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YELLOW-EYED PENGUIN RESEARCH AND MONITORING STUDIES 1990-1991

Compiled and edited by

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CONTENTS

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ABSTRACT

The report contains five papers on recent research on Yellow-eyed Penguin: results of a pilot study on marine-based activities (Moore, Douglas, Mills, McKinley, Nelson, Murphy), and work on Banks Peninsula (Dilks, Grindell), Stewart Island (King), the South Island (Darby, Paterson), and Campbell Island (Moore, Moffat).

PART 1

RESULTS OF PILOT STUDY (1990-91): MARINE-BASED ACTIVITIES OF YELLOW-EYED PENGUIN

by

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SUMMARY OF PART 1

1. Study areas were set up and techniques tested in a pilot study of yellow-eyed penguin marine activities during the 1990-91 breeding season.

2. The activity pattern of six radio-tagged birds at Boulder Beach was monitored in late February 1991 using an automatic data-logger system. Some birds travelled to sea every day, others stayed at sea for 2-3 days or stayed on land for a day.

3. Foraging ranges of radio-tagged birds were estimated by hand-plotting triangulations of bearings from land-based receiving stations (Cargill's Castle and Sandymount), approximately 15 km apart on the Otago Peninsula. There was wide individual variation, with little overlap between the main areas of activity. Overall, birds travelled 3-25 km offshore or 5-35 km from the breeding area, usually using waters 30-70 m deep.

4. "Foraging" type dive sequences included average dive times of 2 min. 39 sec. followed by surface times of 41 sec. "Travelling" type dive sequences included average dives of 35 sec. followed by 21 sec. on the surface.

5. Opalfish was the most numerous fish species eaten in February 1991, followed by red cod, squid, triplefins and warhou. Krill were recorded for the first time.

6. Breeding success at Otago was moderate (0.7 chicks/nest) and at Catlins it was low (0.3 chicks/nest) apparently due to higher levels of chick predation and starvation.

7. Chick fledging weights were moderate, 5.6 kg at Otago and 5.2 kg at Catlins.

1.1 INTRODUCTION

The yellow-eyed penguin (YEP) is one of the most endangered penguin species in the world. The breeding range is from Banks Peninsula to Campbell Island. For at least fifty years the South Island population has been declining. A number of land-based problems have been identified, including the loss of nesting habitat through gradual clearance of coastal forest, deterioration of the remaining habitat through overgrazing by domestic stock, and predation of adults and nestlings by introduced stoats, ferrets, cats and dogs.

A large amount of data has been collected since 1979 by J. Darby (Otago Museum) on these factors and the population dynamics of the species. There may once have been thousands of pairs of yellow-eyed penguins breeding on the South Island coast but by 1985-86 there were only 600-620 pairs (Darby & Seddon 1990).

The YEP is apparently adapted to a reliable year-round food supply within close proximity of the coast, and does not cope well with changes to the food supply (van Heezik 1988). Since the mid 1980s there have been three seasons of poor breeding success or low adult survival which appear to have been associated with marine-based problems. The frequency of poor seasons may be increasing (van Heezik 1990). In 1985-86 starvation and mortality of penguins on the Otago coast was apparently caused by shortage of preferred prey species (van Heezik 1988, 1990). In 1987-88 there was a further major decline in the numbers of birds breeding, probably because of low food abundance (Darby & Seddon 1990). Late in the 1989-90 season 30-60% of breeding adults died on the Otago Peninsula. The causes were unclear. As many adults were in reasonable condition when they died (J. Darby pers. comm.), starvation could not have been the only factor involved. By 91 there were only about 170 pairs breeding on the South Island (J. Darby pers. comm.). Population changes in other parts of the range are not well documented as censuses are either incomplete or there is little detailed monitoring. There is evidence for a decrease in penguin numbers on Campbell Island (Moore in press).

Methods for ameliorating the land-based problems faced by the species have been proposed, mainly involving nesting habitat protection or modification (Department of Conservation 1989). The large die-off of adults in 1989-90 highlighted deficiencies in our understanding of how YEP use the marine environment, and what factors at sea might be affecting them. Van Heezik's (1988, 1990) work provided valuable baseline data on annual, seasonal and regional variation in the YEP diet. Little was known about penguin foraging zones, although there was evidence that they dived to depths of 19-56 m (Seddon & van Heezik 1989).

In order to better understand YEP marine activities, Science & Research Division (DOC) proposed a three-year study of the species in the South Island-Stewart Island sub-population, which would dove-tail in with other studies. It was hoped to look closely at the interactions of foraging patterns, diet, chick growth, breeding success and sea temperatures. An initial pilot study, the results of which are presented in this report, tested techniques to be used in future years.

1.2 AIMS

a) Test techniques of radio-telemetry for estimation of foraging range and time spent at sea on Otago Peninsula
b) Familiarise with stomach pumping method of diet sampling on Otago Peninsula
c) Monitor breeding success chick weights at Otago and Catlins study areas

1.3 METHODS

1.3.1 Radio Tags

Radio tags were put on six penguins at Boulder Beach (A1 Section) on 25-28 January 1991. The birds included two breeding pairs, another breeding female and a non-breeding adult female (Table 1.1). At this time breeding birds were feeding large chicks.

Table 1.1 YEP used in radiotelemetry 1991

Nest No.	Sex	Band	Frequency
1	Female	J10549	410
2	Male	J4585	160
2	Female	J10188	436
3	Male	J6024	210
3	Female	J10548	310
Nonbreeder	Female	J6036	485

Radio tags were applied to feathers of the lower back using a contact adhesive "Loctite 401". Two birds were tagged for a few days, to monitor the effects on their behaviour, before the other four birds were tagged. The transmitters were manufactured and packaged by Sirtrack Electronics, DSIR, Havelock North. They measured 70 mm x 35 mm x 10 mm, with a 280 mm vertical aerial, and weighed c.42 g. Each unit contained a one milliwatt transmitter, pulsed at 80 pulses per minute, and was powered from three 750 mA/hr lithium batteries in series, which provided a battery life of about six weeks.

Packages were removed on 12 February 1991 by peeling away from the feathers, leaving a thin layer of old glue on the feathers.

1.3.2 Activity Pattern

An automatic data-logging station was set up overlooking the Boulder Beach (A1) study area to record the presence or absence of transmitter signals. The station had a fixed single array of element "Yagi" antenna on a 2.5 m mast. A wooden box at the base of the mast contained a "Control-03" data-logger[1], a "Telonics TDP-2" data processor[2], a "DOC-17" Controller[3] and a battery. This system logged the signal strength of each frequency, including a stationary test transmitter every 14 minutes. Light intensity was also recorded. Thus the presence of each bird in the breeding area and the time of departure and arrival to and from the sea was logged throughout a 24 hour period. This data was down-loaded via a serial communications port onto a portable "Toshiba" computer every two days from 26 January to 8 February 1991. Analysis was completed using a computer program to convert pulse amplitude and period to presence and absence records.

1.3.3 Foraging Range

To track bird movements at sea, receiving stations were set up approximately 15 km apart on the Otago Peninsula coastline, near Sandymount trig (319 m) and Cargills Castle (c100 m). At each station a dual array of 5-element "Yagi" antennae was mounted on a 3.25 m mast, similar to Hallberg *et al*. (1974). The antenna arrays were vertically polarised and wired 180° out of phase using ¼ wavelength baluns. The feeder line was coaxial cable. The mast was 42 mm galvanised steel water pipe guyed at a rotating collar about 2.5 m above the ground using polypropylene rope. The mast fitted into a steel sleeve at the base and small handle-bars were used to rotate the mast on its axis. An adjustable 15 cm diameter protractor rose, marked in degrees, was clamped over a

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graticule mounted in the base. A tent at the base of the tower provided shelter for the operators. "Wildlife Materials Falcon V" biotelemetry receivers were used.

Radio-directions were determined by locating the null between the two main peaks of signal amplitude. The quality of the null was variable and probably depended on a number of factors such as transmission path, reflections and weather conditions (Lloyd 1988). Bearing estimates were recorded by the observers to the nearest 0.5^{o}. These bearings were relative to radio-directions of three land-based reference transmitters at each station. The compass rose was re-adjusted each day to decrease the chances of observers memorising the relative positions of reference transmitters. Directions from the stations and the reference transmitter positions and visible trig points were surveyed by theodolite on 31 January. A series of directions to a transmittered dummy duck being towed by a boat was determined simultaneously by radiotelemetry and optically by theodolite on 1 February 1991.

Penguins were radio-tracked for 4-16 hours per day from 29 January to 6 February and 12 February. Observers at each station were in radio contact so fixes on each penguin could be taken at similar times. Receiving was only possible when penguins were on the water's surface between dives. The six frequencies were listened for in a sequence of three pairs; on the hour, 20 minutes past and 40 minutes past the hour. Once accurate fixes were made for each pair of frequencies sequences of dive and surface times were recorded until it was time to listen for the next set of birds.

Foraging ranges were later estimated by plotting by hand the hourly radio-directions of each transmitter from the two stations. The lines intersection estimated the position of the penguin at sea.

1.3.4 Diet

Diet samples were collected from 9 birds, including 5 telemetered birds, at Boulder Beach (A1) on 11-12 February 1991. The stomach pumping technique followed that described by Wilson (1984) and used on YEP by van Heezik (1988). Penguin stomachs were filled with water using a hand pump and 5 mm diameter plastic catheter and they were stimulated by pressure to the abdomen to regurgitate into a bucket. This was repeated until no further prey remains were flushed out. Penguins were then fed black dory fish fillets as a replacement meal. Samples were sieved in a muslin bag and frozen for later analysis. In the laboratory intact prey items were measured. Fish otoliths were dissected from intact skulls. Other flesh and prey remains were broken up by high water pressure and sieved through 3 mm, 850 m and 212 m meshes for ease of sorting. Contents of each sieve were sorted on a black tray to retrieve fish otoliths, squid beaks and invertebrate remains. Otoliths were separated into left and right sided and identified to species using the reference collection of van Heezik (1988).

1.3.5 Breeding Success

Three breeding areas on the Otago Peninsula (Boulder Beach A1 and Highcliff, Sandfly Bay) and two areas at Catlins (Hayward and Long Points) were monitored. Nests were found in September-October, adults banded and measured if necessary and weekly visits made until March 1991.

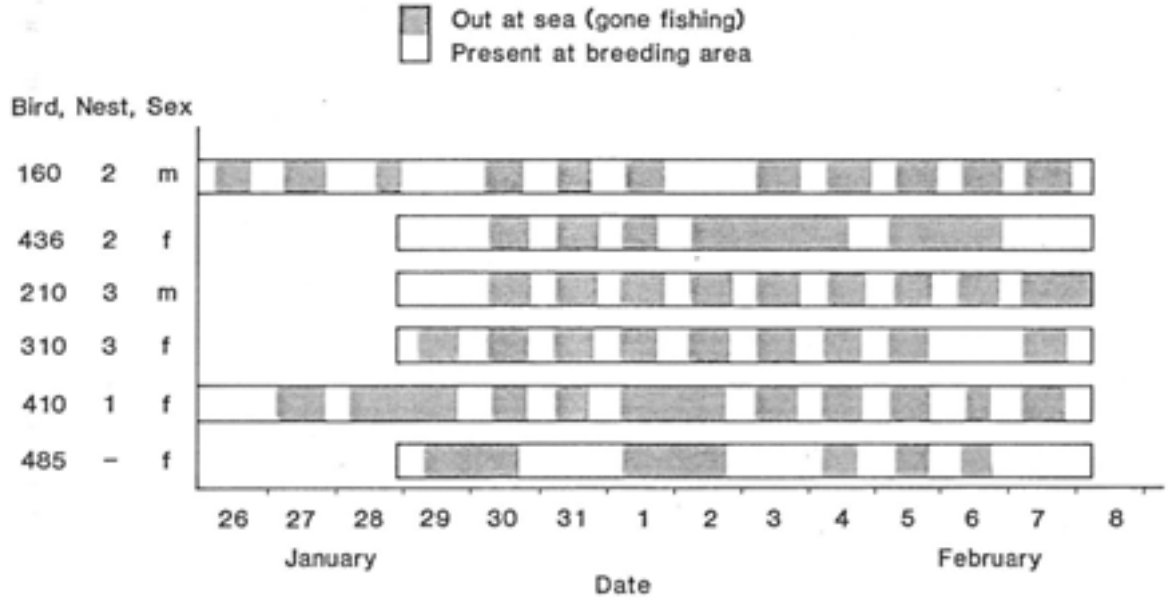
1.3.6 Chick Growth

Chicks were weighed every week until fledging

1.3.7 Sea temperatures

Sixteen satellite photographs of sea surface temperatures from the Otago-Catlins coastline during September 1990 -February 1991 were selected from DSIR Physical Sciences Division records.

Fig. 1.1 Presence/Absence of YEP from Breeding Area



1.4 PRELIMINARY RESULTS

1.4.1 Activity Pattern

Fig 1.1 shows the presence and absence of birds from the breeding area. Overall there was a wide individual variation in activity. The usual pattern was to leave for sea at dawn and return at dusk. Some birds, such as the breeding pair 210-310 followed this pattern on a nearly daily basis. Bird 160 usually travelled to sea every day but twice in 13 days of logging it stayed ashore for a day. Its partner 436 had two trips offshore for 1-2 nights (i.e. a 2-3 day trip to sea). Bird 410 also usually did day-trips to sea but had two overnight trips. The non-breeder 455 at first alternated staying offshore for a night with staying ashore for a day, then made three daily trips to sea.

1.4.2 Telemetry errors

Factors which cause error in estimates of radio bearings include reading errors of the compass; precision limitations (e.g. compass rose marked to nearest degree, difficulties of holding equipment steady in high winds); quality of null as influenced by signal reflections, transmission path, weather; individual variation in observer ability.

Errors during the sea tests are in Table 1.2. These show the difference in expected angles between the dummy duck being towed at sea and the calibration transmitters on land (determined by theodolite bearings) and the observed angles (determined by radio telemetry). The third calibration transmitter at Cargill's Castle (Tx134) was faulty at the time, so is not included in the table. Tx262 was difficult to survey accurately because it was obscured by vegetation, so its results were ommitted from the final Sandymount total. The overall bias was low and the overall standard deviation was about 1^{o}. The standard deviations of the four best calibration transmitters was 0.1-0.81^{o}. The angular precision of radiobearings is analagous to a torch beam from each station. Any point of intersection of radiobearings from the two stations can be represented by an ellipse, which area where the bird is likely to be located, with 95% confidence. As penguins travel further out to sea the length of the ellipse increases, thus accuracy decreases. This has represented in Fig. 1.2 as a contour plot of linear error assuming a standard deviation of both stations (after Lloyd 1958). It can be seen from this plot that the most accurate area is the right-angle intersection from both stations, about 6 km offshore, where birds will be within 500m (the approximate length of the semi-major axis of the 95% error ellipse, which will be almost circular) of the intersection points. Outside this zone, up to about 13 km offshore, the error eclipse semi-major axis will be less than 1 km long. By the time birds are 34 km offshore the error axis will have increased to 5 km long, and the ellipses will be about 10 km long and relatively narrow. Examples of these ellipse types are shown in Fig. 1.2. If the best calibration transmitters gave figures of about 0.5^{o} error from both stations the plot accuracy would improve. There would be a circle about 6 km offshore where the semi-major axes of ellipses were 250 m long, at 13 km offshore they were 500 m, at 20 km they were 1 km, and at 45 km they were 5 km long. These types of plot approximations must be born in mind when interpreting the plots of birds at sea (Figs. 1.3-1.6).

Fig. 1.2 Contour plot of linear error around Otago Peninsula radio-telemetry stations. Contours are the length in kilometres of the semi-major axis of the 95% error ellipse around the true location of a penguin, based on a standard deviation in angular error of 1° at each station. The grid has 10 km squares. Some examples of error ellipses are illustrated.

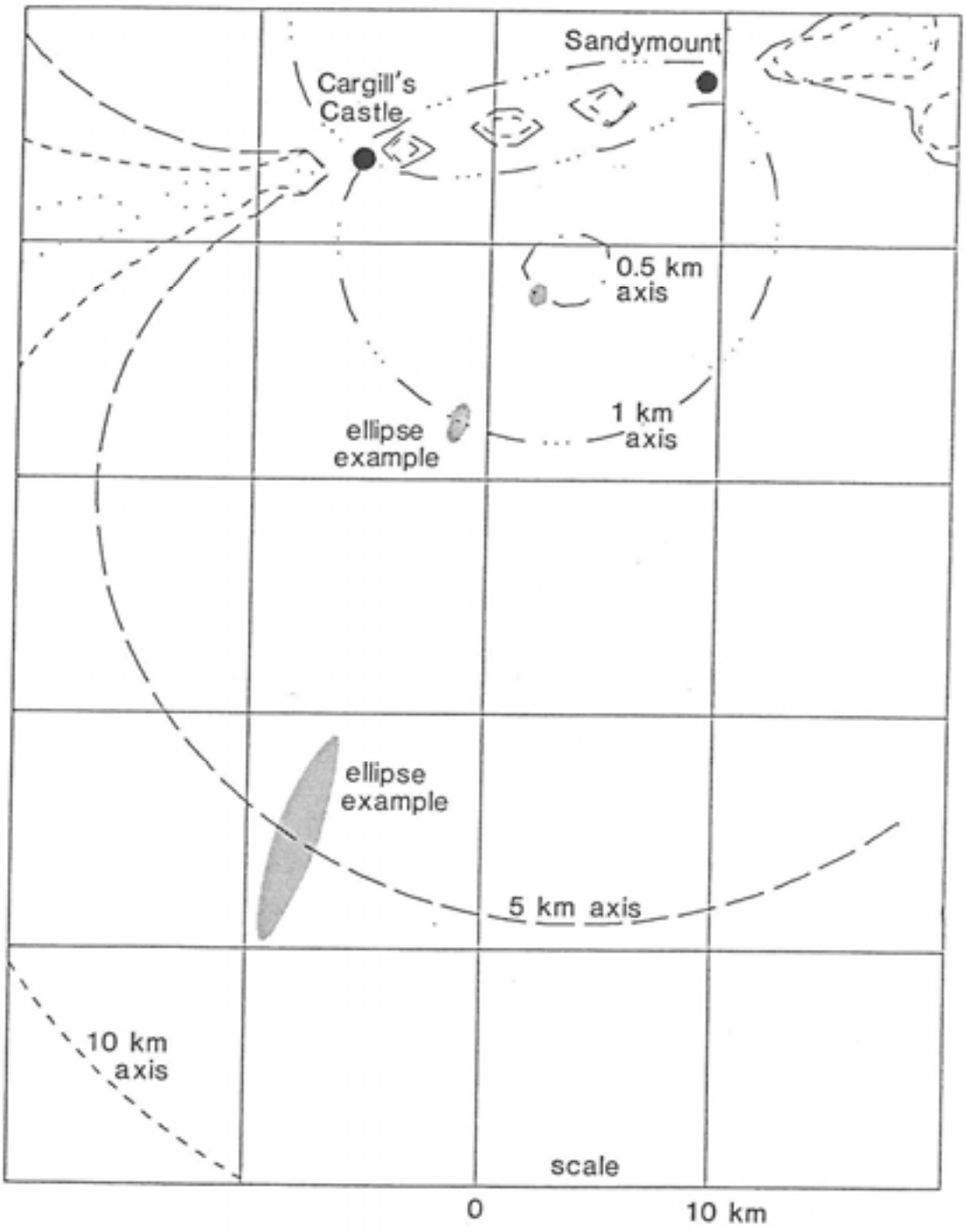


Fig. 1.3 Estimated tracks of radio-tagged YEP at sea on 5 February 1991. Penguin locations were estimated by the hand-plotted intersections of radio bearings to Cargill's Castle and Sandymount receiving stations (see Part 1.4.2, Fig. 1.2 for description of errors). Isobaths were estimated from Carter (1986).

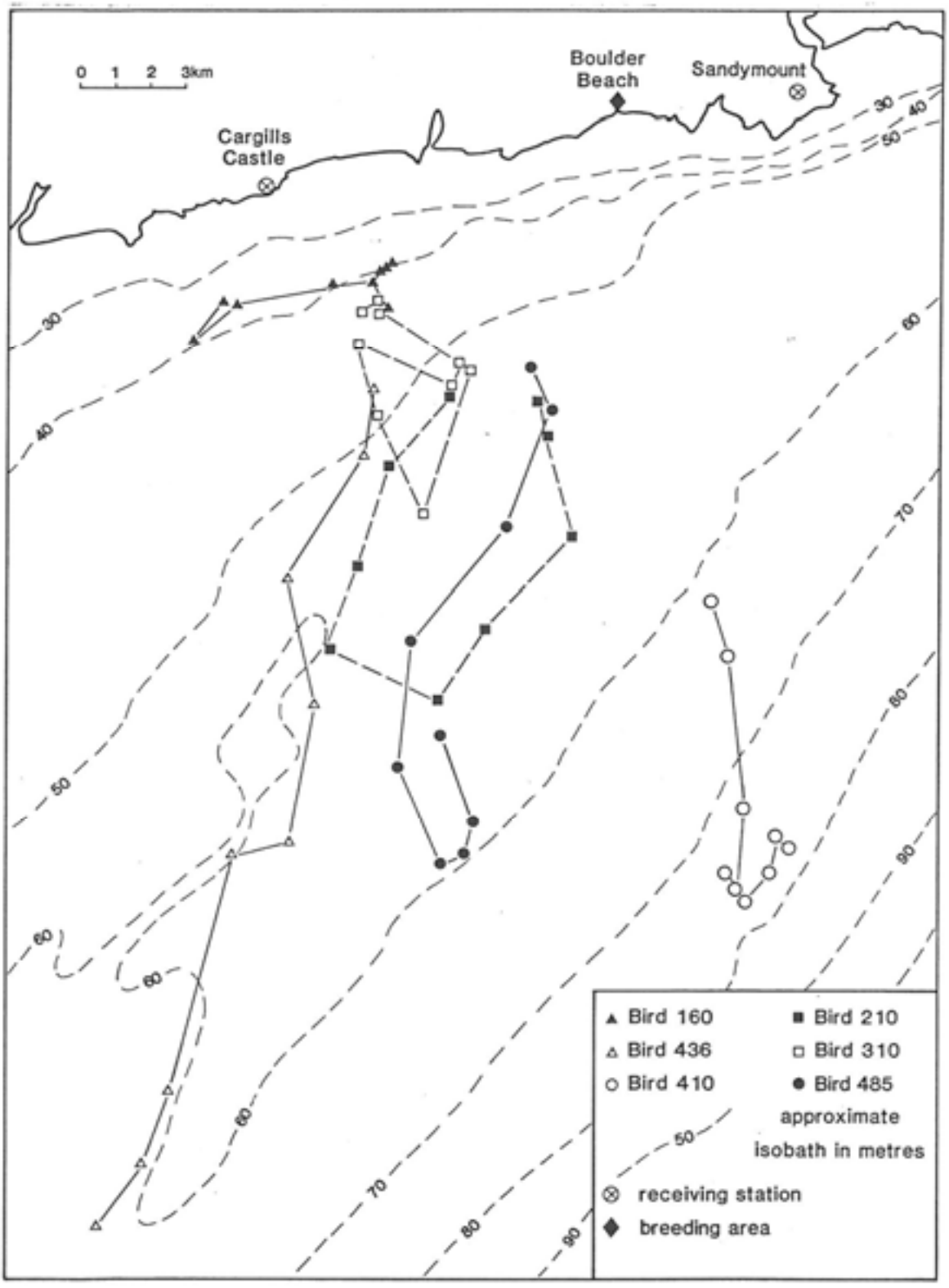


Fig. 1.4 Estimated Foraging Ranges of radio-tagged YEP breeding pair (160, 436) from Boulder Beach, Otago Peninsula during 10 days of Jan.-Feb. 1991. Penguin locations were estimated by the hand-plotted intersections of radio bearings to Cargill's Castle and Sandymount receiving stations (see Part 1.4.2, Fig. 1.2 for description of errors). Isobaths were estimated from Carter (1986).

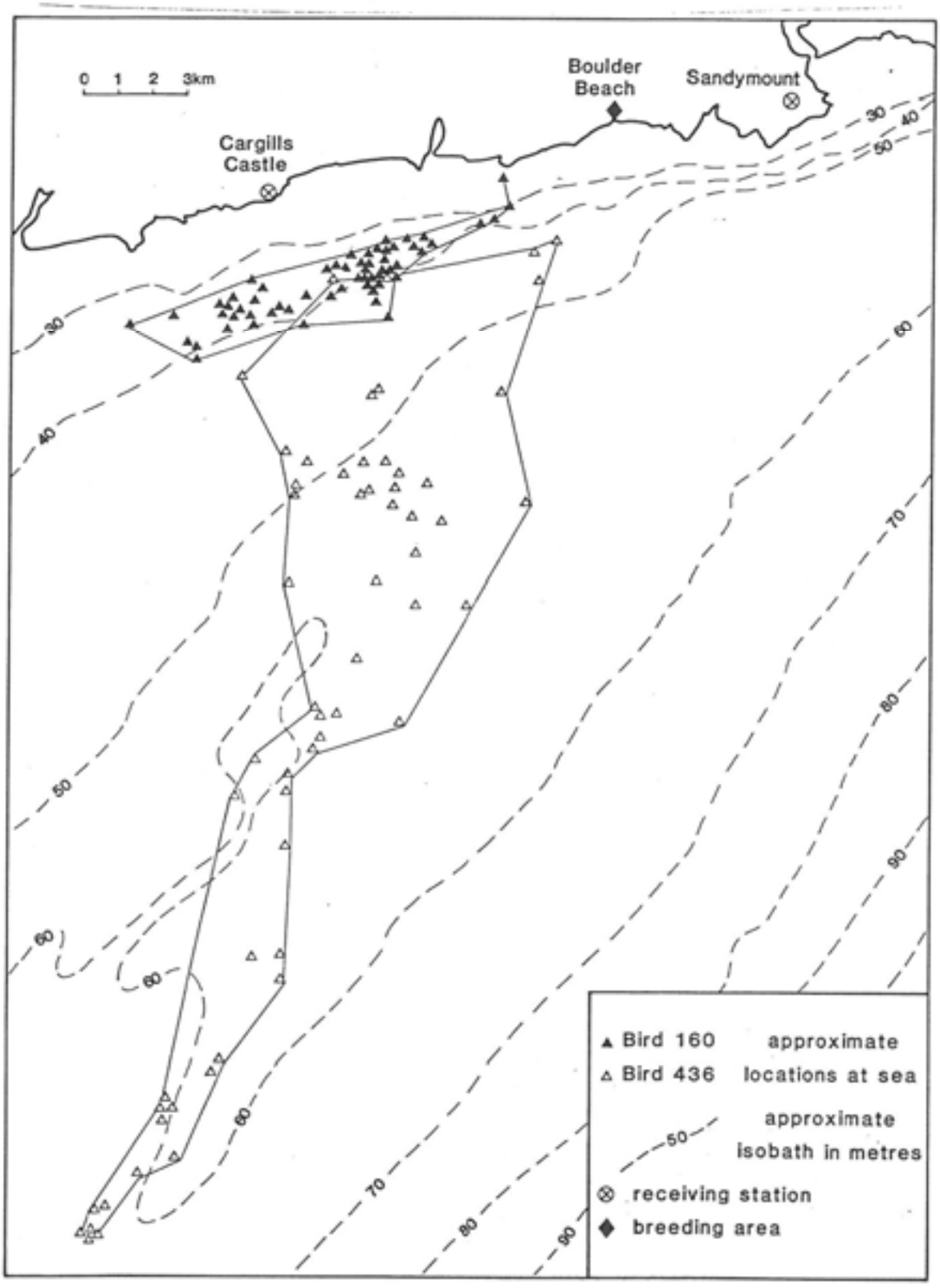


Fig. 1.5 Estimated Foraging Ranges of radio-tagged YEP breeding pair (210, 310) from Boulder Beach, Otago Peninsula during 10 days of Jan.-Feb. 1991. Penguin locations were estimated by the hand-plotted intersections of radio bearings to Cargill's Castle and Sandymount receiving stations (see Part 1.4.2, Fig. 1.2 for description of errors). Isobaths were estimated from Carter (1986).

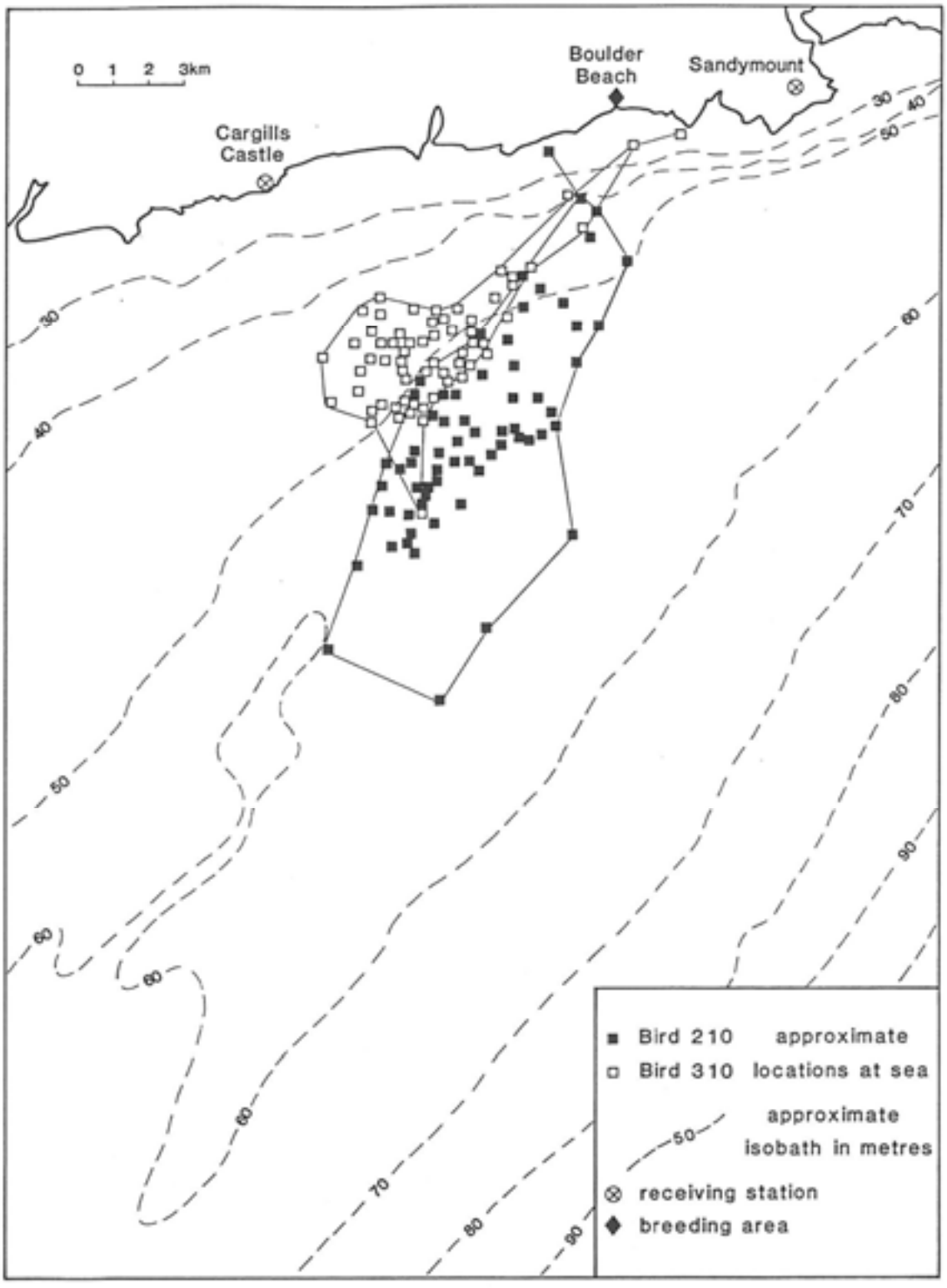


Fig. 1.6 Estimated Foraging Ranges of radio-tagged YEP breeding female (410) and non-breeding female (485) from Boulder Beach, Otago Peninsula during 10 days of Jan.-Feb. 1991. Penguin locations were estimated by the hand-plotted intersections of radio bearings to Cargill's Castle and Sandymount receiving stations (see Part 1.4.2, Fig. 1.2 for description of errors). Isobaths were estimated from Carter (1986).

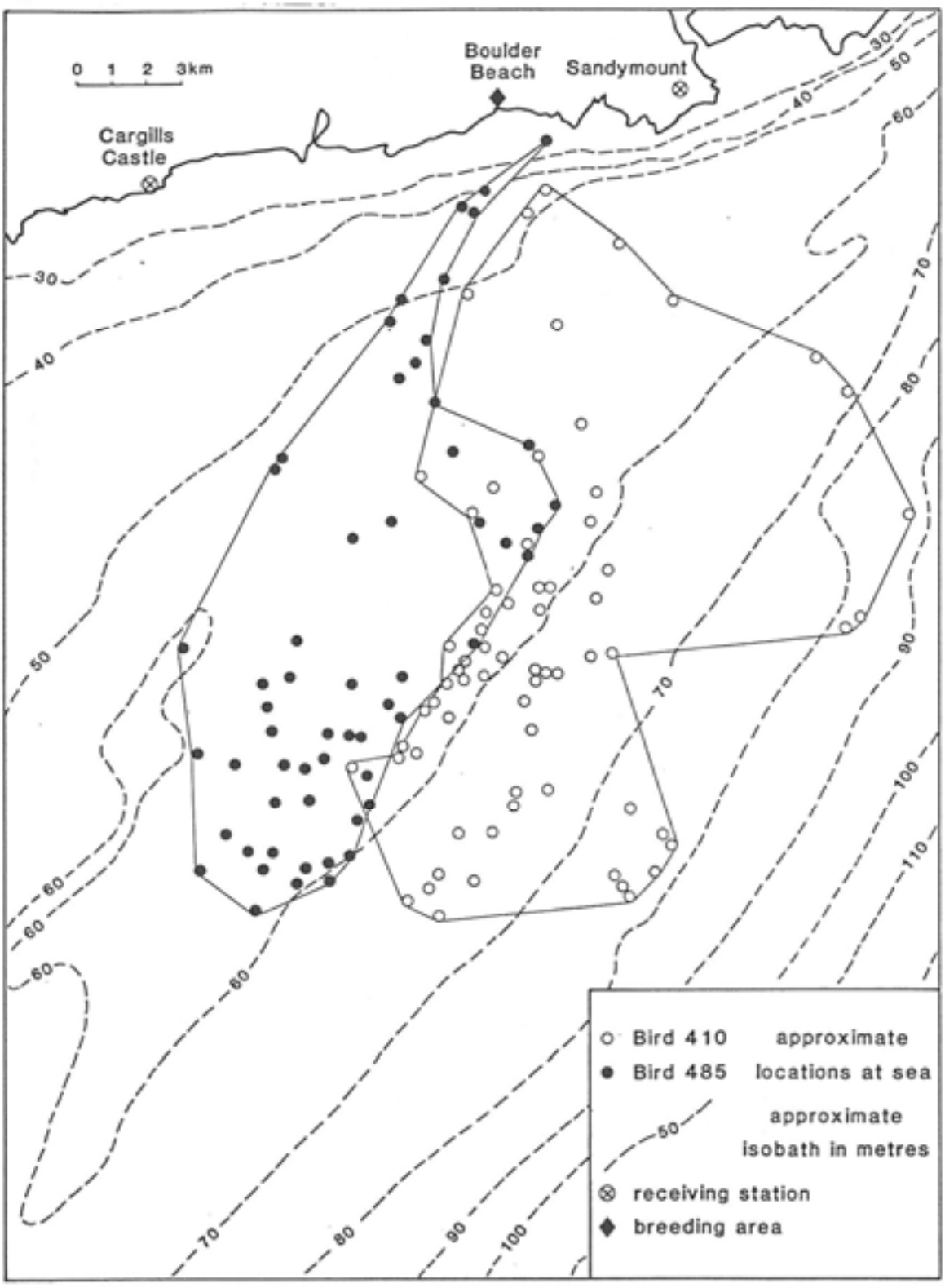


Fig. 1.7 Weight of YEP chicks at Otago Peninsula and Catlins, 1990-91. Mean weights for 7 day intervals of known-age chicks that fledged are graphed separately (Otago N=15, Catlins (N=6) from those that died or were hand-reared at both areas (N=14).

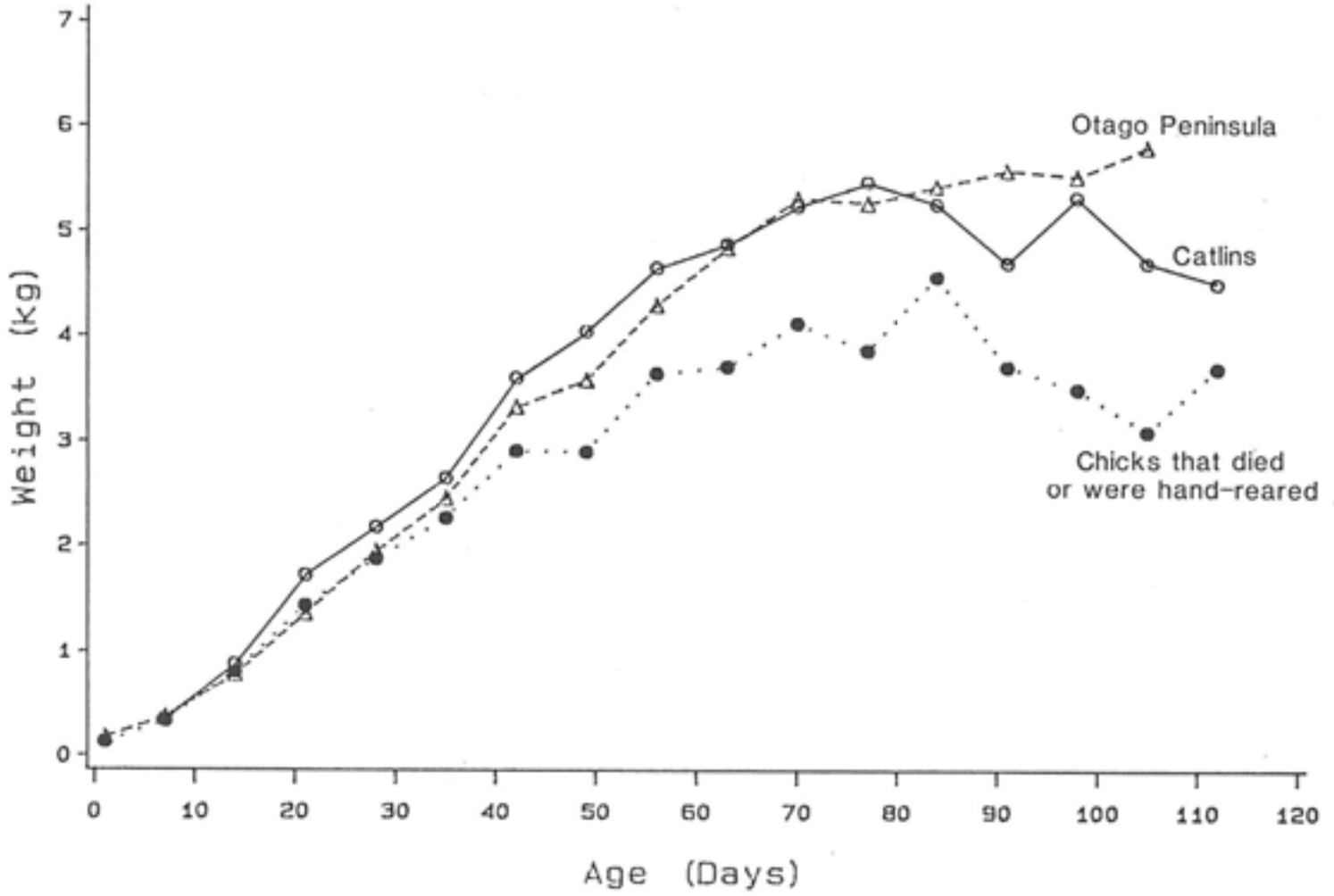


Table 1.2 Bias and error during sea tests of radio telemetry, Otago Peninsula, Jan-Feb. 1991

Mean Bias S.D.(degrees) and N in radio and surveyed directions when angles between dummy duck and calibration transmitters (tx) are compared

Cargill's Castle

	tx386			tx831			Observer Total		
	mean			mean			mean		
Obs.	bias	S.D	N	bias	S.D.	N	bias	S.D.	N
A	-0.43	0.2	9	0.55	0.2	9	0.06	0.54	18
B	-0.46	0.48	8	1.52	0.48	8	0.53	1.12	16
C	-0.96	0.57	5	1.52	0.57	5	0.28	1.41	10
Total	-0.56	0.45	22	1.12	0.62	22			
Castle Total (tx386+831)				0.28	1.01	44			

Sandymount

	tx185			tx588			tx262					
	mean			mean			mean			mean		
Obs.	bias	S.D.	N	bias	S.D.	N	bias	S.D.	N	bias	S.D.	N
D	-0.57	1.03	10	0.21	1.03	10	-2.31	1.03	10	-0.89	1.46	30
E	0.6	0.52	10	-0.12	0.52	10	-1.66	1.08	10	-0.39	1.20	30
Total	0.01	0.10	20	0.04	0.81	20	-1.99	1.08	20			
Sandymount Total (tx185,588 only)				0.03	0.90	40						
Both Stations				0.16	0.96	84						

Another test of accuracy was the daily recording of calibration transmitter bearings by each observer. The difference from expected (determined by theodolite survey) in angles between calibration transmitter bearings was compared for each person. This is summarised in Table 1.3. A few gross errors made at the beginning of the study have been ommitted. This shows that the difference between calibration transmitter bearings can have a bias of as much as 2.42° (although most are less than 1°) with a standard deviation as high as 1.98°. Biases almost cancel out for the total mean and observer means but variation is about 2°. Ultimately these data can be used to calculate computer plots, but for hand plots of bird positions at sea the best possible calibration transmitter from each station was chosen for the days plotting.

Table 1.3 Bias and error in calibration transmitter bearings, Otago Peninsula, Jan-Feb 1991

	Mean bias	S.D.	N
Cargill Castle			
tx386 – tx134	-2.42	1.66	22
tx134 – tx831	0.69	0.67	23
tx831 – tx386	1.7	1.28	25
Sandymount			
tx185 – tx588	0.76	1.52	24
tx588 – tx262	-0.05	1.98	24
tx262 – tx185	-0.64	1.9	23
Total both stns	0.06	2.0	141
Observer			
A	0.03	1.85	31
B	0.09	2.51	22
C	0.07	2.0	38
D	0	1.98	30
E	0.08	1.88	19

1.4.3 Foraging Range

An example of a day's tracking of six penguins at sea is shown in Fig. 1.3. Each line estimates a track between the hourly points of intersection of radio bearings. Errors described above, as well as manual mapping errors, but over the large scale involved, the plots give a reasonable estimation of bird movements and locations. Sea depths are also shown in the figures. These were derived from Carter (1986) but isobaths are approximate only as the coastline did not exactly match the one used for plotting the telemetry stations (NZMS 260 I44 and J44). Each bird travelled a different path during the day. Some birds, e.g. 436, travelled considerable distances of up to 5 km/hr. Others, e.g. 160 were obviously foraging in a more confined area, and at the most, moved 3 km/hr.

By combining the estimated locations of each bird for the 10 days radio-tracking, composite estimates of foraging range were obtained (Figs. 1.4-1.6). There was little apparent overlap between the main areas of activity of the six birds. The male bird 160 had a very confined foraging area (Fig. 1.2) about 3 km offshore, 6-12 km from Boulder Beach. Its partner 436 had a quite different pattern (Fig. 1.2). On day trips to sea it was recorded at distances of 10-21 km from Boulder Beach, but on trips of 2-3 days duration it travelled up to 35 km (30-40 km when the error is allowed for at this distance and angle from shore) from the breeding area. Because the coastline curves southwards to the west of Otago Peninsula, the penguin would have been 20-25 km from land when 35 km from Boulder Beach. The male 210 was usually 5-14km from Boulder Beach or 7-11 km offshore. Its partner 310 fed closer to the shore, 7-11 km from Boulder Beach or 4-8 km offshore. The breeding female 410 was much more variable in range, usually 10-23 km offshore. The nonbreeding female 485 was also variable but usually went to an area 16-24 km from Boulder Beach or 14-20 km offshore.

Most birds travelled southwest from Boulder Beach, with only 410 heading directly offshore to the south, and to the south-east on one occasion. These foraging seem to relate to the bathymetry in that birds often moved along isobaths. Bird 160 was usually in water 30-40 m deep, 310 40-50 m, 210, 436 and 485 50-60 m and 410 55-70 m. Bird 410 took two trips that reached water of 70-90 m depth.

1.4.4 Dive Times

Transmitter signals could only be heard from the receiving stations when the birds were on the surface of the water. Once a signal had been located, it was possible to record sequences of times that birds dived and surfaced. Often there was only time to record a few dives before the next radio fix. These data were later analysed for length of dive and surface times. Each sequence was arbitrarily categorised as a foraging sequence, including regular dive to surface ratios (dives usually >100s), variable dive to surface ratios (mostly dives >100s with some short dives and varied surface times); travelling sequence, including short dives (usually <100s, often with irregular surface times), underwater swimming (more regular pattern of short dives and short surface times), porpoising (surface times of a few seconds); constant signal (pedominantly on surface or still on land). These dive types were modified from descriptions of Trivelpiece *et al.* (1986).

The broad categories are summarised in Table 1.4. This shows that average foraging dives were about 2 min:39 s in duration. Longest dive recorded was 3 min:54 s. The more regular dive sequences had dive to surface ratios of about 169 s:43 s, whereas variable sequences were 120 s:34 s. The shorter travelling dives were on average 35 s in duration. These included short dives with dive to surface ratios of about 38 s:26 s, underwater swimming on 42 s:15 s and porpoising of about 11 s:6 s.

TABLE 1.4 YEP dive and surface times, Jan-Feb 1991

	Dive Time (seconds)				Surface Time (seconds)			
Dive Type	mean	S.D.	range	N	mean	S.D.	range	N
Foraging	159	42.1	1-234	789	41	14.9	3-208	834
Travelling	35	45.1	1-187	235	21	35.9	1-348	238

1.4.6 Effects of Transmitters

Fig. 1.1 shows that three out of six birds stayed ashore for a day after having the transmitter applied, which may have been a response to handling or the back-pack. Birds were observed preening and resting normally, without apparently trying to remove the transmitter. Five birds carried transmitters for 15-18 days. The initial mean weight of the birds was 5.87 kg (s.d.=0.45, n=5) and final weight was 5.89 (s.d.=.50, n=5). Transmitters were removed from the adults one to three weeks from the time their chicks fledged. Nest 1 chick, which had one telemetered parent, fluctuated from 6.0 to 5.5 and back to 6.1 kg. Nest 2 chick, with two telemetered parents, fluctuated from 6.2 to 5.7 and back to 6.2 kg. Nest 3 chick, with two telemetered parents, went from 5.0 up to 5.3 and back to 5.1 kg. This increment was 67 g (s.d.=58, n=3). These chicks had reached their asymptotal weights, so fluctuations are not surprising. However, other chicks at a similar stage of development in the three study areas increased by an average of 364 g (s.d.=323, n=11) during the same 2.5 weeks.

Between 8-12 February one bird apparently left the breeding area, at 2-2.5 weeks after first having the transmitter applied. This male seemed in good condition and weighed 5.8 kg on 8 February (it had been 5.25 kg in November). On 12 and 13 February faint signals were heard of this bird, apparently diving somewhere to the east of the Sandymount tracking tower. After the towers were dismantled, the bird's signal could not be located with a hand antenna, and several subsequent visits to the breeding area were also unsuccessful. Its chick from Nest 1 increased in weight from 6.1-6.8 kg between 11-27 February after which it fledged. It is unknown if this behaviour was related to carrying the transmitter, or if it is behaviour related to the end of the fledging period.

1.4.7 Diet

The qualitative diet analysis (Appendix 1.1) is summarised in Tables 1.5 and 1.6. The results show that opalfish were numerically the most important species, and they occurred in all nine samples. Red cod, squid, cockabullies and warehou were also important prey, with squid occurring in all samples. All birds had some invertebrates present, and one sample had over 1350 krill.

The five birds with transmitters were tracked at sea for about three hours during the day. Bird 160 was about 4 km offshore (c.40 m deep water), 310 was 5 km (c.50 m deep), 436 was 9 km (c.55 m deep), 210 was 10 km (c.55 m deep), and 485 was 14-19 km offshore (c. 55-60 m deep). Most birds were therefore in water that was 50-60 m deep. Those that were in slightly deeper water may have taken a higher proportion of opalfish and squid than the other birds (Appendix 1.1).

TABLE 1.5 Preliminary YEP Diet Summary Feb 1991

	Mean Prey No.	Range	N
Total Fish	53	5-98	9
Total Squid	7	1-22	9
Other Prey	155	1-1358	9

TABLE 1.6 YEP Diet (Fish-Squid only) February 1991

	Mean Prey No.	% No.
MAIN FISH		
red cod	10	16
opalfish	28	46
blue cod	2	4
silversides	0.1	0.2
OTHER FISH		
barracouta	0.1	0.2
cockabully	5	9
warehou	5	9
tarakihi	1	2
hake	0.2	0.3
unknown	1	1
SQUID	7	12

1.4.7 Breeding Success

Twenty-two nests were monitored throughout the breeding season in three areas on Otago Peninsula and a further 19 in two areas of Catlins. Some additional nests were monitored after their discovery in the chick rearing period. Adults were banded and measured where necessary (Appendix 1.2). Weights of adults are in Table 1.7. Weights increased by an average of 400 g between November and January-February. The latter sample included non-breeders, but this had little effect on the average weight. Individuals that were weighed in both periods increased from 5.2 kg (s.d.=0.25, n=4) to 5.9 kg (s.d.=0.39, n=4).

Table 1.7 YEP adult weights 1990-91

		Weight of adult YEP (kg)					
		Otago			Catlins		
Date	Sex	Mean	s.d.	n	Mean	s.d.	n
November	Male	5.3	0.21	15	5.3	0.48	9
	Female	4.9	0.24	7	4.8	0.42	9
	Total						
Jan-Feb	Male	5.9	0.32	6			
	Female	5.4	0.56	8			
	Total	5.6	0.53	14			

Nesting success is summarised in Table 1.8. Some parameters were influenced by egg manipulations, which were undertaken to alleviate adult stress during a potentially bad season (see Part 2). Eighteen of the 22 Otago study nests and 8 of 19 Catlins nests were manipulated in some way at the egg or early chick stage, mostly by removal of an egg or, in four cases, by shifting of eggs or young chicks between nests. Of four two-chick broods at Otago, only one remained intact by fledging time because of death or disappearance of a chick. Five two-chick broods at Catlins failed to fledge both chicks. Three chicks from Sandfly Bay and one from Long Point were taken in for hand-rearing near fledging time because their weights or late development suggested they would not survive. These have been treated as unsuccessful in Table 1.6, or were not included because they were nests found late in the season.

Hatching dates could not always be determined accurately because visits to most areas were more than one week apart. Estimates were improved by using evidence of pipping, observed hatching or chick size, and gave a mean hatch date of 16 November (11 Nov. – 1 Dec., N=39) at both Otago and Catlins. Nests at Catlins were much less successful than at Otago. At Otago three nests failed at the egg stage because the egg was infertile. Six chicks died at the nest early in the guard stage, probably from natural causes. One died from starvation during the post-guard stage, and two were handreared to prevent starvation. At Catlins three nests disappeared at the egg stage, possibly from predation, and two failed with infertile or abandoned eggs. Of 14 chick losses, half died early in the guard stage. Eight disappeared without trace, four were found dead at the nest, one drowned and three starved. Patterns of losses from some adjacent nests at Catlins suggested predation was occurring. There was no predator control there, whereas at Otago predators were trapped during critical periods.

Table 1.8 YEP Nesting Success 1990-91

Locality	No. Monitored Nests	No. Chicks Hatched	No. Chicks Fledged	% Chicks Fledged	Mean/nest
Boulder Beach	7	9	5	55.6	0.71
Highcliff	8	8	6	75	0.75
Sandfly Bay	7	7	4	57.1	0.57
Otago Total	**22**	**24**	**15**	**62.5**	**0.68**
Hayward Pt.	8	9	2	22.2	0.25
Long Pt.	11	11	4	36.4	0.36
Catlins Total	**19**	**20**	**6**	**30.0**	**0.32**

Table 1.9 YEP Chick Fledging Weights 1991

Locality	Mean (kg)	s.d.	Range	n
Boulder Beach	5.4	0.8	4.7-6.8	5
Highcliff	5.6	0.5	4.9-6.1	6
Sandfly Bay	5.8	0.27	5.4-5.9	6
Otago Total	5.6	0.54	4.7-6.8	17
Banding Wt	5.0	0.60	3.5-6.0	20
Hayward Pt	5.1	0.78	4.5-5.6	2
Long Point	5.3	0.45	4.7-5.9	5
Catlins Total	5.2	0.50	4.5-5.9	7
Banding Wt	4.6	1.33	1.9-6.0	11

1.4.8 Chick Weights

Average chick growth is shown in Fig 1.7 for the two areas of study. There was similar weight change for chicks that survived in both areas, although the few Catlins chicks tended to drop in weight during the fledging period. The combined line showing weights of chicks that died or were taken in for hand-rearing showed that most birds did not reach 4 kg.

Chick fledging weights are summarised in Table 1.9. These were the last weights taken before chicks departed. Departure dates were between mid February and mid March when most chicks were over 100 days old. Weight at banding time (2 Febuary at Otago and 5-8 February 1991 at Catlins) is provided in Table 1.8 for comparison with other Otago areas (data held by J. Darby).

1.5 DISCUSSION

The testing of radio-telemetry on YEP was successful. The Cargill's Castle-Sandymount station baseline of about 15 km proved adequate for the directions that birds usually travelled at sea. A longer baseline would have been better for the offshore feeders but less useful for the birds that fed quite close to shore. The hand plots usually showed logical progressions of movement between the hourly points of intersection, indicating reliability of tracking. Transmitter signals were usually clear and there were not the problems of reflection and deviation that can occur over uneven terrain or vegetation. A quick appraisal of the sea tracking trials indicated that errors in radio-directions were not large. However, some of the land-based reference transmitters caused problems for some observers. The tracking required five people full-time for about two weeks, and because setting up equipment, on site evaluation and methodology testing, manual tracking, data logger maintenance, data analysis and plotting all occurred simultaneously, it was a very demanding exercise.

There did not appear to be any major effects of transmitters on the birds, however it is not known if this influenced the apparent departure of one bird from its breeding area about three weeks before its chick fledged. For two weeks prior to this it had a fairly regular foraging pattern and foraging area, although on the last day of full tracking it headed to the south-east.

Previously it was thought that YEP foraged away from the coast, over the continental shelf which generally extends about 15 km off the coast (van Heezik 1988, 1990). At Otago the shelf (up to about 130 m deep) extends only about 12 km south-east of Cape Saunders but there is a wide expanse of shallow water up to 43 km due south of Boulder Beach (Caner 1986). Dietary analysis suggested that YEP fed mainly in the upper portion of the water column, but also demersally (van Heezik 1988, 1990). During incubation, mean maximum dives of 34 m (19-56 m) were made while mostly feeding on bottom-dwelling fish. The position of the 30-40 m isobaths suggested that YEP foraging occurred 7-13 km offshore (Seddon & van Heezik 1989). However, their description of coastal bathymetry appears to be incorrect, as the 30-40 m isobaths are within 3 km of Boulder Beach (Carter 1986). It was thought that birds could dive to a least 100 m because six birds had apparently been trapped in fishing nets at this depth (Darby in Marchant & Higgins 1990).

The Pilot Programme has begun to clarify the foraging patterns of YEP, at least late in the chick rearing period. YEP do appear to move away from the coast before feeding, but range 3-25 km offshore or 5-35 km from the breeding area, mostly in waters 30-70 m deep and up to 90 m deep for the longer trips. The wide individual variation and lack of overlap between ranges were interesting results. The variation in the areas used by those birds feeding further offshore suggested that they at least travelled in a similar direction to previous foraging trips or followed a depth contour out to sea. Although there were only two males monitored, they both fed closer inshore than most of the females. Breeding birds did not use the same areas to feed as their partners and sometimes stayed one or two nights offshore.

Diet sampling followed by food replacement was successfully tried on nine birds. They had to be stomach pumped 2-6 times to obtain the whole sample because large items often prevented the remainder of the contents from being regurgitated. The birds are under stress during the operation although how high the level of stress is compared with other handling procedures is difficult to assess. They are robust birds and appeared to cope with the interference. During Y. van Heezik's (1988, 1990) study some individuals were pumped on up to five times in a year with no obvious ill effects or effect on their breeding (Y. van Heezik pers. comm.). The operation was attempted with three people to make catching, handling and refeeding birds easier. It seems unlikely that more than five birds could be handled in an evening, especially if specific individuals are targetted.

Opalfish was the most numerous fish species taken in February 1991, followed by red cod, squid, triplefins and warehou. Van Heezik (1990) found seven main prey; red cod, opalfish, sprat, arrow squid, ahuru, silversides, blue cod, in order of importance of calculated weight. Opalfish was the third most important numerically behind red cod and sprat. At Boulder Beach in January 1985 opalfish were the most important species but the following year, which was a poor season for YEP, more squid and miscellaneous species were taken than previously. The high proportion of squid, other fish and invertebrates suggests that YEP preferred species were less available than normal. Krill were recorded in large numbers from one individual, something not found in 512 samples by van Heezik (1990). The birds sampled were radio-tracked at 4-22 km offshore, or in water m deep. Assuming opalfish are always a bottom-dwelling species, this suggests that YEP were feeding from the bottom for a large proportion of dives.

Because of the large number of adult deaths the previous breeding season there were fewer breeding pairs in some areas in 1990-91. For example there were 12 nests at each of Highcliff and Sandfly Bay in 1989-90 (Darby in and Higgins 1990) and 9 in each area in 1990-91. At Haywards and Long Points there were 7 and 11 nests the previous season and 8 and 12 nests in 1990-91. Some other areas were more affected by the decline, for

example at the Nuggets there were 18 nests in 1989-90 but only 3 this season.

Breeding success is difficult to compare between Otago and Catlins because there were different degrees of egg manipulation and predator control. Losses were higher at Catlins, apparently from predation and starvation. Fledging success at Otago at around 63% was close to the figure of 69% during in 6 seasons from 1981-86 (Darby and Seddon 1990), but less than 76% from 1936-52 (Richdale 1957) or 85% in 1987-88 on Campbell Island (Moore and Moffat 1990). The Otago figure of about 0.7 chicks produced per nest is less than figures of 1.1-1.4 found during most other studies cited above, although during years of high predation almost no chicks are produced from some areas. The low level of chick production per nest was influenced by one egg being removed from each nest but few two-chick nests were completely successful either.

Mean fledging weights of 5.6 kg at Otago and 5.2 kg at Catlins were lower than found in some studies; e.g. 5.9 kg (Richdale 1957, Darby in and Higgins 1990). In 1985-86, a season of poor breeding success and survival, fledging weights 4.8 kg at Boulder Beach and 4.4 kg at the Nuggets (van Heezik 1988). The 1990-91 figures are probably within the normal annual variation, for example the mean fledging weight on Campbell Island in 1987-88 was 5.1 kg (Moore and Moffat 1990).

In summary, the success and fledging weight data suggest an average breeding season at Otago and poor season at the Catlins.

1.6 ACKNOWLEDGEMENTS

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APPENDIX 1.1
Number of Prey in YEP Stomachs, 11-12 February 1991

	Number of Prey Items in Stomach								
nest.sex	2.m	2.f	3.m	3.f	nb.f	80.f	m	f	f
band	4585	10188	6024	10548	6036	2702	2670	9350	5908
frequency	160	436	210	310	485				
red cod	7	3							78
opalfish	4	56	4	35	63	7	34	43	2
sprat									
ahuru									
blue cod	6	1	1		7	4			
silversides				1					
barracouta							1		
cockabully	2	17		8	7		3	11	
warhou	25	1			17	1			5
ling									
tarakihi		2		1	1		1	6	1
hoki									
rattail									
hake		1?			1				
unknown	1	2			2			2	
squid (new)	3	17	2	2	10	1	5	3	22
squid (old)					22				21
crustacean	2	1	1	2		1	2	4	
euphausid				1352					
invert.	3	3	3					2	
insect		2					1	1	
nematode		1	4	1	1			3	
polychaete		4							
mollusc								3	
unknown			+	+	+			+	
Total fish	45	83	5	44	98	12	39	62	87
Total squid	3	17	2	2	10	1	5	3	22
Other	2	11	8	1358	1	1	3	11	2

APPENDIX 1.2
Measurements of South Island yellow-eyed penguins, 1990

Locality	Nest	Band	Sex	Date	Hd (mm)	Bill (mm)	Ft (mm)	Wt (kg)
Boulder Beach (A1)	1	J10544	m	27.11.90	143	54.9	128	5.25
				25.01.91				5.8
	1	J10549	f	25.01.91	140	53.8	124	4.8
	2	J4585	m	27.11.90	143	54.7	127	5.5
				25.01.91				5.6
				12.02.91				5.9
	2	J10188	f	28.01.91	139	53.4	128	6.1
				12.02.91				6.1
	3	J6024	m	27.11.90	145	57.8	127	5.2
				28.01.91				6.4
				12.02.91				6.45
	3	J10548	f	28.01.91	136	52.0	125	5.25
				12.02.91				5.1
	5	J10183	m	27.11.90	145	55.3	129	5.1
	5	J2163	f					
	6	J2247						
	6	J10550						
	7	J10179	m	27.11.90	141	53.9	126	5.35
	7	J3878	f					
	9	J9847	m	30.11.90	146	56.8	130	
	9	J6025	f	27.11.90	138	53.3	124	4.45
	-	J9949	f	25.01.91	137	52.3	125	4.7
	-	J10100	m	28.01.91	144	54.6	136	6.25
	-	J10065	m	28.01.91	146	55.3	125	5.75
	-	J6036		28.01.91				6.0
			f	12.02.91	134	50.3	125	5.9
	-	J9350	f	11.02.91	136	53.9	124	4.9
	-	J5908	f	11.02.91	135	52.1	127	5.8
Boulder Beach (Highcliff)	B65	J10546	m	27.11.90	142	55.2	134	5.3
	10	J5933	m	27.11.90	140	54.1	128	5.1
	10	J2377	f	30.11.90	134	53.3	124	4.7
	11	J5604	m	27.11.90	144	55.8	132	5.5
	11	J2228	f					
	12	J2714	f	27.11.90	137	52.1	122	5.1
	12	J2229	m					
	13	J5754	m	30.11.90	146	57.2	129	5.5
	14	J5756	m	27.11.90	144	56.7	129	5.65
	14	J1081	f					
	15	J10547	m	27.11.90	146	57.4	133	5.35
	80	J2702	f	27.11.90	140	53.9	124	4.9
				11.02.91				5.6
	80	J9873	m					
	-	J2670	m	11.02.91	145	56.0	130	5.8

APPENDIX 1.2 ctd.
Measurements of South Island yellow-eyed penguins, 1990

Locality	Nest	Band	Sex	Date	Hd (mm)	Bill (mm)	Ft (mm)	Wt (kg)
Sandfly Bay	36a	J11108	f	27.11.90	136	52.9	121	5.1
	36a	J2281	m	30.11.90	142	54.8	127	5.25
	37	J2339	m	27.11.90	143	54.0	129	5.3
	37	J9347	f	30.11.90	136	55.8	129	
	411	J11105	m	10.12.90	146	58.5	129	4.95
	411	J10171	f	27.11.90	137	53.5	122	5.0
	412	J10172	f	10.12.90	137	52.2	124	4.85
	412	J2331	m					
	413	J10173	f	27.11.90	139	53.8	123	4.8
	413	J9940	m					
	414	J11106	m	21.11.90	143	55.9	132	
	414	J11107	f	21.11.90	136	51.3	125	
	415	J9343	m	27.11.90	142	54.7	125	4.9
	415	J10176	f					
Haywards Point	1	J9344	m	28.11.90	146	56.6	130	6.0
	1	J10316	f	23.11.90	135		128	5.2
	2	J9345	m	28.11.90	142	53.5	127	5.5
	2	J10318	f	29.11.90	139	54.6	126	5.65
	3	J10315	m	23.11.90	141		132	
	3	J10322	f	13.12.90	138	52.7	125	4.4
	4	J10313	m	28.11.90	140	55.8	128	5.65
	4	J2625	f					
	5	J10314	m	28.11.90	144	55.0	127	5.35
	5	J10312						
	6	J10320	m	29.11.90	144	56.2	127	4.9
	6	J9346	f	28.11.90	138	53.7	121	4.7
	8	J10317	m	23.11.90	147		130	
	8	J10319	f	29.11.90	139	55.1	120	4.6
Long Point	5	J10335	m	22.11.90	143		131	5.5
	5	J10346	f	13.12.90	140	54.0	130	5.0
	6	J10333	f	23.11.90	135		121	4.55
	6	J10342	m					
	7	J10347	m	29.11.90	139	54.8	126	5.1
	7	J10339	f	22.11.90	137	52.6	124	
	8	J10340	m	29.11.90	141	53.8	123	4.95
	8	J10338	f	22.11.90	138		125	
	9	J10349	m	29.11.90	140	53.4	122	4.4
	9	J10334	f	23.11.90	139		122	4.15
	10	J10350						
	10?	J10337		22.11.90	137		122	4.8
	10?	J10336		22.11.90	133		130	4.7
	0	J10332	m	13.12.90	143	54.8	131	5.1
	0	J10331	f?	13.12.90	141	52.4	127	4.7
	0	J10321	m	13.12.90	144	54.0	134	5.1

YELLOW EYED PENGUINS ON BANKS PENINSULA 1990-91

by

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2.1 Introduction

Yellow-eyed penguins (YEP) were first reported on Banks Peninsula in late 1967 when a pair was recorded from Otanerito (Long) Bay (Harrow 1971). Harrow kept these birds under observation from 1967-1970 when he carried out wider surveys and found "a substantial population" of YEP at Big and Little Fishermans Bays (Red and Shell Bays on the NZMS 1 map). A local farmer reported that these birds first arrived in 1965 and numbers had steadily built up until a "couple of dozen" could be seen at the landing at one time (Harrow 1971). No further work was carried out on these YEP although locally it was always known that a few pairs were resident at Otanerito Bay. This bay has more public usage than the Fishermans Bay complex.

Between October 1984 and January 1985, Locky Carmichael carried out surveys at most bays of the south and southeast coasts of the Peninsula (Carmichael 1985). Although detailed watches to determine numbers of penguins were not carried out, he found that YEP were present and breeding at seven bays and estimated the population to be 34 birds.

In the 1980s YEP started to gain a higher profile in Otago and Southland, especially on Otago Peninsula, where John Darby was carrying out long term studies (Darby and Seddon 1990). Concern was expressed at the decline in numbers of birds there and at all mainland sites. A YEP recovery plan was being prepared and this needed up-to-date information on YEP from throughout their range. Partly as a response to this and because of a general interest in penguins we commenced a survey of YEP on Banks Peninsula in October 1988 (Dilks and Grindell 1990). We concentrated initially on the areas where Carmichael had found birds in 1984-85. These surveys and monitoring of penguin numbers and breeding success are ongoing.

Each year during October and November, all bays from Harbour to Hickory Bay are visited. Landowners at bays further north were contacted but no recent records of YEP were obtained. Any birds found are checked for bands. Nests are monitored by visiting once during incubation, again at hatching time and then in late January to weigh and band the chicks and adults. Evening watches are carried out at each of the main penguin bays to determine the number of birds present. Observations are made from a point overlooking the landing site from approximately 1600 hours until dark.

2.2 Results

As in previous years, we surveyed the bays where YEP have been found in recent years. We carried out evening watches to count penguins coming ashore at each bay but as birds were returning after dark, or staying away overnight, the census was of little use. Similar behaviour also affected last year's census.

2.2.1 Surveys of Bays

2.2.1.1. Grassshills Bay

Scattered YEP droppings were found on 11 October 1990 at the usual landing site but sheep have damaged the track up the steep bank and penguins may not be using this track now. There was no sign of penguins using the usual moulting/loafing site on open grass north of the scrub edge above this landing.

Scattered droppings were found at a second landing site. One adult YEP was found 25 m uphill in a large nettle patch against a large rock. There were a lot of droppings but no sign of a nest. At 1925 an untagged adult arrived at the landing site. It called several times from the beach but there was no response from any other bird.

Although no nests were found, in late January Alistair Hutt found a large downy penguin chick near the beach. This confirmed that a pair had nested successfully somewhere amongst the dense scrub and nettles. Two birds were reported moulting at this bay in March 1991.

2.2.1.2 Damons Bay

Fresh YEP droppings were found on 12 October 1990 at the landing site and on the hill slopes immediately above. There was some sign at last year's nest site further up the hill but no fresh nesting material had been added to the nest bowl.

An evening watch was abandoned before dark because of heavy rain. No birds arrived but the fresh sign suggested at least one bird was using this bay.

2.2.1.3 Stony Bay

No active nests were found on 9 October 1990 but as in previous years we suspected that birds may have attempted to breed high up the hill slopes at an unknown site. Last year's nest sites were checked.

Site 1 A banded adult J-5651 was present at this site with an unbanded adult. However there was no sign of any attempt to construct a nest. The banded bird had bred at this site in the previous two seasons. A dead bird had been found near this site last year, suggesting this may have been a new pairing.

Site 2 No evidence was found of breeding activity but there were widespread droppings 25m above the end of the beach. There were also many old feathers indicating that a bird had moulted here.

Site 3 No sign of any birds nesting in this area immediately above the landing site.

At 1815 an unbanded adult landed at the end of the beach, preened briefly, then climbed up into the scrub towards Site 2. A dead bird had also been found near this nest site last season and this could explain why no birds bred here this season. No other birds arrived that evening.

Although six birds had been present at Stony Bay in April 1990, no birds were seen in the evenings during the winter of 1990. Early in the breeding season (October 1990) three birds were returning regularly and by April 1991 five birds were seen on most nights.

A juvenile YEP (J-10396) from Double Bay on Otago peninsula was found starving in Akaroa harbour in August 1990. It was looked after by Alistair Hutt for a few days and then taken to Stony Bay to be fed and cared for by the Armstrongs. They named it Monday and it appeared on television in "What Now". After being at Stony Bay for 7 months it died as it started to moult - a period of stress for all penguins.

2.2.1.4 Otanerito Bay

On 8 October YEP droppings were found at the landing site and well-formed tracks headed up the hill and through the fence in two different places. There was no recent sign that the cave site or either had been used.

There were a few twigs and some YEP droppings under a dense coprosma bush directly uphill from the row of large ngaio trees (well above the fence). This was not used as a nest this season.

Nest 1 This was at the base of a *Coprosma* bush well up the hill just below the track to Sleepy Cove. The nest site was very open and exposed to the sun. An adult was incubating one egg on 8 October. Alistair Hutt visited the nest on 15 October after it was found that both eggs had rolled down the hill. The eggs were returned to the nest and the site was secured and shaded with cut manuka. The pair continued to incubate the eggs and hatched one chick which did not survive.

On the evening of 15-10-90 five adult YEP were present within the area fenced for penguins.

On the north side of the bay, a few droppings were found in the small bay where J-5686 was banded last year.

Otanerito Bay also had an ailing YEP in residence. A juvenile bird from Papanui Beach on Otago Peninsula (J-10403) regularly sat at the head of the beach. This bird was very tame as it had been hand reared after the death of its parents. It was eventually released at Moeraki on 2 March 1990. This bird, ("Honky"), was later found starving at Goughs Bay and was fed by the Narbys. It moulted into adult plumage and has now joined the group of resident birds that live on the south side of the bay.

In April 1991 6-8 birds were regularly seen at the landing area on the south side of the bay.

2.2.1.5 Goughs Bay

When we arrived at the beach on 8 October 1990, two birds were near the old boiler at the north end of the beach; J-5655 was inside the boiler and J-4174 nearby. As these two birds did not associate with each other, they were probably not a pair.

Last year's nest sites were checked.

Site 1 No sign of use.

Site 2 No sign of use. Both members of this pair J-5652 & J-5656 were found dead last season.

Site 3 A lot of YEP droppings around this nest site but no sign of use. One of the adults from this nest was seen injured late last season and may have died.

Site 4 No sign of use. One of the adults from this nest J-5660 was found dead on the beach last season.

Site 5 A lot of droppings were found around last year's nest site. One of the birds seen at the boiler on this visit, J-4174 was frequenting this nest site last season.

Site 6 A lot of YEP droppings near this site but no sign of breeding.

Site 7 No sign of use.

No other birds returned to the beach before dark.

On 19 December 1990 all of the above nest sites were in the same condition, and a new nest on the small peninsula at the end of the bay. Two birds were attending the poorly constructed nest site and there were a lot of droppings nearby. J-2263 was last seen as a breeding adult at Hickory bay on 8 October 1988 attending a nest with two other adults. J-5665 was banded as a chick on 28 January 1989 at Stony Bay. These may form a new breeding pair.

2.2.1.6 Hickory Bay

This area was visited on 6 Octoher 1990.

Nest 1 J-5674 was attending a nest in a nest box just above the beach. A fresh egg which had rolled out was returned to the nest and the corner of the nest stuffed with grass to prevent this happening again. The nest was visited again the next day and a different bird was incubating the egg. This nest was checked again on 19-12-90. No chicks were present so it failed at the egg or early chick stage.

At 1755 on 6 Octoher a banded adult landed, climbed 100 m uphill and vanished under a *Fuchsia* bush. We returned and checked this site the next day and found J-5672 at a nest with fresh grass in the bowl. No eggs were laid here however. J-5672 was banded as a juvenile at Hickory Bay on 1February 1989. As it now was three years old it will probably breed for the first time in October 1991, if it finds a mate.

At 1945 another banded adult, possibly the mate of nest 1, landed and went up the track into the bushes.

2.2.1.7 Long Bay

On 10 October 1990 there were a lot of droppings at the landing site and along the track up the steep hill slopes. There was a large grassy nest occupied by a possum in the cave nest site that we found last year but there was no sign of penguin use. Another nest bowl, containing fresh penguin droppings, was found under the same bluffs but it may have been a white flippered penguin nest. Another possible nest site was found near the large patch of flax and elderberry. There were no birds present at any of these sites.

At 1730 an unbanded adult landed and stood preening on the lower hill slopes. No other birds arrived before dark.

2.2.2 Breeding Success

1990-91 was the worst breeding season of the three years that we have been observing the Banks Peninsula birds. Eggs were laid at only three bays (Grasshills, Otanerito and Hickory Bays), and only one chick was reared (at Grasshills Bay). Last season (1989-90) seven chicks were reared. Several adults were known to have died last season. In some pairs, both birds died. Even when only one member died, it may take the survivor several years to find a new partner among the very small, scattered Banks Peninsula population. It is of great concern that there were no successful breeding pairs at Goughs and Stony Bays. In the past two seasons, these two bays produced a total of 17 chicks, the only chicks reared on the peninsula.

2.3 Discussion

In 1990-91 all of the bays where YEP have been recorded in recent years were surveyed. Each bay was inhabited but the number of birds recorded was lower than found previously (Table 2.1). Breeding activity was low, presumably because of the deaths of several breeding adults the previous season. Breeding activity was also low in other South Island breeding areas (J. Darby pers. comm.).

Numbers of YEP and breeding success at each bay of Banks Peninsula has varied between years (Table 2.1). During the last three seasons the number of successfully reared young has been 11, 6 and 1 respectively. From this total of 18 chicks only one has susequently been recorded on Banks Peninsula. This bird, which was reared at Stony Bay, was observed at Goughs Bay as a two year old member of a non-breeding pair.

YEP have been breeding at various eastern bays of Banks Peninsula since the mid 1960s. At that time there were more than 30 YEP using the Otanerito/Fishermans Bays complex (Harrow 1971). Although numbers have not changed greatly some bays are no longer used. For example, in 1990-91 only one pair attempted to breed at Otanerito Bay and no birds have been recorded at Fishermans Bays since the 1984 survey (Carmichael 1985).

Four of the 26 breeding birds on Banks Peninsula found during the 1988/89 season were banded as chicks at Boulder Beach, Otago. It is likely that more of the unbanded birds were from Otago and the Banks Peninsula population may not be self sustaining. For this reason it is important to continue monitoring YEP on Banks Peninsula.

2.4 Acknowledgements

Thanks to the Banks Peninsula landowners who allowed us access to the bays and to DOC staff, Alistair Hutt and Robin Burley, who assisted with field observations. Comments on a draft of this report were made by Peter Moore.

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Table 2.1 YEP breeding success and numbers at the Bank's Peninsula penguin bays.

Year	88/89			89/90			90/91		
Bay	Nests	Young	Birds	Nests	Young	Birds	Nests	Young	Birds
Long	?	?	?	1?	0	1?	0	-	1
Lucas	1	0	3	0	-	1	-	-	-
Grasshills	?	?	?	0	-	2	1	1	2
Damons	0	-	0	1	0	2	0	-	1?
Stony	4	8	9	4	4	8	0	-	5
Otanerito	2	0	5	1	0	4	1	0	6
Goughs	2	3	11	4	2	10	0	-	4
Hickory	1	0	3	1	0	2	1	0	3
Totals	10	11	31	12	6	30*	3	1	22#

* This includes six breeding adults that are known to have died during the breeding season.

\# This total is a minimum as birds were especially difficult to census this past season, often returning to land well after dark.

APPENDIX 2.1 YEP Banding records, Banks Peninsula, 1988-91.

Tag No	Status	Date Tagged	
Stony Bay			
J-3006	Adult	27/1/84	Boulder Beach - Otago as chick
J-5651	Adult	6/10/88	
J-5665	Chick	28/1/89	
J-5666	"	"	
J-5667	"	"	
J-5668	"	"	
J-5669	"	"	
J-5670	"	"	
J-5678	"	23/1/90	
J-5679	"	"	
J-5680	"	"	
J-5682	"	"	
Goughs Bay			
J-2396	Adult	2/2/84	Boulder Beach - Otago as chick.
J-4174	"	24/1/84	Boulder Beach - Otago as chick
J-5652	Adult	28/10/88	
J-5653	Adult	"	
J-5654	Juvenile	"	
J-5655	Adult	"	
J-5656	Juvenile	"	
J-5658	Chick	27/1/89	
J-5659	Adult	"	
J-5660	Adult	"	
J-5662	Chick	"	
J-5663	"	"	
J-5664	Juvenile	"	
J-5683	Chick	23/1/90	
J-5684	"	"	
J-5685	"	"	
J-5687	Juvenile	12/2/90	
Hickory Bay			
J-2263	Adult	31/1/84	Boulder Beach - Otago as chick
J-5657	Juvenile	28/10/88	
J-5672	"	1/2/89	
J-5673	"	"	
J-5674	Adult	1/2/89	
J-5675	"	"	
Otanerito Bay			
J-5686	Adult	23/1/90	

Others			
J-5676	Juvenile	9/6/90	"Solo"
J-5688	"	3/9/90	Found sick at Goughs Bay - released Stony Bay
J-5690	"	14/5/90	Found injured Flea Bay -released Stony Bay

PART 3

YELLOW-EYED PENGUIN SURVEY, EAST COAST STEWART ISLAND SUMMARY OF 1990-91 RESULTS

by

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3.1 Methods

From 21 January to 4 February 1991 Paul Johnston and Matt Wakelin checked areas between Port Adventure and Lords River on the east coast of Stewart Island for yellow-eyed penguin tracks and landing sites. Where possible, evening counts of penguins arriving at the landing sites were made. A few days were spent at Port Pegasus but adverse weather prevented any useful work being done. The survey was carried out using a stabi-craft dingy for access to sites. The Department of Conservation boat, the Jester, was used to shift base camps.

3.2 Results & Discussion

I now feel that the coast from Ocean Beach to Big Kuri has been looked at to the best of our ability. This stretch of the east coast of Stewart Island is approximately 50 km in extent, and 48 areas have been checked during the 1989-90 and 1990-91 seasons. Penguins were found at only 10 areas:

- Chew Tobacco Bay (5 landing sites in two areas, low numbers),
- Pikakoro Bay (3 sites in two areas, 8 birds counted 18.10.89),
- Weka Island (1 landing site, 14 birds counted coming in on 22.1.91),
- East Kaika (3-4 landing sites, c.6-8 birds, 31.5.90),
- Joss' Passage - Shelter Point (possibly one pair 24.1.91),
- Owen Island (2 landing sites, 4 birds 9.15pm 26.1.91),
- Cooey Cove (possible sign).

Details of areas checked are on a map NZMS 260 E49, located in the YEP count box file, and individual site information is kept in the YEP observation ring binder, Halfmoon Bay Field Centre, Department of Conservation, Stewart Island.

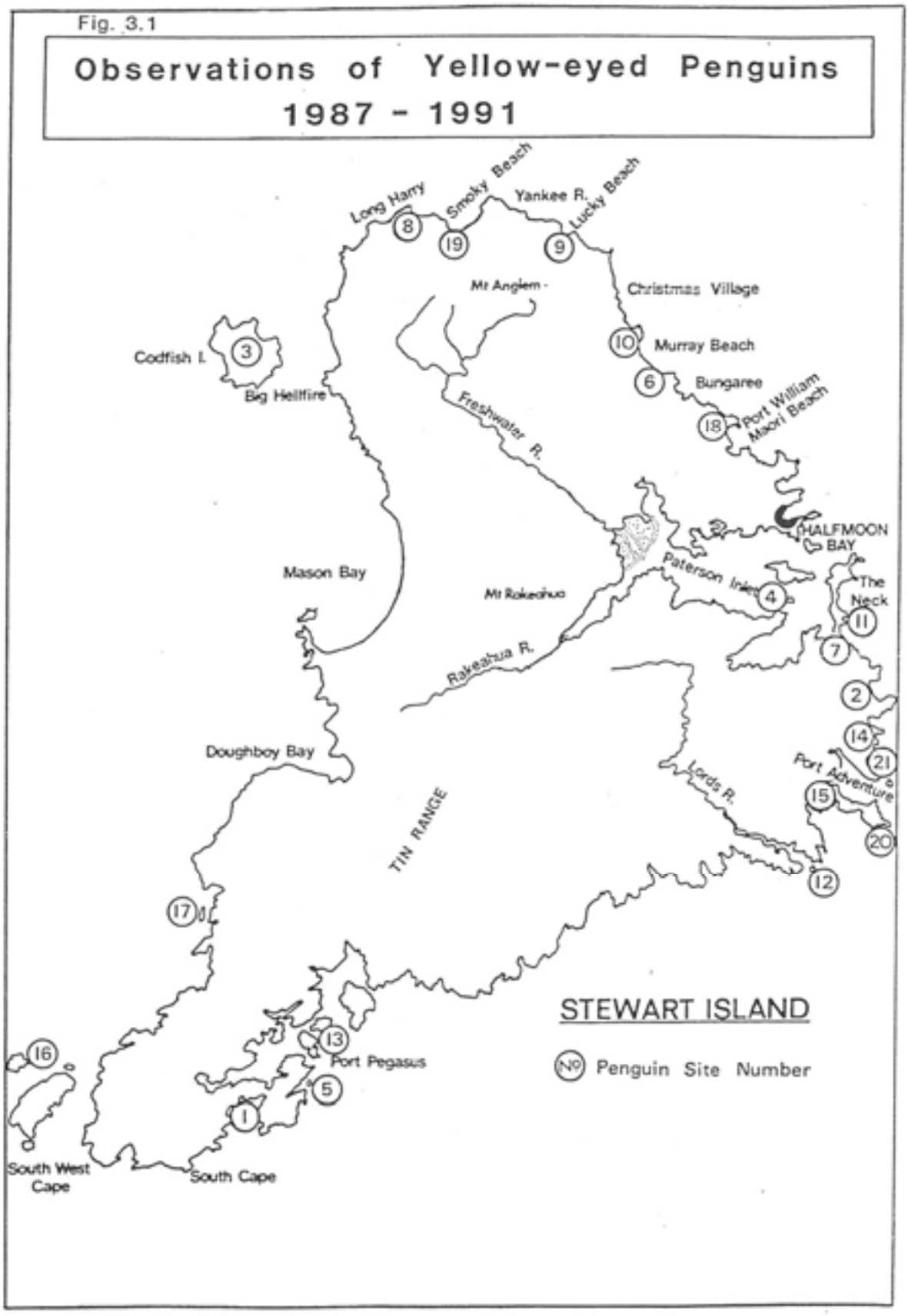
A summary of known YEP sites and observations made since 1987 is provided in Appendix 3.1 and Fig. 3.1. Outlying islands have not been shown on the map; however, Bench Island, Bunkers Islets, Women's and Motonui Islands all have YEP, the first two apparently having healthy populations. Apart from the surveys detailed above and counts conducted on Codfish Island, most of the coastline has not been searched specifically for penguins. Most of the observations of YEP have been incidental to other work.

Future survey priority should be given to the Port Pegasus-Broad Bay area as work has been started but not completed there. Second priority would be the north-east coast as far as Long Harry, followed by outlying islands. Information on the islands may possibly be obtained through the muttonbirders but surveys of accessible islands (eg. Bench Island) could be considered.

3.3 Acknowledgements

Peter Moore combined a file report and letter into this report and made useful comments, as did Peter Dlks.

Fig. 3.1


Observations of Yellow-eyed Penguins
1987 - 1991
Long Harry
Smoky Beach
Yankee R.
Lucky Beach
8
19
9
Mt Anglem
Christmas Village
Codfish I.
3
10
Murray Beach
6
Bungaree
Big Hellfire
Freshwater R.
Port William
Maori Beach
18
HALFMOON
BAY
Mason Bay
Mt Rakeahua
Paterson Inlet
4
The
Neck
11
7
Rakeahua R.
2
14
21
Doughboy Bay
Lords R.
Port Adventure
15
20
TIN RANGE
12
17
STEWART ISLAND
16
13
Port Pegasus
Nº Penguin Site Number
5
1
South West
Cape
South Cape

APPENDIX 3.1 Observations of YEP on Stewart Island, 1987-91.

YEP sites are mapped on Fig. 3.1.

1. Broad Bay
   Birds breeding at head of bay and eastern headland. Low numbers estimated (<10 pairs) (S. King, DOC, 1990).
2. Chew Tobacco Bay
   Five landing sites. Low to moderate numbers estimated (S. King 1989).
3. Codfish Island
   Several landing sites. High numbers (120-150 pairs) (J. Darby in YEP Species Conservation Strategy 1989).
4. Bravo Group
   Breeding on at least four out of six islands. Moderate, possibly high numbers (S. King, P. Johnston, DOC, 1990).
5. Ernest Island.
   Breeding, low numbers (R. Grace, 1989).
6. Golden Beach
   Low numbers (W. Hockly, DOC, 1990-91).
7. Little Glory
   Possibly only one pair, evidence of moult (S. King 1990).
8. Long Harry
   Estimated two pairs (P. Gardner, Cons. Corps. 1990).
9. Lucky Beach
   Estimated two pairs (P. Gardner 1990).
10. Murray Beach.
    One seen landing, low numbers (J. Hare, DOC, 1988).
11. The Neck
    Breeding, low numbers (P. Johnston, S. King 1989-90).
12. Owen Island
    Birds seen ashore, low numbers (P. Johnston, 1991).
13. Port Pegasus
    Breeding on Anchorage and Nobel Islands and on southern coast of the bay. No reasonable estimate of numbers but probably low (P. Johnston, S. King 1990).
14. Pikaroro Bay
    Birds present in two places, low-moderate numbers (S. King 1989-90).
15. Port Adventure
    One area with 3-4 landing sites, low numbers (M. Wakelin, DOC, 1991).
16. Putauhinu Island
    Eleven birds seen at one landing site, low numbers estimated (P. Johnston, A. Roberts, DOC, 1991).
17. Rat Island
    No estimate of numbers, but described as "healthy" colony (E.R. Jones, local resident, 1991).
18. Sawyers Beach
    One pair (A. Austin, DOC, 1987).
19. Smokey Beach
    Four birds landing (P. Gardner, 1990).

20. Shelter Point
    Possibly only one pair (P. Johnston 1991).
21. Weka Island
    Fourteen birds landing (P. Johnston 1991).

PART 4

NOTES ON YELLOW-EYED PENGUIN FIELD SEASON, SOUTH ISLAND, 1990-91

by

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4.1 INTRODUCTION

This report is a summary of two field reports to the Department of Conservation, dated 4 December 1990 and *25* July 1991. It briefly outlines the results of the 1990-91 YEP field season. Most work was conducted on the Otago Peninsula.

4.2 SOUTH ISLAND POPULATION

The annual YEP census was carried out during October. It showed that lower numbers of birds were returning each evening and there was a higher proportion of non-breeders than usual. The beach counts and ground searches in a number of breeding areas suggested a South Island YEP population of 150-160 pairs, a reduction of over 50% from last season.

The December census, which estimates the number of breeding pairs from the number of outgoing birds (usually from two-chick nests) from midday to 6.30pm, and more detailed ground searches, gave an estimate of 140 breeding pairs for the South Island (Table 4.1). Accuracy of the census was hampered by egg manipulation, which reduced the number of two-chick nests, and the relatively late breeding season compared with previous seasons.

4.3 SURVIVAL OF BIRDS SINCE 1989-90

During the 1989-90 breeding season large numbers of breeding adult YEP died. In January 1990, when the magnitude of adult mortality was realised, starving chicks were taken into captivity. Later in the season other chicks were captive-reared to relieve their parents of chick care. It was hoped that this would enhance the adult survival by allowing them to spend longer at sea and forage more freely, without the stress of feeding chicks every day. Removing most of the chicks appears to have been successful at Boulder Beach A1 Section, where 12 out of 14 adults breeding in 1989-90 survived to breed the following season. At Boulder Beach Mid Section and Double Bay, where some chicks were left to fledge naturally, breeding numbers halved between seasons.

Of 194 chicks that fledged in 1989-90, 78 did so naturally, while 116 had been held in captivity for periods ranging from a few days to several months. Six banded chicks were found dead (five had been hand-reared), and six were known to have survived to (three were still being hand-fed in August 1991). The remainder disappeared. Thus, only 1.5% chicks are known to have survived in the wild between seasons.

TABLE 4.1 Estimated numbers of YEP breeding pairs in South Island areas, 1990-91

Area	Locality	Estimated Breeding Pairs	
South Otago	Slope Point	2	
	Blue Cod Bay	2	
	North Head	0	
	Te Rere	2	
	Waiparau	1	
	Wallace Head	0	
	Chaslands	0	
	Mahaka	0	
	Long Point	9	
	Hinahina Cove	4	
	Penguin Bay	3	
	Tunnel Rocks	3	
	Owaka Heads	9	
	Sandy Bay	3	
	Nuggets	2	
	Total		40
Otago Peninsula	Highcliff	9	
	Boulder Beach A1	9	
	Boulder Beach Mid-section	7	
	Double Bay	9	
	Sandfly Bay	9	
	Alfred and Cecily	2	
	Pipikaretu	12	
	Waterfall Bay	0	
	Sandymount	0	
	Papanui	2	
	Fuchsia Gully	0	
	Dicks Bush	0	
	Victory Beach	2	
	Ryans Beach	8	
	Penguin Beach	10	
	Reids	0	
	Otekio	0	
	Green Island	10	
	Total		89
North Otago	Bobby's Head	2	
	Barracouta	4	
	Katiki	1	
	Bushy Beach	2	
	Shag Point	0	
	Total		9
Banks Peninsula	Total		2
Grand Total			140

Although this level of survival appears to be very low, 1990-91 was also not a good season and some juveniles may yet return in future seasons. If the chicks had been left at the nests they would have died as would have many more of their parents. Chicks were probably released into a system with a lack of food, therefore their immediate survivorship would have been low.

4.4 EGG MANIPULATION

In late October 1990 DOC approved a proposal from J.T.D. to remove an egg from as many YEP nests as possible.

4.4.1 Evidence for a Poor YEP Season

Following the disasterous season of 1989-90 there was evidence that suggested 1990-91 was turning into another bad season for YEP. For example, the number of birds arriving at landing sites in the evening from late May to November 1990 fluctuated widely. Total penguin numbers were low and, from September to November, birds were at the landing sites later in the evening than usual. The number of incoming birds was greater than the number of nests recorded in any given area (i.e. many birds did not attempt to breed. Three adult YEP were found dead in late October-early November. There was also indirect evidence, for example, Stewart Island shags on the Otago Peninsula deserted eggs and chicks at the end of October. Large flocks of sooty shearwaters were seen flying north off Otago Peninsula during October-November, instead of south as expected. This abnormal behaviour was also seen in 1985 and 1989, which were poor years for YEP. Large numbers of sooty shearwaters were reported dead off the east coast of the North Island in late October. There was a major decline in the flatfish fishery (Bob Street, fisheries consultant, pers. comm.), as also occurred in 1985 and 1989.

4.4.2 Rationale for Egg Removal

During good years, the weight difference between single or twin fledglings is negligible, but during poor years twins tend to be lighter. Single chicks also tend to fledge earlier. By removing one egg from all two egg nests the survival of the remaining should be enhanced. The main benefit is to the adults, as parents of single chicks have less work to do in feeding chicks. As the season was later than usual, and as late moulters have a higher mortality than early moulters, it was hoped that egg manipuation would allow the adults to moult relatively early.

The reasons for not suggesting artificial incubation, reducing brood size or taking chicks in for hand-rearing at a later date were:

> The priority of YEP conservation is to maintain the population in the wild, and releasing hand-raised birds from captivity is usually unsuccessful.
>
> Adult deaths in 1986 and 1990 occurred during the post-guard stage, suggesting that removal of chicks at that time would be too late to save the adults.
>
> The chick-rearing exercise in 1990 was very expensive for DOC and local individuals. It was largely unsuccessful in terms of juvenile survival.

4.4.3 Manipulation Method

Having received permission to remove an egg from two egg clutches, all eggs were checked for fertility by:

Checking the warmth of the egg by hand. A cool egg is generally infertile.

Shaking the eggs, as contents of infertile eggs or dead embryos "slosh" around.

Weight would also be a criterion, as fresh eggs average 138g and lose weight during development to about 90-100 g at hatching. Infertile eggs tend to remain as heavy as fresh eggs, however the weighing scales available were not accurate enough to compare weights of eggs with that expected for their stage of incubation.

Forty-two eggs were removed from nests. Eleven were infertile eggs, three had dead embryos, and 28 were fertile eggs. All eggs were measured and weighed. Infertile and dead embryo eggs were blown, cleaned and incorporated into the Otago Museum collection, and fertile eggs were frozen. When possible, nests with a single infertile egg received a replacement fertile egg from a two-egg clutch.

4.4.4 Result of Manipulation

We believe that the removal of 28 fertile eggs has probably enhanced the survival of 56 adults. If the proportion of eggs that eventually produce breeding adults is 15% (Richdale 1957), removal of 28 fertile eggs represents the potential loss to the system of four breeding adults. This is a small future loss compared with the protection of a large number of current breeders.

Irrespective of the original nest contents mean chick weights at banding time (early February) varied little. Weights of chicks from two egg nests, one egg nests and nests where one egg was removed were 5.0 kg, 5.2 kg and 5.3 kg respectively. Breeding success at areas of Otago Peninsula where egg manipulation occurred was 0.79 chicks raised per nest. One area of Otago Peninsula, which had 12 nests and no egg manipulation, was relatively successful at 1.0 chicks/nest and had a mean fledging weight of 5.5 kg (s.d.=0.4). This suggests that conditions for YEP improved during the season. At Catlins, breeding success was only 0.41 chicks/nest, apparently a result of higher predation levels than on Otago Peninsula.

Five nests that fledged two chicks were followed in detail. Three of the breeding pairs did not complete their moult until the first to third weeks of May, whereas all other breeding birds had moulted by late April. Late moulting may have threatened survival of these birds.

4.5 BREEDING OBSERVATIONS

Of the estimated 140 nests on the South Island, 84 were followed in detail and a further 12 were visited occasionally. Forty-two eggs were collected during the egg manipulation, and 14 (33%) of these were infertile. Of the two-egg clutches left intact, 20% of eggs were infertile, giving an overall infertility rate of 26%. This is almost double the level of 13.6% infertility, found over a six year period, 1980-86 (N = 1215,

Darby and Seddon 1990) and is possibly another indication that was going to be another poor season.

TABLE 4.2 YEP Nesting Data, 1990-91

	N
Nests	96
Eggs	169
One egg nests (natural)	18
Two egg nests	58
Nests where one egg removed	34

TABLE 4.3 YEP Laying and Hatching Dates, 1990-91

Area	Locality	Mean Laying Date	N	Mean Hatch Date	N
Otago Peninsula	Highcliff	30/09/90	4	19/11/90	7
	Boulder Beach A1	1/10/90	7	15/11/90	7
	Mid Section	29/09/90	6	16/11/90	5
	Double Bay	4/10/90	6	20/11/90	8
	Sandfly Bay			25/11/90	8
	Total	1/10/90	30	19/11/90	46
South Otago	Long Point			20/11/90	
	Hayward Point			19/11/90	

The mean laying date for the 1990 season was almost one week later than the mean of 24 September for 1936-54 (Richdale 1957). The 1939-40 season was the worst during that period and the mean laying date was 30 September. Mean hatch date for 1936-54 was 9 November, giving a mean incubation span of 43 days, even during the worst season. Individual incubation spans vary from 38-51 days, those with long spans probably being young birds (Richdale 1957). In 1990 the mean hatch date was the latest on record, giving a mean incubation span of 49 days. Although this may have been influenced by young birds breeding, many were actually known-age banded birds. Possibly the availability of food influences the incubation span, rather than age of birds.

4.6 DISCUSSION

The number of breeding birds on the Otago Peninsula in 1990-91 was less than 40% of the total in 1986. Over the whole mainland range numbers were 22% of the 1986 total, i.e. a decline of 78%. There were indications that birds had not fully recovered from the 1989-90 season, for example, the lateness of laying, high infertility rate, long incubation period, low breeding numbers and the high proportion of non-breeders.

In previous seasons, that is in 1985-86, 1989-90, when food has apparently been in short supply, the shortage has occurred in late December-early January. Some chicks in 1990-91 also lost weight or slowed in growth during this period. This may be an important period to monitor diet.

Egg manipulation made it difficult to compare breeding success with previous years. The breeding season was very poor in the Catlins and even worse on Banks Peninsula.

The behaviour of penguins early in the breeding season is a good indicator of the likely outcome of breeding success. One of the best management techniques, in the face of potential disaster, is to manipulate eggs and or chicks, with a preference for the former.

4.7 ACKNOWLEDGEMENTS

Thanks for information supplied by Peter Moore, Brian Murphy, Bruce McKinlay, Dave Houston (DOC), Janice Jones (Moeraki) and others who helped in the field and did beach censuses. Thanks for help and hospitality from Howard and Elisabeth at Pipikaretu and Ryans Beaches. We are also grateful for financial support from Otago Conservancy of DOC, use of a vehicle from Cooke (Toyota) and assistance with vehicle running costs from North Rotary. This chapter was summarised by Peter Moore from two field reports submitted to Otago Conservancy of DOC. Peter Moore and Peter Dilks made comments on a draft.

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PART 5

SUMMARY OF YELLOW-EYED PENGUIN COUNTS AT CAMPBELL ISLAND 1987-1990

by

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5.1 INTRODUCTION

Recent surveys of YEP populations on Campbell Island (Moore and Moffat 1990) and Auckland Islands (Moore 1990) have improved our knowledge of the species' status in the subantarctic. In 1988 the Campbell Island population of about 490-600 pairs may have constituted 28-29% of the total YEP population (Moore in press). However, the recent decline in YEP numbers on the South Island illustrates the need for continued monitoring studies in the subantarctic to determine the extent of population changes there.

5.2 METHODS

Periodically since 1987 penguins have been counted at some of the main landing sites on Campbell Island. YEP were counted at landing sites as they left for sea in the morning or returned in the evening. Duration of counts depended on the time of year, but was designed to cover the peak times of departures and arrivals.

5.3 RESULTS

Annual variation in YEP counts at Campbell Island is summarised in Table 5.2.1. and landing site identifications can be found in Moore and Moffat (1990). Individual counts and comparisons are in Appendices 5.1-5.2.

Between May-July 1987 and May-July 1988 penguin numbers changed little, but by 1990 at Middle Bay (landing sites NW-7,8) and Capstan Cove (NW-11) the numbers had fallen by at least 69%. At Middle Bay I attributed this to the local effects of disturbance and predation by sea lions that had occurred in 1988, but I do not know whether the adjacent Capstan Cove was similarly affected. In 1990, some minor landing sites also appeared to be used by fewer penguins than previously. The counts at Sandy Bay (landing sites NW-2,3) suggest a stable population there, because counts fluctuated within the normal range of daily variation (0-15%) that was recorded at Middle Bay in Overall, between the winters of 1987 and 1990, counts at the five Northwest Bay landing sites (NW-2,3,7,8,11) declined by 45%, from 339 to 188 adults. At Southeast Harbour there was also a decline in penguin numbers.

Table 5.3.1: Summary of annual variation in numbers of Yellow-eyed Penguins at Campbell Island, 1987-1990

Locality & Landing Site	Date	No. of Adults at Landing Site 1987	1988	1990	% Change 1987 -1990	1988 -1990
Northwest Bay						
NW-2	Feb	-	114	130	-	+14
NW-2,3	May-Jul[1]	161	172	150	-7	-13
NW-2	Aug	-	109	137	-	+26
NW-2	Nov	61	-	67	+10	-
NW-7,8,11	Feb	-	170	42	-	-75
NW-7,8,11	May-Jul[1]	178	158	38	-79	-76
NW-7,8	Aug	-	51	16	-	-69
NW-7	Nov	52	-	3	-94	-
Southeast Harbour						
SE-5,11,12	Aug	-	84	53	-	-37
SE-5,11,12	Nov	63	-	30	-52	-

Key: [1] Where possible, counts in the closest corresponding month were used for the comparison

5.4 DISCUSSION

There were few indications of the numbers of yellow-eyed penguins on Campbell Island prior to the estimate of 490-600 pairs in 1988 (Moore in press). Westerskov (1960) thought there were fewer than 200 pairs, however no counts were made and their secretive habits make casual estimates of their numbers very unreliable. Between 1988 and 1990 there have been major decreases in penguin numbers in two parts of Northwest Bay but little change in a third area. Although some of this change was probably caused by sea lion predation and disturbance in 1988 (Moore & Moffat, in press), the evidence from Southeast Harbour suggests a more widespread decline. If the 45% decline shown by the winter counts at Northwest Bay is as great elsewhere, in 1990 the population may have been only 270-330 pairs. More intensive surveys are needed to clarify the extent of the decline of the whole Campbell Island population and whether the changes are short-term fluctuations or part of a longer-term decline.

5.5 ACKNOWLEDGEMENTS

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5.6 REFERENCES

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Moore, P.J. in press. Population estimates of Yellow-eyed Penguin *(Megadyptes antipodes)* on Campbell and Auckland Islands. *Notornis.*

Moore, P.J., and Moffat, R.D. 1990. Yellow-eyed penguin on Campbell Island. *Science and Research Internal Report 58.*

Moore, P.J., and Moffat, R.D. in press. Predation of yellow-eyed penguin by Hooker's sea lion. *Notornis.*

Appendix 5.1 Yellow-eyed Penguin Counts at Campbell Island

Date	Time NZST	Locality	Landing Site	No. Adults[1]	Juv.
9.06.87	1530-1730	Capstan Cove	NW-11	62	
			NW-12	24	
			NW-13	3	
			NW-14-15	25	
10.06.87	-1740	Middle Bay	NW-7	96	4
25.07.87	visit		NW-8	20	
25.07.87		Sandy Bay	NW-3	33	
26.07.87			NW-2	128	13
4.08.87	2 hours	Moubray		10	
13.11.88	1500-2000	Middle Bay	NW-7	6 (4b)	
14.11.88	1600-2000		NW-7	6 (4b)	
16?.5.89	1500-1700	Middle Bay	NW-7	25 (13b)	12
			NW-8	4 (1b)	
17.05.89	1440-1645	Sandy Bay	NW-2	139 (5b)	16
16.02.90	1430-2100	Middle Bay	NW-7	20 (9b)	
16.02.90	1430-2100		NW-8	2 (2b)	
17.02.90	1430-2100	Sandy Bay	NW-2	130 (2b)	5
18.02.90	0427-0820	Capstan Cove	NW-11	20	
	very cloudy view other side		NW-12-13?	4	
10.06.90	1530-1830	Middle Bay	NW-7	12 (6b)	
	visit 1840		NW-8	7 (2b)	
11.06.90	1545-1825	Sandy Bay	NW-2	121	2
	0640-0930	Capstan Cove	NW-11	15	
		view other side	NW-12-13	3	
			NW-14-15	12	
12.06.90	0715-0930	Middle Bay	NW-5-6	12	
			NW-7	18 (8b)	
	visit 0700		NW-8	9 (3b)	
12.06.90	1530-1830	Sandy Bay	NW-3	29	
19.08.90	1515-1905	Southeast Harbour	SE-11	27	
19.08.90	1515-1905		SE-12	6	
20.08.90	0625-0900		SE-5	15	1
			SE-6	4	
			SE-7	6	
			SE-10	13	
			SE-11	28	

Date	Time	Locality	Landing Site	No. Adults[1]	Juv.
20.08.90	0625-0900	Southeast Harbour	SE-12	13	
		long view	SE-13-14	8	
		long view	SE-15-16	5	
		sev. tracks seen	SE-2-4	?	
23.08.90	1700-1830	Middle Bay	NW-7	7	
	(started too late?)				
	1700-1830		NW-8	2	
24.08.90	0637-0900		NW-7	12	
	0637-0900		NW-8	5	
24.08.90	1745-1830	Sandy Bay	NW-2	137 (2b)	
25.08.90	1550-1830	Capstan Cove	NW-11	7	
		views other side	NW-12-13	8	
1.11.90	1400-2045	Middle Bay	NW-7	3 (2b)	
			NW-8	2 (1b)	
1.11.90	1406-2045	Sandy Bay	NW-2	67	3
9.11.90	1533-2045	Southeast Harbour	SE-1	21	
	1508-2120		SE-5	12	
			SE-6-7	6	
			SE-10	6	
10.11.90	0416-0720		SE-2-4	0	
			SE-5	16	
			SE-6	2	
			SE-7	2	
			SE-10	6	
			SE-11	8	
			SE-12	8	
		long view	SE-13?	7	
		long view	SE-14?	2	
		long view	SE-15-16	5	

Key:

[1] number in brackets were banded birds

NW-7 See maps for locations of landing sites

long view; view other side probably not as accurate as closer views

Data Source:

Jun. - Jul. 1987 R. Moffat, A. Wardle (Moubray)

Nov. 1988 - May 1989 P. Hatfield

Feb. - Nov. 1990 R. Moffat, Bill Perry (NW-8, 23.08.90; NW-2, 24.08.90), Andy Cox (part NW-7, 1.11.90), Murray Williams? (part NW-2, 1.11.90), Ron Goudswaard (part NW-2, 1.11.90; SE-5-10, 9.11.90; SE-11-16, 10.11.90)

Appendix 5.2 Key:

¹	% change since the earliest count, during the closest corresponding month
*	Mean Count
!	low numbers make % change comparison invalid

Data Source: Appendix 5.1, Moore and Moffat 1990