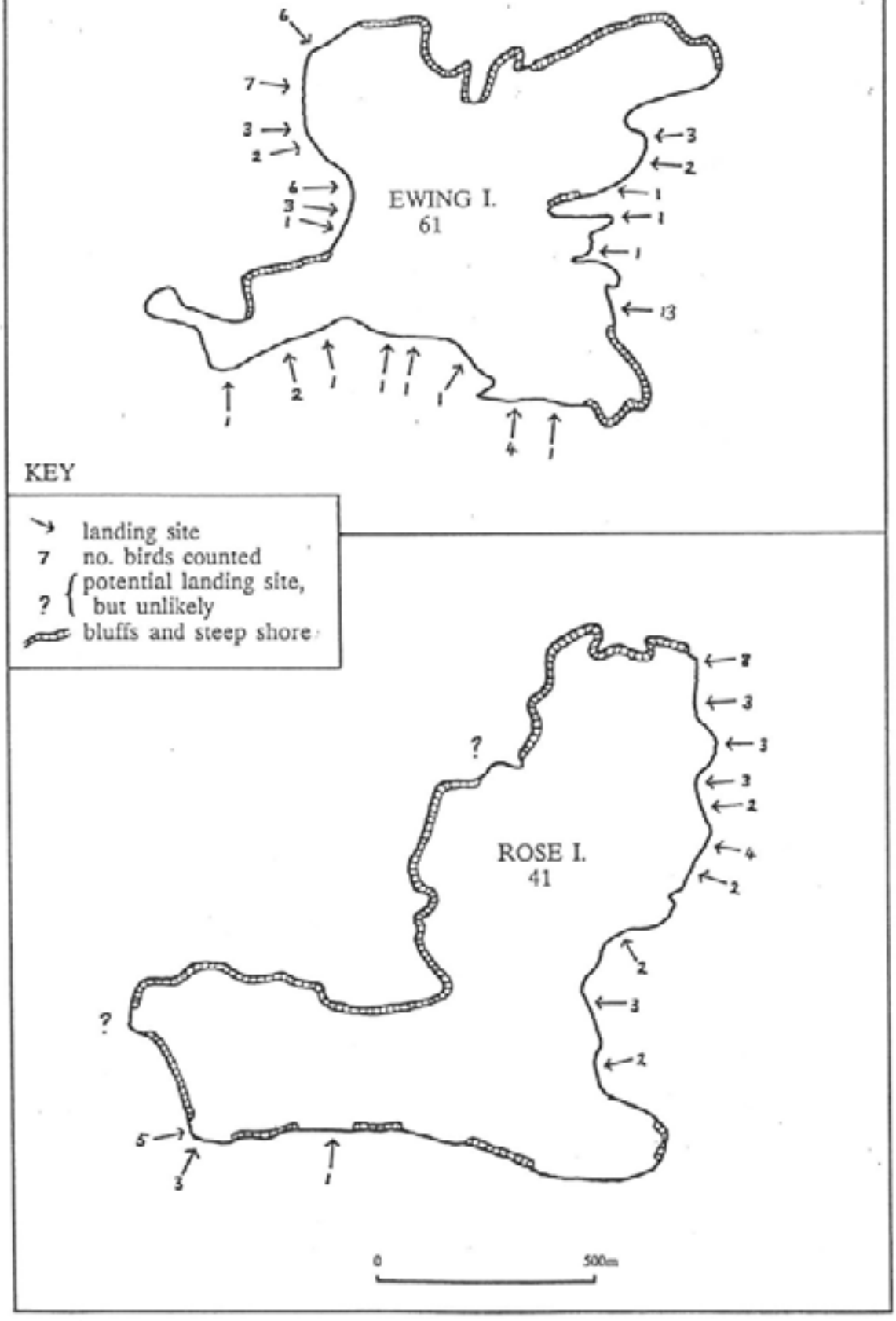
Locality	No. Landing Sites	Ad.	J.	Tot.	Mean No./ Site	OUT -2	Extra Ad.	J.	Grand Total
Enderby Is.	25	581	12	593	23.7	10	13	6	622
Ewing Is.	21	59	2	61	2.9			3	64
Rose Is.	13	40	1	41	3.2	4	4		49
Ocean Is.	1	2+		2+					2+
North Harbour	12	86	2	88	7.3	2			90
Matheson Bay	6	43		43	7.2	1	3		47
Port Ross (north)	7	13+		13+					13+
Webling Bay	9	25	1	26	2.9	4			30
Tagua Bay	2	3+		3+					3+
Adams Island	19	62	2	64	3.4	7	2		73
	115	914	20	934	8.7	28	22	9	993

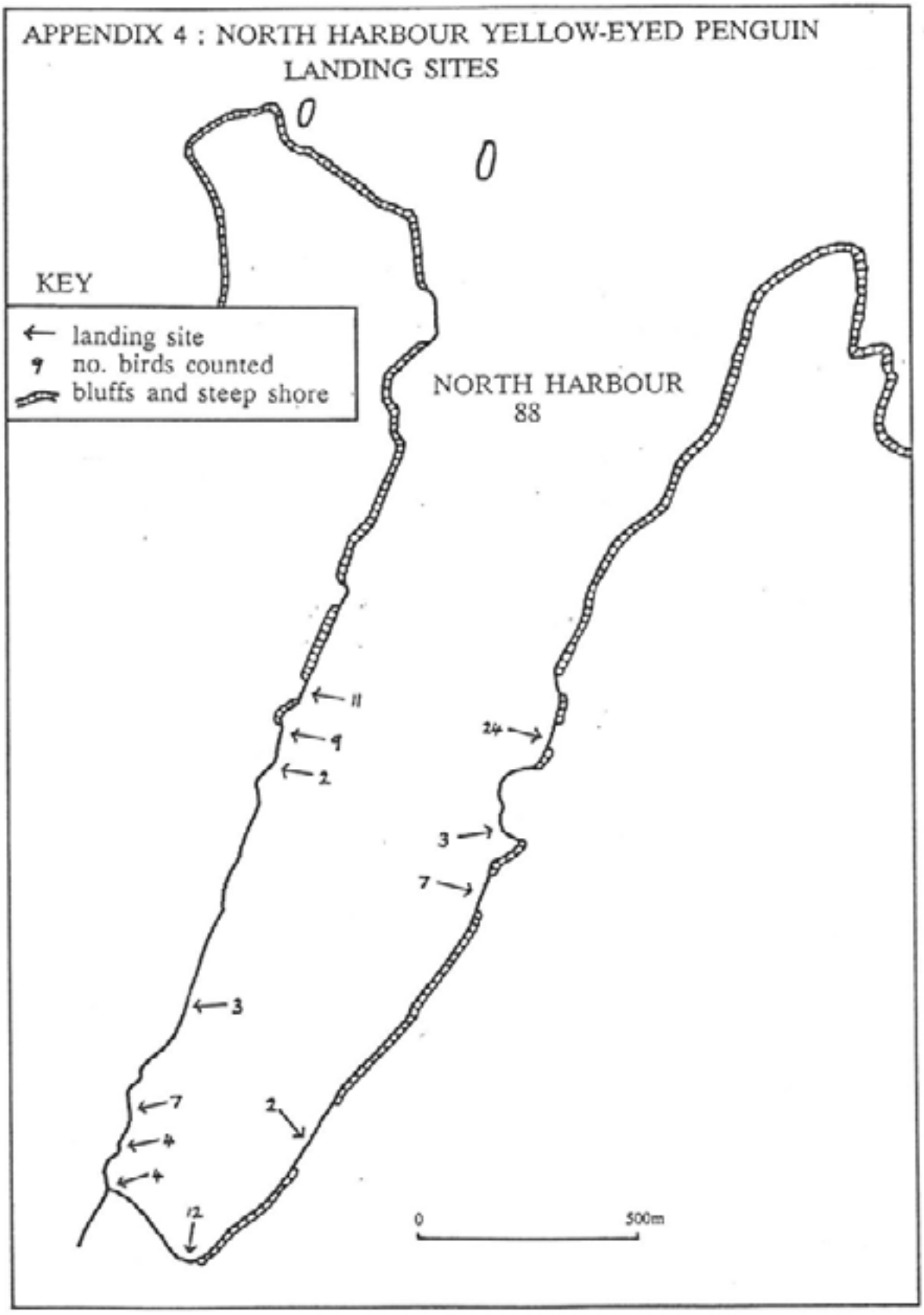
KEY:
Ad. : Adults counted at the landing sites leaving for sea in the morning or arriving from sea in the evening
J :Juvenile
Out-2 : Birds counted going out to sea in the evening, when most were coming in from the sea
Extra Ad. and J.: Additional birds which were seen near the landing sites but did not leave for sea
+ : Minimum number seen or estimated, but area not fully surveyed

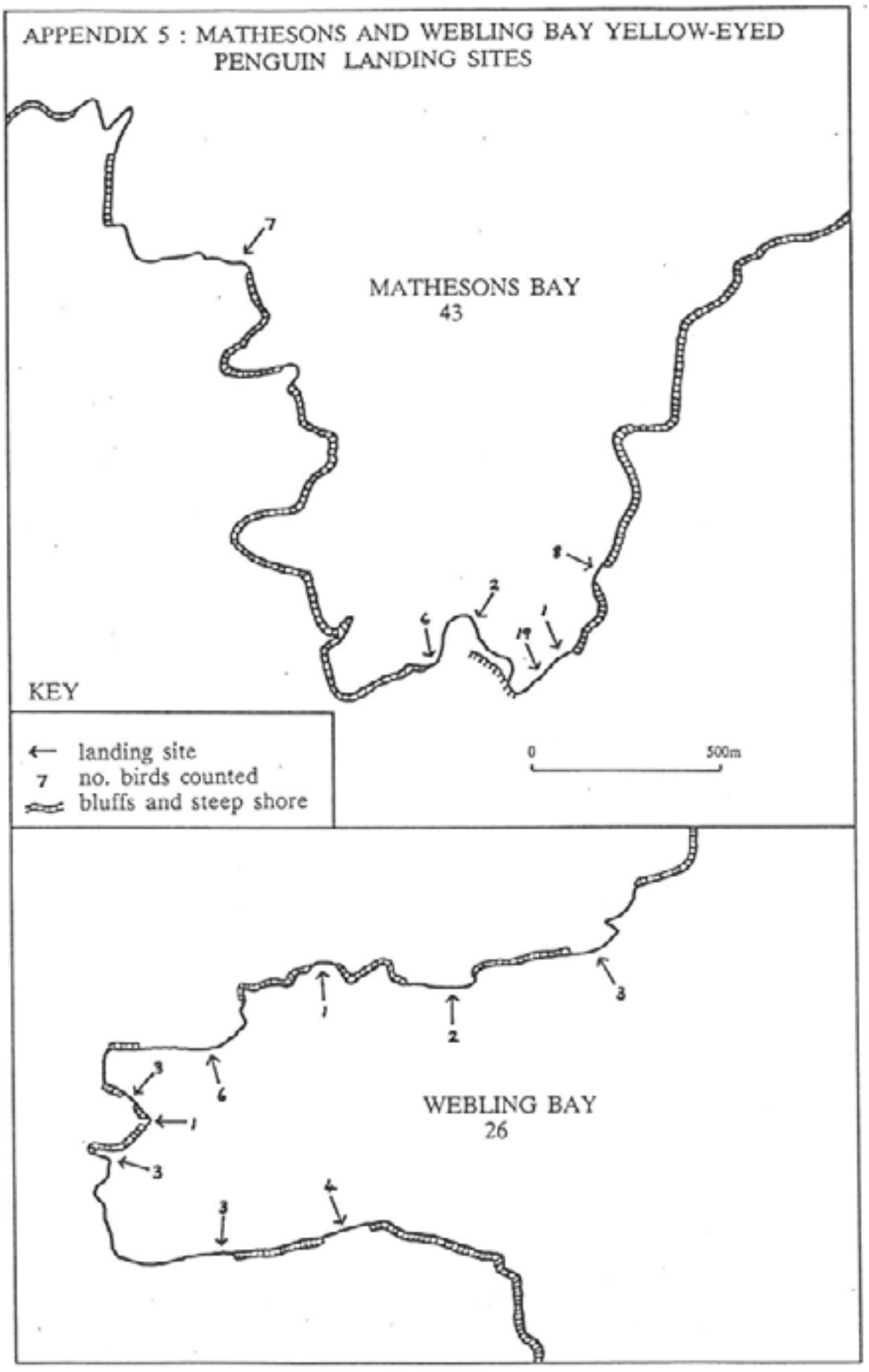
APPENDIX 2 : ENDERBY ISLAND YELLOW-EYED PENGUIN LANDING SITES

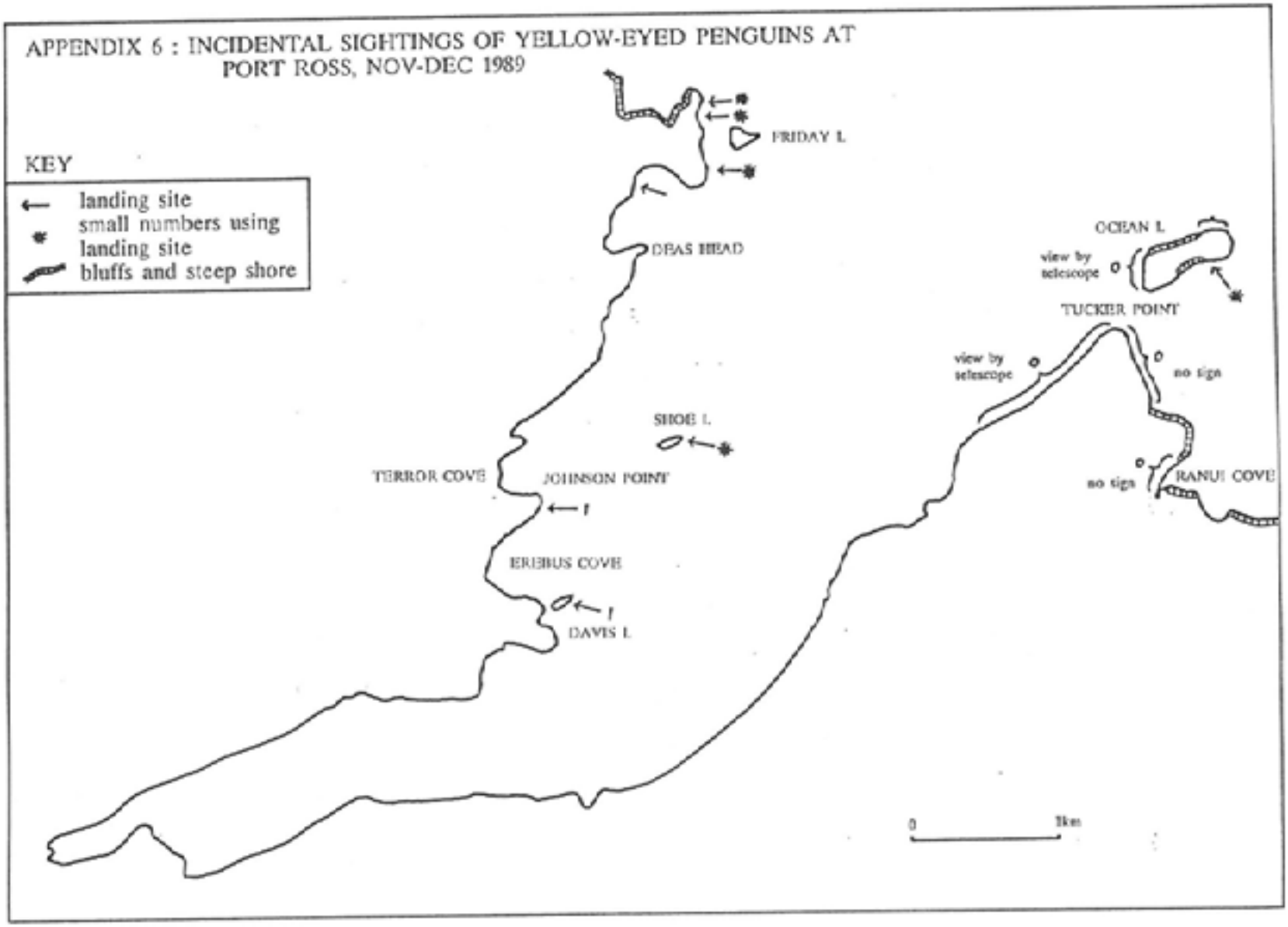


APPENDIX 3 : EWING AND ROSE ISLAND YELLOW-EYED PENGUIN LANDING SITES

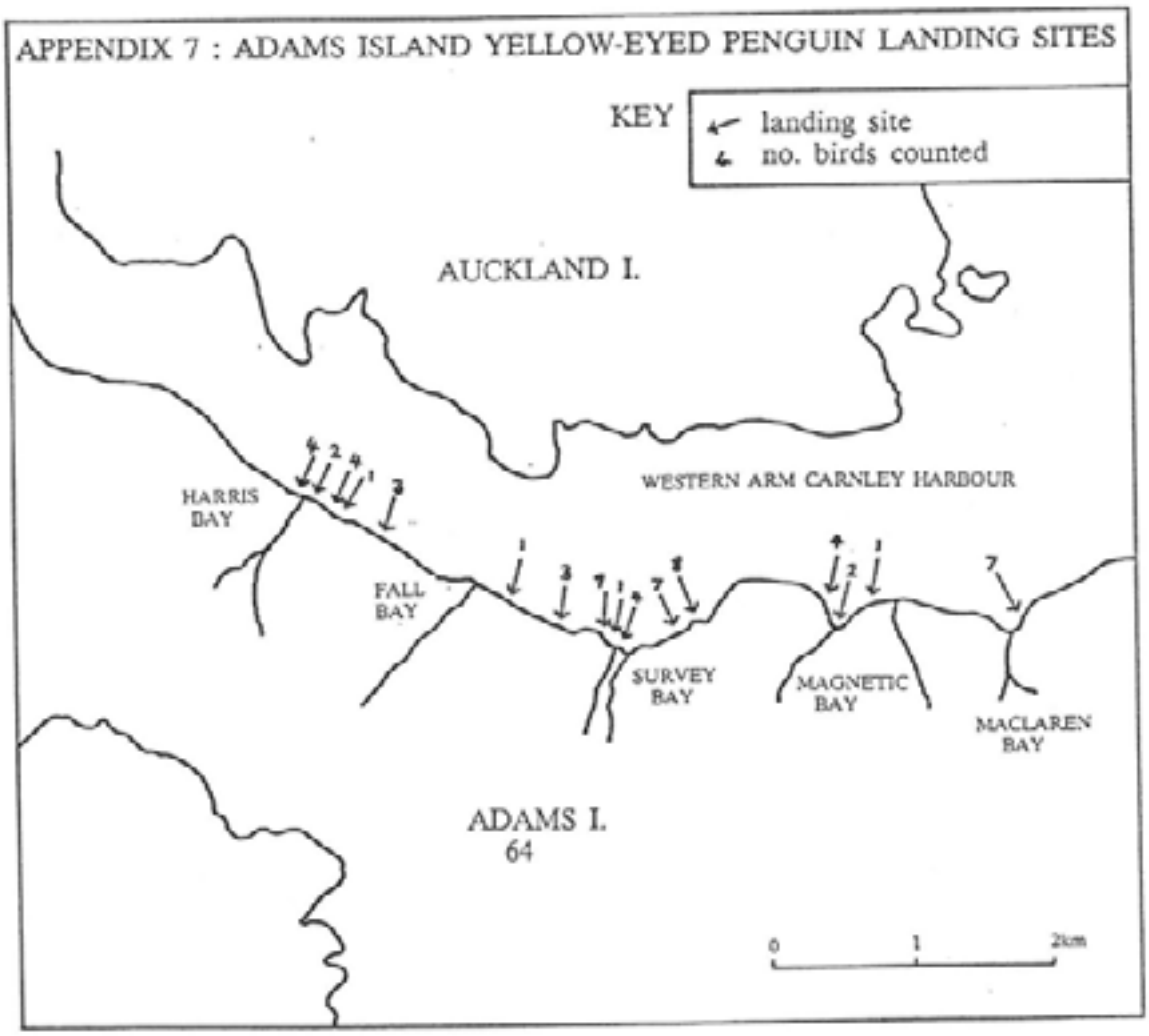



APPENDIX 4 : NORTH HARBOUR YELLOW-EYED PENGUIN
LANDING SITES
KEY
landing site
no. birds counted
bluffs and steep shore
NORTH HARBOUR
88
11
9
2
24
3
7
3
7
4
4
2
12
0
500m


APPENDIX 5 : MATHESONS AND WEBLING BAY YELLOW-EYED PENGUIN LANDING SITES
MATHESONS BAY
43
KEY
landing site
no. birds counted
bluffs and steep shore
0
500m
WEBLING BAY
26


APPENDIX 6 : INCIDENTAL SIGHTINGS OF YELLOW-EYED PENGUINS AT PORT ROSS, NOV-DEC 1989
KEY
landing site
small numbers using landing site
bluffs and steep shore
FRIDAY I.
DEAS HEAD
OCEAN I.
view by telescope
TUCKER POINT
view by telescope
no sign
SHOE I.
TERROR COVE
JOHNSON POINT
no sign
RANUI COVE
EREBUS COVE
DAVIS I.
0
1km

APPENDIX 7 : ADAMS ISLAND YELLOW-EYED PENGUIN LANDING SITES



APPENDIX 8 : Yellow-eyed penguin counts at Sandy Bay, Enderby Island, Nov-Dec. 1989

a. Hourly Totals

Time	10.11.89		3.12.89	
(NZST)	OUT	IN	OUT	IN
0400	6		64	
0500	23		19	
0600	22		31	
0700	18		2	
0800	3		3	
0900	3			
1000			1	1
1100				1
1200				
1300				
1400		1		2
1500		2		4
1600		5		9
1700		13	5	24
1800	1	25	4	29
1900		14	5	43
2000		6		25
2100				7
	76	66	134	145

b. Landing Site Totals Of Adults And Juveniles

Date	Stream 1-2	Stream 3-4	Rock Ramps	Total
10.11.89	OUT-1 24	14	36 + 1J	74 + 1J
	OUT-2		1	1
	IN 21 + 3J	15	27	63 + 3J
3.12.89	OUT-1 51	15	51 + 3J	117 + 3J
	OUT-2 7	2	5	14
	IN 48	22	75	145

KEY
OUT-1:Main departure peak in the morning
OUT-2 :Second departure peak in the evening
IN : Arrival peak in the evening
J: Juvenile
Streams 1-4 (see Appendix 2)

APPENDIX 9: Counting yellow-eyed penguins : A guide for visitors to the Auckland Islands

AIMS : Monitor the population at Sandy Bay on Enderby Island

METHODS : Count all penguins that land or leave from the sandy beach landing sites at Sandy Bay (see Appendix 2). Use binoculars to scan the far end of the beach. If a telescope is available, count the penguins using the rocky ramps at the far eastern end of the bay. The best vantage point is from the boat-house at the western end of the bay.

The most useful times:

mid-November	1500-2100 NZ Standard Time
mid-May	1500-1830 NZ Standard Time

Conduct at least one count. Remain until it seems obvious that no more penguins are coming home (or until you cannot see). If two people are available it would be useful to conduct a count by sharing shifts from before dawn until after dusk. This is especially useful for counts between December and March, when birds move to and from their nests at all times of day.

Record :
a) the number of penguins in each group that come in from the sea (some may go out also);
b) the time each individual or group lands (preferably write these times in NZST or note that the times are in Daylight Time for the summer counts);
c) the landing site used (Use Appendix 2 as a guide, or provide a map to explain symbols used in your notebook);
d) note any juveniles (these have only faint yellow feathers on the side of the head whereas adults have a bright yellow band across the back of the head);
e) total numbers for the count.

Example:

Time	Stream 1-2	Stream 3-4	Rocky Ramps	Cumulative Total In	Cumulative Total Out
1520	1 Ad out				1
1540	1 Ad in		1	2	
1555	1 Ad out	2 Ad in		4	2
1603	1 Juv in			4 + 1J	
1608	3 Ad		6 + 1J	7 + 2J	
1610	2 land but retreat from sea lion				
1615			3	10 + 2J	

Send results to Peter Moore, DOC, PO Box 10-420, Wellington.