



Second transfer of fairy
prion (titiwainui)
chicks from
Takapourewa to Mana
Island, January 2003



Department of Conservation
Te Papa Atawhai

Second transfer of fairy prion (titiwainui) chicks from Takapourewa to Mana Island, January 2003

By Colin Miskelly and Helen Gummer

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Cover photo: Adult fairy prion, Takapourewa, January 2003. Photo: C. Miskelly.

CONTENTS

Executive summary	5
<hr/>	
1. Introduction	
<hr/>	
1.1 Restoring Mana Island	6
1.2 Previous seabird transfers in New Zealand	6
3.3 Fairy prion transfer	6
2. Methods and sequence of events	
<hr/>	
2.1 Capture of the chicks on Takapourewa	8
2.2 Mana Island	9
3. Results	
<hr/>	
3.1 Fairy prion chicks on Takapourewa	15
3.2 Fairy prion chicks on Mana Island	16
4. Discussion	22
<hr/>	
5. Recommendations	23
<hr/>	
Acknowledgements	25
<hr/>	
References	26
<hr/>	
Appendix 1	
<hr/>	
Fairy prion project labour (volunteers and staff) for 2003 and recommendations for labour in 2004	27
Appendix 2	
<hr/>	
Fairy prion chick feeding equipment list	29
Appendix 3	
<hr/>	
Fledging data of fairy prion chicks, Mana Island (2003)	31
Appendix 4	
<hr/>	
Effect of different sardine brands on wing growth of fairy prion chicks on Mana Island (2003)	33
Appendix 5	
<hr/>	
Images from the fairy prion transfer from Takapourewa to Mana Island, January 2003	35

Executive summary

The Friends of Mana Island and the Department of Conservation are attempting to re-establish a breeding colony of fairy prions (titiwainui, *Pachyptila turtur*) on Mana Island by transferring almost fully-grown chicks from Takapourewa (Stephens Island), and hand feeding them on Mana Island until they fledge.

Forty fairy prion chicks (100%) were presumed to have fledged successfully from Mana Island in January 2002, the first year of a planned three-year translocation project. The results of food trials identified an appropriate artificial diet based on tinned sardines.

The second transfer of chicks occurred on 14 January 2003, when 100 were transferred between the islands, and the kaitiakitanga of the chicks was transferred from Ngati Koata to Ngati Toa. The chicks were kept in artificial burrows, and were fed a sardine-based liquid diet once a day until they fledged.

All 100 chicks fledged successfully 5–21 days after transfer. No problems occurred with either variation of two sardine-based diets during the project. Chicks fledged at a mean weight of $120.5 \pm \text{s.e. } 1.21$ g, and with a mean wing length of $169.2 \pm \text{s.e. } 0.55$ mm. Chick wing growth was calculated as a mean of $3.41 \pm \text{s.e. } 0.03$ mm per day. Chicks had spent a mean of $11.5 \pm \text{s.e. } 0.4$ days on Mana Island, departing on average on the fourth night following removal of gates from the burrow entrance. Ten percent of chicks left on the first night with no gate present. Stick fences placed at burrow entrances to monitor chick emergence behaviour revealed that 56% of chicks departed on the first night of emergence from the burrow; no chicks were found to spend more than three nights at the surface before fledging.

All aspects of the project on Mana Island ran smoothly, apart from the very long days required initially to feed 100 chicks. The assistance and enthusiasm of Ngati Koata, Ngati Toa and the three teams of volunteer feeders (organised by the Friends of Mana Island; total of 139 volunteer days) contributed enormously to the success of the project.

Recommendations are made for the planned third and final transfer of fairy prion chicks from Takapourewa to Mana Island in January 2004.

1. Introduction

1.1 RESTORING MANA ISLAND

Mana Island is a 217-ha scientific reserve administered by the Department of Conservation. Following the removal of farm stock in 1986, and the eradication of mice in 1989/90, Mana Island is free of all introduced mammals. Ecological restoration of the island is guided by the *Mana Island Ecological Restoration Plan* (Miskelly 1999), and is actively supported by the Friends of Mana Island Incorporated Society, who provided the funding for the first and second years of fairy prion chick transfers.

Burrowing petrels are foundation species on many New Zealand islands, providing major nutrient inputs (droppings, regurgitations, corpses) for terrestrial ecosystems, and habitat (burrows) for many invertebrates and reptiles. Restoring colonies of burrowing seabirds, principally fairy prions *Pachyptila turtur*, fluttering shearwaters *Puffinus gavia* and diving petrels *Pelecanoides urinatrix*, to Mana Island is one of the six key tasks identified in the *Mana Island Ecological Restoration Plan*. The success of many other restoration projects, including re-introductions of threatened plants, reptiles, and invertebrates, may be dependent on burrowing seabirds being present.

The bones of fairy prions have been found in middens on Mana Island. It is highly likely, therefore, that fairy prions colonies were present on the island before 500 years of human habitation and farming obliterated them.

1.2 PREVIOUS SEABIRD TRANSFERS IN NEW ZEALAND

Seabirds are strongly faithful to their natal colony, and very few new colonies are established unless populations are rapidly expanding. This is especially true for petrels and albatrosses. A lot of work is still needed to develop successful translocation techniques for establishing burrowing petrels in new habitats. The current project is the first attempt to transfer fairy prions to a new site, but builds on experience developed for black petrels *Procellaria parkinsoni* (to Little Barrier Island), fluttering shearwaters (to Maud Island), diving petrels (to Mana Island), Pycroft's petrels *Pterodroma pycrofti* (to Cuvier Island) and Chatham petrels *Pterodroma axillaris* (to Pitt Island). Feeding techniques were similar to those developed for Pycroft's petrel and Chatham petrel, and refined during the first fairy prion transfer to Mana Island in January 2002.

1.3 FAIRY PRION TRANSFER

The fairy prion is a dove-sized bluish-grey seabird that is common around New Zealand coastal waters. Its main breeding areas are at the Poor Knights Islands, Cook Strait, Foveaux Strait and the Chatham Islands. The Friends of Mana Island Society Inc. and the Department of Conservation are attempting to re-establish a breeding colony of fairy prions on Mana Island as part of an ecological restoration

project, by transferring almost fully-grown chicks and hand-feeding them on Mana Island to the time of fledging. Chicks are being sourced from Takapourewa (Stephens Island), situated within the same ecological district, where there are an estimated one million breeding pairs of fairy prions (Brown [2001]).

Although there has been some research on fairy prion breeding ecology and interactions with tuatara on Takapourewa (e.g. Walls 1978; Markwell 1997, 1998), there was no accurate information available on growth rates or fledging dates of fairy prions on Cook Strait Islands before the 2002 transfer. We used measurements of chicks obtained on Takapourewa in January 2002, and growth rates of the first 40 chicks transferred that year to estimate that 10–14 January would be the best time to move the birds, and to provide guidance on how far chicks were from fledging (Miskelly & Williams 2002). We hoped to select chicks of three age classes for transfer: 25 that would stay on Mana for 5–10 days, 50 that would stay 10–15 days, and 25 that would be on Mana for 15–20 days before fledging.

In the first year of a planned three year translocation project, 40 chicks were transferred to Mana Island in January 2002. These were split into two groups fed on two different diets: krill and tinned sardines. A comparison of fledging data for chicks fed on each diet revealed that the sardine diet produced chicks in better condition on their departure from Mana Island, as well as sardines being easier to obtain, store and prepare than krill.

The feeding regime for the chicks transferred in 2003 followed the techniques that were developed for the sardine diet during the 2002 transfer (Miskelly & Williams 2002). In addition, we trialed 16 birds on a modified diet using a different brand of sardines that had been provided at a reduced cost by a sponsor (see 2.2.3 Methods).

In this second year of the project, 100 chicks were transferred to Mana Island on 14 January 2003. Anuru Paul of Ngati Koata handed over the chicks to Ngati Toa representative Eddie Coker, and karakia and mihimihi were performed to welcome the birds to the island. Chicks were blockaded into artificial burrows—previously used in the diving petrel translocation and the first fairy prion transfer—for a minimum of three nights. Gates were removed when each chick's wing length reached 160 mm, in accordance with recommendations made in the 2002 transfer report. Chicks were fed daily until they departed.

If permissions and funding allow, a final cohort of up to 100 chicks will be transferred in 2004, to complete transfer of a maximum of 240 chicks over the three years 2002–04.

The objectives of this second fairy prion transfer were:

- 1 To continue working towards establishment of a fairy prion colony on Mana Island
- 2 To involve tangata whenua, sponsors and volunteers in an innovative conservation project
- 3 To transfer sufficient numbers of chicks of three nominal age classes to allow (eventual) determination of the ideal age at which to transfer fairy prion chicks
- 4 To assess the suitability of a different brand of tinned sardines by comparing fledging weights and wing lengths of chicks fed on the new and the proven brand respectively
- 5 To learn details of prion growth rates and fledging dates that could aid planning for future transfers

This trial could not have proceeded without the fund raising and volunteer involvement of the Friends of Mana Island Society Inc.

2. Methods and sequence of events

2.1 CAPTURE OF THE CHICKS ON TAKAPOUREWA

Permission to source fairy prion chicks from Takapourewa was obtained from the Ngati Koata Trust Board and Nelson/Marlborough Conservancy, Department of Conservation.

Transport to Takapourewa on 10 January 2002 was by helicopter from Wellington (4 team members) and French Pass (4 team members), as weather conditions did not allow a boat landing on Takapourewa.

A powhiri was held outside the caretakers' house on arrival, with Anuru Paul and Brian Simpson (Ngati Koata), Mike Aviss (Sounds Area) and Bruce & Carol Knight (Stephens Island) representing and supporting the tangata whenua, and welcoming the manuhiri comprising Eddie Coker (Ngati Toa), Jason Christensen (Mana Island), Clinton Purches (Kapiti Area) and Lynn Adams and Colin Miskelly (Wellington Conservancy).

The collection team comprised:

Anuru Paul	Ngati Koata, Nelson
Brian Simpson	Ngati Koata, Nelson
Eddie Coker	Ngati Toa, Porirua
Mike Aviss	Sounds Area, Department of Conservation
Jason Christensen	Mana Island, Kapiti Area, Department of Conservation
Clinton Purches	Kapiti Area, Department of Conservation
Lynn Adams	Wellington Conservancy, Department of Conservation
Colin Miskelly	Wellington Conservancy, Department of Conservation

The team was assisted at times by the island caretakers, Bruce & Carol Knight.

Burrows were searched during daylight hours on 10 & 11 January. The area chosen for searching was the southern side of the dam paddock (Plates 1-3), where 78% of the 40 chicks transferred in 2002 were sourced from.

Fairy prions were the only burrowing seabirds found at the collection site, although tuatara, spotted skinks, common skinks, common geckos and giant weta (1) were occasionally encountered. The dried remains of one diving petrel were found near the cliff edge on the lower margin of the search area.

Each burrow was checked to see if the end could be reached. If the burrow was empty or too long to reach the end, it was marked by disturbed earth at the burrow entrance, to avoid double searching. Any prion chicks that could be reached were removed and their weights recorded and wings measured. Any chicks that were heavier than 120 g and had wing lengths that met predetermined criteria (Table 1) were banded until we had marked samples of 30 small chicks, 60 medium chicks and 30 large chicks (total = 120 chicks banded). This provided a contingency of 20 banded chicks to allow for any deaths, injuries or disappearances among the 100 first-choice chicks before transfer day planned for 14 January. Burrow sites of banded chicks were marked with 0.4 m bamboo wands, numbered with the band number, and these burrows were mapped on 12 January.

TABLE 1. WING LENGTHS (mm) USED FOR PREDICTING FLEDGING DATES OF TRANSFERRED FAIRY PRION CHICKS, ASSUMING A TARGET TRANSFER DATE OF 14 JANUARY. ALL CHICKS SELECTED FOR TRANSFER WERE FOUND ON 10 & 11 JANUARY.

DATE MEASURED	PREDICTED FLEDGING DATE		
	19-23 JAN	24-28 JAN	29 JAN-2 FEB
10 Jan	123-137	107-122	92-106
11 Jan	126-140	110-125	95-109
12 Jan	129-143	113-128	98-112
13 Jan	132-147	116-131	101-115
14 Jan	136-150	119-135	105-118

Within each size category of banded chicks, the lightest weight chicks (17%) were selected and marked as “contingency” chicks during burrow mapping on 12 January (i.e. 5 small chicks, 10 medium chicks, 5 large chicks).

On 14 January, 98 of the preferred 100 chicks were found in good condition, and were placed in the transfer boxes for transport to the lighthouse complex. Two contingency chicks were required, as one chick had disappeared down a deep burrow, and at another multi-chambered burrow only three unbanded chicks could be found. Location and collection of the 100 birds took 5 people one hour. Each box (a cardboard cat-carry box) was divided in two diagonally with an extra cardboard sheet, and extra ventilation holes were punched in the lid. Two chicks were placed in each box (one per compartment; Plate 4).

All bamboo wands were left in place in case changed circumstances required all chicks to be returned to their natal burrows. The 120 wands were subsequently retrieved by Bruce & Carol Knight, and are available for reuse in 2004.

At the lighthouse complex, each chick was reweighed and measured, and the band number, weight and wing length written on the outside of each box. The 50 boxes, containing 100 chicks, were then transported by helicopter direct to Mana Island, accompanied by Eddie Coker and Jason Christensen (first flight; 50 birds), and Anaru Paul and Colin Miskelly (second flight; 50 birds).

2.2 MANA ISLAND

Details of volunteer and staff labour required for the 2003 project are in Appendix 1. Appendix 2 lists equipment used for burrow preparation, food preparation, feeding, weighing/measuring birds, cleaning, and all water requirements.

2.2.1 Before arrival of the chicks

A team of six people arrived on Mana Island to set up the project on 12 January 2003.

Graeme Taylor (DOC seabird ecologist), Helen Gummer (contractor) and four volunteers prepared existing burrows at the colony site by cleaning out debris from

entrances and chambers, stabilizing burrow lids, and lining chambers with dry grass. Additional new burrows were excavated and numbered at the northern end of the site, up to burrow 103. Burrows 70–72 were not used in the project this year, as these adjacent burrows were known to be used and visited by a pair of diving petrels in 2002. Two spare burrows (104 and 105) were also set up as back-up options. Burrows showed no signs of flooding following heavy overnight rainfall.

A plastic mesh gate was placed firmly at the entrance of each burrow to prevent the chicks from leaving prematurely. Any chicks that wander to sites away from artificial burrows may not be found and could miss potentially important meals.

On 13 January the ‘bird’ kitchen in the Mana Island Field Centre office was thoroughly cleaned with Virkon (broad spectrum disinfectant) solution. All food preparation and feeding equipment was washed, soaked in anti-bacterial solution overnight, and rinsed prior to use. Details of feeding regimes and food preparation were finalised.

Waterproof notebooks were drawn up and dated to allow all records for an individual bird to be kept together on the same page for easy reference and minimal scribing in the field.

2.2.2 Arrival of the chicks

On 14 January 2003, 100 fairy prion chicks were flown directly from Takapourewa to the artificial colony site on Mana Island in two helicopter loads. The first 50 birds arrived at around 1240 hrs, with the remainder delivered at around 1410 hrs. Boxes were immediately placed in the ‘petrel feeding shed’ where they were sheltered from the strong southerly wind. Soon after arrival each chick was given up to 5 ml of fresh water (boiled then allowed to cool) to compensate for any dehydration during the transfer. Band numbers were recorded, and chicks were placed into the numbered burrows 1–69 and 73–103. Gates were checked for firm placement, each blockading the chick in for at least the next three nights. All chicks were to receive their first artificial meal on 15 January 2003, the day following the transfer.

Sixteen chicks destined to be trialed on ‘Ocean Catch’ Chilean sardines were placed into burrows 1–16; this sample comprised 4 ‘small’, 9 ‘medium’ and 3 ‘large’ chicks to obtain a spread of chick ages in the trial. Criteria for this selection were based on wing length only, as measured on 10 & 11 January (Table 1). The sample size of 16 birds was chosen in relation to the number of chicks that was estimated could be fed from a single 425 g can of Chilean sardines.

The remaining 84 chicks destined to be fed the proven brand of ‘Brunswick’ Canadian sardines, were placed in burrows 17–69 and 73–103. This group also contained a spread of ages, including 21 ‘small’, 41 ‘medium’ and 22 ‘large’ chicks; size classification was based on wing measurements taken on 10 & 11 January.

2.2.3 Food preparation

Up to 2 litres of water was boiled for several minutes each evening and cooled overnight ready for use in food preparation the next day. An additional 6 litres of water was boiled and cooled to take up to the colony for rinsing feeding equipment. On the morning of feeding, an additional 5 litres of water was boiled and placed in thermos flasks to provide hot water at the colony site for warming food. All water quantities decreased as the project progressed.

Before food preparation, hands were washed with Dettol anti-bacterial soap. Equipment was removed from the anti-bacterial solution where it had been soaking overnight, and rinsed.

Over 300 tins of sardines were used (Table 2). Note that on the first day of feeding, medium-sized feeds only (up to 20 ml of food per chick) were delivered to chicks allowing adjustment to the new diet and artificial feeding method. Large feeds began on the second feeding day.

'Brunswick' Canadian sardines in soya oil (net weight 106 g)

One tin of 'Brunswick' sardines in soya oil combined with 60 ml cold (pre-boiled) water fed 3–4 chicks in the early part of the project, and at least four chicks later in the project. Two tins of fish (minimum for good blending) were blended in a food processor with 120 ml of water producing a smooth mixture that flowed easily down the crop needles.

'Ocean Catch' Chilean sardines in natural oil/water (net weight 425 g)

One tin of 'Ocean Catch' Chilean sardines in natural oil combined with cold (pre-boiled) water fed 16 (full sample) chicks on the first feeding day but only 12 chicks on subsequent days during the time when chicks demanded large meals.

TABLE 2. NUMBER OF TINS OF SARDINES USED TO FEED THE 100 FAIRY PRION CHICKS.

DATE	CANADIAN SARDINES (106 g TINS)		CHILEAN SARDINES (425 g TINS)	
	NO. CHICKS	NO. TINS	NO. CHICKS	NO. TINS
15 Jan	84	17	16	1
16 Jan	84	26	16	1*
17 Jan	84	26	16	2
18 Jan	84	26	16	2
19 Jan	84	26	16	2
20 Jan	78	24	15	2
21 Jan	75	22	15	1
22 Jan	70	22	15	1
23 Jan	66	20	13	1
24 Jan	56	20	10	1
25 Jan	50	16	7	1
26 Jan	43	12	5	1
27 Jan	35	10	5	1
28 Jan	28	8	5	1
29 Jan	18	6	4	1
30 Jan	13	4	1	1
31 Jan	10	2	1	1
1 Feb	6	2	0	0
2 Feb	4	2	0	0
3 Feb	2	2	0	0
4 Feb	1	2	0	0
Total		295		21

* Five chicks in the Chilean sardine trial were fed Canadian sardines for one day only on 16 January; at this point it became apparent that one tin did not provide sufficient food for 16 chicks.

As 1×425 g tin = approximately 4×106 g tins, it was estimated that a 425 g tin would require a minimum of 240 ml of pre-boiled water added to match the Canadian sardine mix. However, the Chilean sardine tins were highly variable in their fluid content: tins contained an average of 125 ml of fluid with a range from 80 ml to 170 ml. This meant that no single fixed quantity of water could be determined to add to the fish/fluid mix. All fluid contained in each tin was poured into a measuring jug and made up to the 240 ml mark with cold (pre-boiled) water. If the tin contained a proportionally large amount of fish, more water (often up to a further 50 ml) was required to blend the fish to the required consistency. This was achieved by slowly syringing water into the blender during the blending process until the mixture became smooth.

Fish mixtures were poured into 350 ml plastic pottles with sealable lids for transport up to the feeding site. Each pottle held food for 6–8 chicks in the early part of the project. During the first two weeks of the project, at least half the food pottles were placed in the freezer for up to 10 minutes to cool the fish mixture before being placed in the chilly bin. The blending action warmed the food slightly during preparation, and cooling was undertaken to reduce the risk of spoilage. The pottles were of a suitable size to sit firmly in a 1 litre food flask containing hot water, which acted as a water-bath to warm the food before feeding.

All food was warmed before feeding this year because:

- a Weather conditions were frequently cool, especially in the early mornings
- b Pottles of food allocated for afternoon feeds needed to be kept cool in a chilly bin through the day (important on hot days to avoid contamination), but needed to be warm at time of feeding. Such pottles were slowly warmed in the sun before being placed in the water-bath at time of use
- c Difficult chicks took food more readily if it was warm, and were less likely to regurgitate following feeding.

2.2.4 Chick handling and feeding regime

During the first week of feeding, two teams of three people worked at the colony site, with one team processing chicks in burrows 1–50 (including the Chilean sardine trial chicks in burrows 1–16), and the other team processing chicks in burrows 51–103. The first team to complete their burrow group would then assist with the other team's remaining burrows. In the second week, additional team members allowed the contractor to oversee feeding amounts, re-check wing measurements, and train new team members. Team sizes reduced as the project progressed and chicks departed.

Each team consisted of a *feeder*, a *bolder*, and a *runner*, and sometimes a separate *scribe* who double-checked wing measurements. *Runners* would remove a chick from its chamber, leaving the burrow lid off the burrow (unless raining) ready for the chick's return after feeding. *Runners* took the chick to the feeding shed for weighing and wing measurement. Chicks were then passed to the *bolder* for food delivery by the *feeder*. The *runner* was then able to collect the next chick, and record weight and wing measurement whilst the first chick was being fed. If the feeding had not finished, the second chick was placed in a box next to the *bolder*. The *runner* was then free to receive the most recently fed chick from the *bolder*, record a post-feed weight, and return the chick to the lowest burrow number with the lid off. Chicks were always returned via the chamber; this was especially

important with younger, less mobile chicks, but also ensured that chicks were not accidentally introduced to an already occupied burrow.

Band numbers were only occasionally checked against burrow number, as daily checks of 100 band numbers was not practicable. The system of retrieving and returning chicks minimized the risk of birds getting mixed up. Band numbers were always checked if there was a significant difference in measurements between days. All artificial burrows were checked daily for occupants—either residents or other chicks that may have moved in. No searches were made for chicks under vegetation, as all chicks were considered to have departed at appropriate wing lengths and weights.

2.2.5 Weight and wing measurements

Chicks were weighed before and after feeding in 250 mm x 300 mm plastic bags, using a 300 g Pesola balance. All weights were recorded as total chick and bag weights; the bags weighed only 2 g, which was subtracted from gross weights during analysis. Bags were discarded if soiled by regurgitant or excrement.

Right wing lengths were recorded every third day until they reached 150 mm, after which measurements were taken on a daily basis. Wings were flattened (not straightened) for consistency with the measuring technique used at the time of selection at the source colony. It was not possible to have a single person take all wing measurements. The contractor calibrated measurements taken by new personnel, and double-checked any wing measurement around 160 mm, as this was the trigger for gate removal. Wing measurements of birds considered very close to departing were also double-checked, to obtain accurate final wing lengths.

Individual chick data were recorded on a single page assigned to that chick/burrow throughout the project, allowing easy detection of any anomaly in the measurements. This also meant that burrow and band numbers did not have to be repeatedly written each day.

2.2.6 Feeding

Feeding took place next to or inside the shed; chicks seemed more settled inside the shed, out of the wind and direct sunlight. Chicks were fed only up to 20 g on the first day of feeding, to allow chicks to adjust to the new diet and feeding technique. For the rest of the first week chicks were fed as much as they would readily take, up to around 50 g. Only a few young, heavy chicks took more than this (50–60 g) on relatively few occasions. Chick meal sizes reduced towards fledging time with many chicks taking less than 10 g of food by the day of departure. Chicks that were a problem to feed, or that regurgitated the entire meal during handling, were scheduled for a second smaller feed at the end of the day if considered necessary.

Feeding techniques were similar to those used in the previous season, although in most cases the *feeder* held the bill (upper only) whilst operating the syringe/crop-needle, whilst the *holder* positioned the chick and held a soft tissue under the lower bill to catch any spilt food, preventing soiling of the plumage. *Feeders* also had to ensure that pottles of food were the right temperature for feeding. Warm water (a mixture of cold pre-boiled, and hot-boiled) was used to rinse food off crop needles prior to insertion, helping to reduce discomfort to the chick.

Crop needles were sterilised with chlorhexidine and rinsed between chicks as in the previous season; syringes were sterilised (or clean ones used) only occasionally during the day as they did not come into contact with the chicks.

2.2.7 Clean up

Procedures for cleaning feeding equipment were the same as in the previous season. Surplus fish mixture was discarded in the sea. Crop needles were soaked in anti-bacterial solution for less than an hour to reduce corrosion; the rest of the equipment was sterilised by overnight soaking.

2.2.8 Gate removal

The removal of gates from burrow entrances was undertaken at the end of the day when all feeding had finished. This meant that restless chicks ready for gate removal could not wander out during the day. Two people visited all burrows, checked the gate status, and removed gates from burrows containing chicks with wings ≥ 160 mm. The first gates were removed on 17 January, three days after chick arrival on the island, and the last gate came off on 29 January.

2.2.9 Pre-fledging emergence behaviour

Stick fences were set at non-gated burrow entrances from 18 January onwards to give an indication of any chick movement out of burrows before fledging. Initially, only two-stick fences were erected; as the project progressed (28 January onwards), more time was available to carefully set three-stick fences at each entrance. The status of the three-stick fences—down or intact—was more easily and more reliably interpreted the following morning than for the two-stick fences.

2.2.10 Statistical analysis

Means are presented \pm standard error (s.e.). Data sets were compared using two-tailed Student's t-tests, assuming unequal variance. The relationships between fledging wing length, weight and the time (days) chicks spent on Mana Island were explored using correlation analysis within Microsoft Excel.

3. Results

3.1 FAIRY PRION CHICKS ON TAKAPOUREWA

3.1.1 Finding the chicks

Prion chicks were relatively easy to locate at the dam paddock. A total of 56.75 person-hours was required to find 120 chicks that met the predetermined size criteria (Table 1). A total of 225 chicks was found at a rate of 4.0 per person-hour of searching (compared to a rate of 3.5 chicks per person-hour of searching at the same site in 2002). During this search a further 181 burrows were recorded as empty, 20 had addled eggs and 8 contained tuatara. No record was kept of burrows that were too long to reach the nest chamber, but these comprised at least half of the total.

3.1.2 Selecting chicks for transfer

Wing lengths of chicks found ranged from 30 to 167 mm, with a modal length of 121 mm. The chicks selected for transfer all had wing lengths 95–140 mm, and weighed more than 128 g (Fig. 1). By the time the chicks were transferred (14 January) wing lengths were 106–155 mm (mean 130.0 ± 1.14 mm), and weights were 111–184 g (mean 153.2 ± 1.60 g). Band numbers used on Takapourewa were D-180401 to D-180520; band numbers of the 100 chicks transferred are given in Appendix 3.

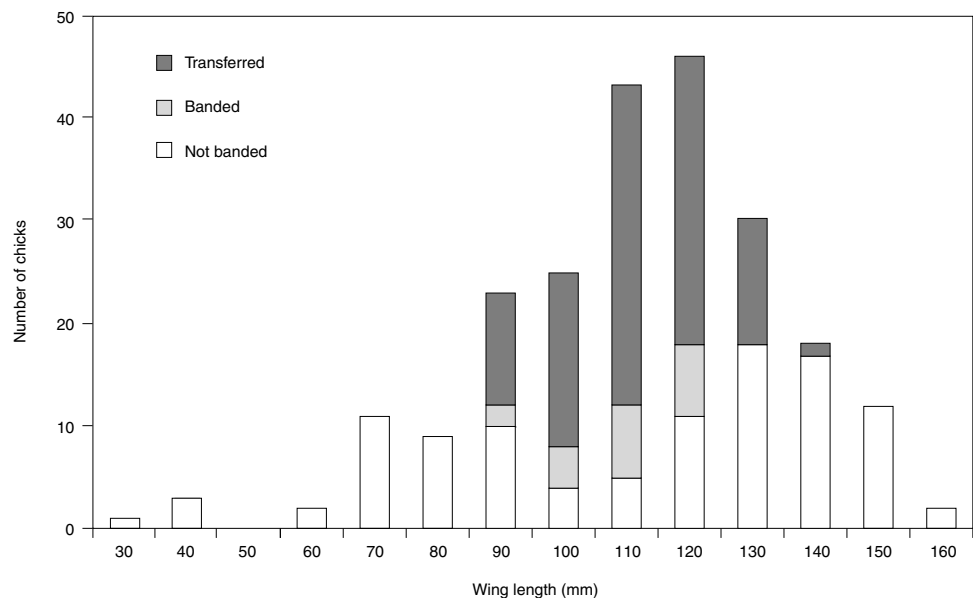


Figure 1. Wing lengths of fairy prion chicks handled on Takapourewa 10–11 January 2003. Most chicks with wing lengths 92–140 mm were banded ($n = 120$), and 100 of these were selected for transfer.

Of the 197 chicks with wing lengths greater than 91 mm handled in 2003, 91% weighed 120 g or more, and 98% weighed 110 g or more.

3.1.3 Predicting fledging date based on wing lengths

Mean wing growth rate for the 100 transferred chicks while on Takapourewa was 4.0 ± 0.08 mm per day. Assuming a wing length of 169 mm at fledging (Miskelly &

Williams 2002), the estimated fledging dates for the 225 chicks handled on Takapourewa would have been 10 January to 14 February, peaking about 22 January (Fig. 2).

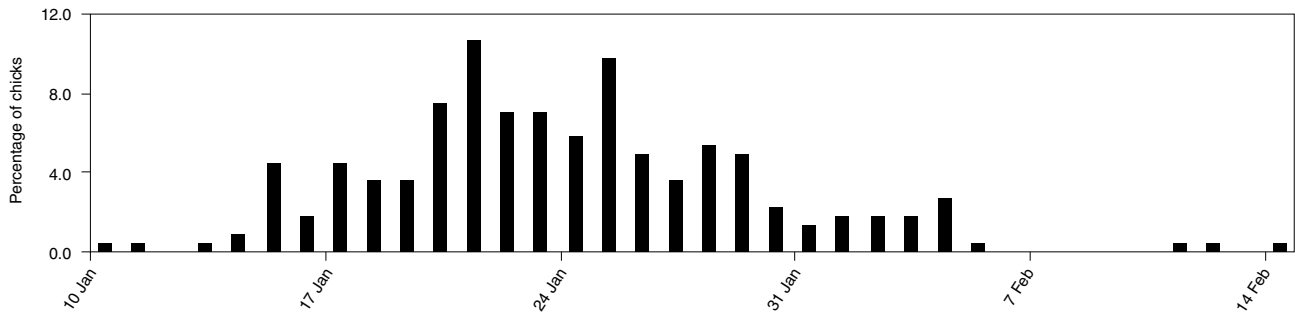


Figure 2. Predicted fledging dates for fairy prion chicks from the dam paddock, based on wing lengths of 225 chicks measured on 10 & 11 January 2003.

3.1.4 Comparisons with 2002 chicks on Takapourewa

On average, the 2003 prion chicks were about 2 days ahead of the stage of development recorded for chicks in 2002 (modal wing-length 121 mm and 115 mm on 10–11 January each year respectively). Mean daily wing growth rate for the transferred chicks while on Takapourewa was significantly faster in 2003 (4.0 mm) than 2002 (3.2 ± 0.23 mm; t-test, $P < 0.001$) and this may be sufficient to explain the slightly advanced development. Note that lay and hatch dates were not known for either year.

3.2 FAIRY PRION CHICKS ON MANA ISLAND

3.2.1 Survival rates

All 100 fairy prion chicks transferred to Mana Island in 2003 are presumed to have fledged, and all departed at weights and wing lengths considered appropriate for fledging.

Both brands of sardine were readily accepted, and no associated poor health or mortality was recorded. During the transition from a natural parent-fed diet to the artificial sardine diet, regurgitant was seen to contain orange oil in the first day of feeding, then a green-coloured oil, and thereafter the yellow (soya) oil. Health issues not related to diet included a chick with a sealed eye found on the day after transfer; the eye was bathed daily in water until it opened, and it appeared ‘healed’ well before fledging. Ticks were observed on the faces of several chicks during the first few days after transfer but were not noticed after this.

One burrow had its gate reinstalled for the fourth and fifth night following first removal, to prevent the chick leaving. This chick badly soiled its head feathers by regurgitation of stomach oil after a feed, and it needed to clean up (preen) before departing to sea. The chick fledged the night that the gate was removed again; its departure may therefore have been artificially delayed by a day or two. The departure of another chick may have been delayed by one night when it was accidentally returned to a neighbouring gated burrow; the mix-up was identified and rectified the following morning.

3.2.2 Growth rates

Chicks fed Chilean sardines were, on average, heavier on arrival, but this difference was not significant (Table 3, $P = 0.12$); there was no significant difference in initial wing length. Wing length growth rates were very similar between the two groups, but birds fed on Chilean sardines lost weight more rapidly (mean 5.4 ± 0.62 g d^{-1} vs 3.0 ± 0.26 g d^{-1} ; $P = 0.002$). This meant that “Chilean” birds were comparatively lighter when they reached the threshold wing length for gate removal, resulting in them departing more rapidly after the gates were removed ($P = 0.02$). As the heavier “Canadian” chicks stayed longer after reaching the threshold wing length, their wings continued to grow, resulting in this group having significantly longer wings at fledging (Table 3, and Appendix 4; $P = 0.03$). Birds with longer/broader wings are able to carry more bodyweight, and the “Canadian” chicks fledged on average 18 g heavier ($P < 0.001$). During the time that the chicks were on Mana Island, “Chilean” chicks lost an average of 53.5 ± 3.24 g, and “Canadian” chicks lost an average of 28.8 ± 1.73 g ($P < 0.001$).

TABLE 3. FLEDGING DATA FOR FAIRY PRION CHICKS FED TWO DIFFERENT BRANDS OF TINNED SARDINES ON MANA ISLAND (2003).

	CHILEAN SARDINES* (N=16)			CANADIAN SARDINES (N=84)			T-TEST P	ALL CHICKS (N=100)		
	MEAN	S.E.	RANGE	MEAN	S.E.	RANGE		MEAN	S.E.	RANGE
No. of days chick on Mana Island	11.0	0.82	5-17	11.6	0.42	5-21	0.52	11.5	0.38	5-21
Arrival weight (g)	158.4	3.38	126-184	152.2	1.78	111-184	0.12	153.2	1.60	111-184
Pre-feed chick weight on morning of fledging (g)	105.0	1.51	94-118	123.4	1.16	100-149	<0.001	120.5	1.21	94-149
Mean rate of weight loss (g d^{-1})	5.4	0.62	2.1-11.2	3.0	0.26	-1.0-10.5	0.002	3.4	0.26	-1.0-11.2
Total weight loss during feeding (g)	53.5	3.24	31-79	28.8	1.73	-9-63	<0.001	32.7	1.78	-9-79
Wing length on arrival (mm)	128.7	2.34	110-145	130.3	1.28	106-155	0.55	130.0	1.14	106-155
Wing length on morning of fledging (mm)	166.6	1.23	160-175	169.6	0.59	159-182	0.03	169.2	0.55	159-182
Mean rate of wing length increase (mm d^{-1})	3.5	0.10	2.7-4.4	3.4	0.03	2.8-3.9	0.48	3.4	0.03	2.7-4.4
No. of nights gate off before chick departure	3.1	0.38	1-6	4.2	0.21	1-8	0.02	4.0	0.19	1-8

* Five chicks fed daily on the Chilean sardines received a single day of Canadian sardines mix on 16 January when the Chilean mix ran out for that day. The Chilean sardines then lasted to the end of the project.

Chick fledging wing lengths and weights appeared to be influenced by the length of time that individual chicks were on Mana Island, i.e. the number of days chicks received the artificial diet. Well-developed chicks that fledged soon after transfer fledged with significantly shorter wing lengths ($r = -0.86$, $P < 0.001$) and lighter weights ($r = 0.41$, $P < 0.001$) than those chicks that received the artificial diet for a longer period (Tables 4 & 5). This is probably due to birds that were fed sardines for

longer maintaining their fat reserves longer, and needing to develop longer wings before being able to take flight. This suggests that sardines provided a more energy-rich diet than the natural diet (predominantly small crustaceans).

TABLE 4. FLEDGING DATA FOR FAIRY PRION CHICKS IN RELATION TO DAYS ON MANA ISLAND (2003).

NO. DAYS ON MANA I.	CHICK FLEDGING WEIGHT (g)			CHICK FLEDGING WING LENGTH (mm)		
	MEAN	S.E.	RANGE	MEAN	S.E.	RANGE
1-5 days (n=7)	113.1	1.62	108-120	164.3	1.11	161-169
6-10 days (n=36)	117.3	1.78	98-134	167.0	0.76	159-177
11-15 days (n=43)	120.5	1.85	94-148	169.6	0.80	160-180
16-21 days (n=14)	132.1	2.93	106-149	175.6	0.73	173-182

TABLE 5. CORRELATION ANALYSIS OF FACTORS THAT MAY INFLUENCE SIZE AND CONDITION OF FAIRY PRION FLEDGLINGS.

PARAMETERS COMPARED	<i>R</i>	<i>P</i>
Days on Mana vs arrival weight	-0.108	NS
Days on Mana vs departure weight	0.411	< 0.001
Days on Mana vs change in weight	0.377	< 0.001
Days on Mana vs arrival wing length	-0.864	< 0.001
Days on Mana vs departure wing length	0.558	< 0.001
Days on Mana vs change in wing length	0.971	< 0.001
Arrival weight vs departure weight	0.221	< 0.05
Arrival weight vs change in wing length	-0.110	NS.
Departure weight vs change in wing length	0.405	< 0.05

3.2.3 Fledging dates

All chicks spent a minimum of three days on Mana Island, blockaded into burrows. The first chicks departed on the night of 19 January 2003, after five days on the island (Table 6). The last chick to fledge departed on the night of 4 Feb 2003, after a stay of 21 days. The mean number of days that chicks spent on Mana Island was 11.5 ± 0.38 days, with chicks fed Chilean sardines staying a mean of 11.0 ± 0.82 days, compared to 11.6 ± 0.42 days for chicks fed Canadian sardines (Appendix 3; Table 3, t-test, $P = 0.52$).

Of the 100 chick sample, only 10% fledged on the first night after gate removal from their burrow entrance (Table 7), indicating that the recommended wing length of 160 mm before gate removal was appropriate. The mean number of days that chicks occupied burrows after gates had been removed was 4.0 ± 0.19 days, with chicks fed Chilean sardines staying in burrows a mean of 3.1 ± 0.38 days, compared to 4.2 ± 0.21 days for chicks fed Canadian sardines (Table 3).

TABLE 6. LENGTH OF TIME FAIRY PRION CHICKS SPENT ON MANA ISLAND IN 2003

	NUMBER OF DAYS SPENT ON MANA ISLAND																
	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
No. chicks (Chilean)	1	0	0	2	3	3	2	0	0	1	3	0	1	0	0	0	0
No. chicks (Canadian)	6	3	5	4	10	6	7	8	7	10	5	3	4	2	2	1	1
Total no. chicks	7	3	5	6	13	9	9	8	7	11	8	3	5	2	2	1	1

TABLE 7. FAIRY PRION CHICK OCCUPANCY IN BURROWS FOLLOWING GATE REMOVAL ON MANA ISLAND (2003).

No. nights gate off before chick fledged	1	2	3	4	5	6	7	8
No. of chicks(= % of total chicks)	10	14	21	17	16	8*	10	4

* Includes chick 59 with delayed departure (gate deliberately reinstalled for 4th and 5th night), and chick 75 accidentally placed in an adjacent gated burrow on its 5th night.

Monitoring of pre-fledging emergence behaviour revealed that 56% of fairy prion chicks fledged on their first night outside the burrow (Table 8). Thirty-six percent of chicks are likely to have emerged, or at least put heads out the burrow entrance, on the night before the actual fledging night. Approximately 7% of the burrows showed evidence that the occupants emerged for three nights, fledging on the third. Any fences knocked down before or in the middle of a series of intact recordings were discarded as likely to be knocked over by other means (e.g. wind, or another bird). Based on the low number of nights that the prions spent outside their burrows before fledging, we predict that the length of time prion chicks spent on Mana will have little effect on rates of return to Mana Island (i.e. it is unlikely that any of the transferred chicks had emerged from their burrows while on Takapourewa).

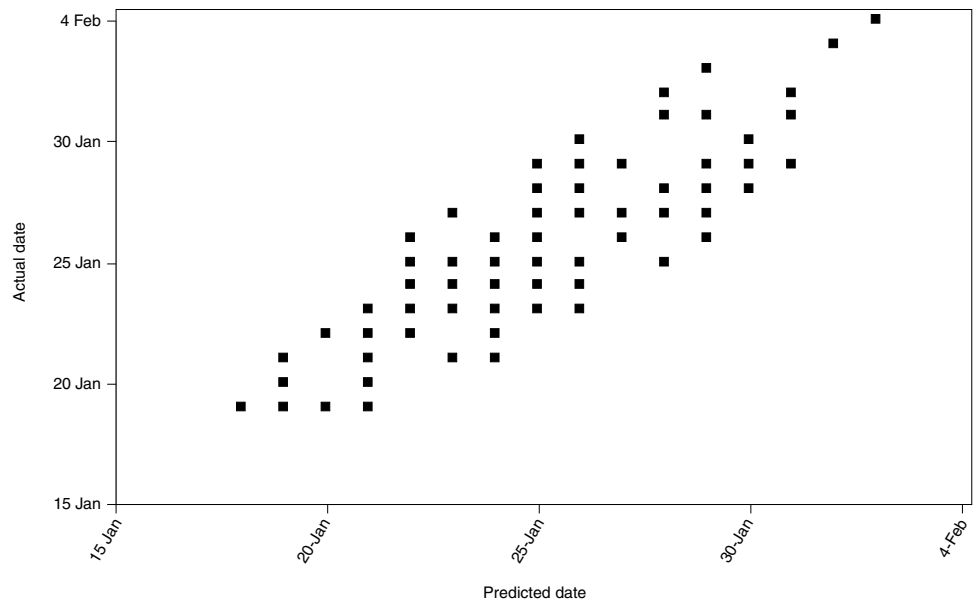
TABLE 8. PRE-FLEDGING EMERGENCE BEHAVIOUR OF FAIRY PRION CHICKS ON MANA ISLAND (2003).

NO. SUCCESSIVE NIGHTS FENCE DOWN BEFORE CHICK FLEDGED (INCLUDES NIGHT OF FLEDGE)			
	1	2	3
No. chicks (n= 96)	54	35	7

Only one chick was known to have entered a burrow other than its own. Burrow 40 chick was found one morning in the adjacent burrow 38, sitting on top of the resident chick. Burrow 40 chick was close to departing; the two burrow entrances were situated very close together.

All 100 chicks fledged within 4 days of their predicted fledging date (based on wing measurements from 14 January): 23% fledged on the predicted date, 49% within 1 day, 83% within 2 days, and 93% within 3 days (Fig. 3). Thirty-six percent fledged before their predicted date, and 41% after.

Figure 3. Relationship between predicted and actual fledging dates of 100 fairy prions transferred to Mana Island in January 2003; $r = 0.86$, $P < 0.001$. All birds fledged within 4 days of their predicted fledging date.



3.2.4 Comparison between chicks fed with Canadian sardines in 2002 & 2003

The chicks transferred to Mana Island in 2003 were purposely selected to be, on average, about 3 days less advanced than the chicks transferred in 2002 (Table 9), making comparisons of arrival wing lengths and the length of time spent on Mana Island meaningless. Also, the 84 chicks selected for feeding Canadian sardines in 2003 were much heavier on transfer than the 20 chicks fed Canadian sardines in 2002 (mean 152 ± 1.8 g versus 135 ± 2.1 g respectively; Table 9, $P < 0.001$). The good condition of the chicks transferred in 2003 was carried through to fledging, although there was no significant difference in the rate of weight loss between the two years (t-test, $P = 0.67$). There was no significant difference between wing growth rates between the two years (t-test, $P = 0.76$) or in fledging wing length (t-test, $P = 0.47$).

TABLE 9. COMPARISON OF CHICK GROWTH RATES FOR CHICKS FED ON CANADIAN “BRUNSWICK” SARDINES IN 2002 AND 2003.

	2002 (N=20)			2003 (N=84)			T-TEST P
	MEAN	S.E.	RANGE	MEAN	S.E.	RANGE	
No. of days chick on Mana Island	8.2	0.65	3-13	11.6	0.42	5-21	
Arrival weight (g)	134.6	2.10	118-154	152.2	1.78	111-184	< 0.001
Pre-feed chick weight on morning of fledging (g)	115.3	1.52	105-135	123.4	1.16	100-149	< 0.001
Mean rate of weight loss (g/day)	2.6	0.44	0.2-9.2	3.0	0.26	-1.0-10.5	0.67
Wing length on arrival (mm)	141.3	2.02	127-156	130.3	1.28	106-155	
Wing length on morning of fledging (mm)	169.0	0.63	166-176	169.6	0.59	159-182	0.47
Mean rate of wing length increase (mm/day)	3.4	0.11	2.6-4.3	3.4	0.03	2.8-3.9	0.76

3.2.5 Comparison of fledging weights with those from previous studies

The fairy prions fed on Canadian sardines on Mana Island in 2003 fledged in excellent condition, with body weights well in excess of those predicted for fledglings from the latitude of Cook Strait (Table 10). Unfortunately there is no data available on natural fledging weights for fairy prions from Stephens Island (latitude 40° 40' S); however, these are likely to average about 106 g, based on fledging weights from the Poor Knights Islands (lat 35° 30' S; mean 100.5 g) and Whero Island, Stewart Island (lat 47° S; mean 112.7 g). The birds fed on Chilean sardines fledged at an average weight of 105 g, while the birds fed on Canadian sardines were significantly heavier (Tables 3 & 10), and were comparable in size to fledglings from the southernmost study location of the Snares Islands (latitude 48° S).

TABLE 10. FAIRY PRION FLEDGING WEIGHTS FROM FOUR LOCALITIES. DATA FOR OTHER STUDIES FROM HARPER (1976; POOR KNIGHTS I.), MISKELLY & WILLIAMS (2002; MANA ISLAND 2002), RICHDALE (1965; WHERO ISLAND), AND MISKELLY *ET AL.* (2001) AND ALAN TENNYSON PERS. COMM. (SNARES I.).

LOCATION	LAT. (°S)	DIET	FLEDGING WEIGHT (g)			
			N	MIN	MEAN	MAX
Poor Knights Islands	35.5	Natural	26	85	100.5	118
Mana Island 2002	41.1	Krill	18	88	104.3	126
Mana Island 2003	41.1	Chilean sardines	16	94	105.0	118
Mana Island 2002	41.1	Canadian sardines	20	105	115.3	135
Mana Island 2003	41.1	Canadian sardines	84	100	123.4	149
Whero Island	47.0	Natural		90	112.7	131
Snares Islands	48.0	Natural	17	106	126.5	144

3.2.6 Comparison of two sardine brands

The 106 g tins of Canadian sardines were easier to prepare to the appropriate consistency, with a single 'recipe' (water volume to fish) for every blend. The 425 g tins of larger Chilean sardines took longer to prepare and different batches did not always contain the same volume of water to fish. The lower cost of these tins may not prove more economic, as a full tin stills needs to be opened to feed just a few chicks towards the end of the project (i.e. there is greater food wastage than when using tins containing a quarter of the net weight).

Birds fed the Canadian sardines had lower rates of weight loss, and fledged at significantly higher bodyweights. The Canadian sardines were therefore easier to prepare and provided a better diet.

3.2.7 Storm-cast fairy prions bought to Mana Island from the mainland

On 25 January 2003 two extra fairy prions fledglings were delivered to the Mana Island colony site and housed in two spare burrows, each gated for two nights. Measurements were taken and each bird was fed a total of 55 g and 57 g of Canadian sardine diet over three feeds. Gates were removed on 27 January and burrows were found to be empty the following morning. The birds were banded D-175901 and D-175902, and fledged at 96 g weight and 169 mm wing, and 107 g weight and 182 mm wing respectively.

4. Discussion

Fairy prion chicks were easier to find on Takapourewa in 2003, and were in better condition (and growing faster) than the chicks found in 2002. The first two transfers of fairy prion chicks have resulted in good numbers of chicks fledging from Mana Island after 6–15 days on the island, and lesser numbers of older and younger chicks. Once chicks start returning to Mana Island, it will be invaluable to learn the age of transferred chicks that produces the highest rate of return, to guide future restoration programmes (e.g. on the Rangitoto Islands off D'Urville Island).

Effort should be made in 2004 to select a large proportion of chicks close to fledging, with smaller numbers of chicks in each of the 6–10, 11–15 and 16–20 day ranges as per Table 11. Although this will produce a relatively small total for birds that spend more than 16 days on Mana (30 chicks), available information on dates of emergence for fairy prions (only 0–2 nights before fledging) suggest that there will be little added benefit for chicks to spend more than two weeks at the transfer site. Focusing effort on one age group (i.e. chicks less than 5 days from fledging) will also reduce the search effort required on Takapourewa compared to trying to build up numbers in both 0–5 and 16–20 day categories. We suggest that in 2004 the transfer date be 17 January (i.e. 5 days before predicted modal fledging date of 22 January; Table 12), with the collection team present 13–17 January.

TABLE 11. ACTUAL (2002 & 2003) AND TARGET (2004) LENGTH OF TIME FAIRY PRIONS SPENT ON MANA ISLAND BEFORE FLEDGING, TO ENSURE A RANGE OF AGES IN ORDER TO ALLOW DETERMINATION OF THE BEST AGE FOR TRANSFER.

	0-5 DAYS	6-10 DAYS	11-15 DAYS	16-20+ DAYS
2002 (actual)	10	20	10	0
2003 (actual)	7	36	43	14
2004 (target)	53	14	17	16
Total (target)	70	70	70	30

TABLE 12. WING LENGTHS (mm) FOR PREDICTING FLEDGING DATES OF TRANSFERRED FAIRY PRION CHICKS, ASSUMING A TARGET TRANSFER DATE OF 17 JANUARY.

DATE MEASURED	PREDICTED FLEDGING DATE			
	19-22 JAN	23-27 JAN	28 JAN-1 FEB	2-6 FEB
13 Jan	131-141	117-130	105-116	92-104
14 Jan	135-145	121-134	109-120	96-108
15 Jan	139-149	125-138	113-124	100-112
16 Jan	143-153	129-142	117-128	104-116
17 Jan	147-157	133-146	121-132	108-120

5. Recommendations

Following the success of this second transfer of fairy prion chicks, we make the following recommendations:

1. That the Friends of Mana Island Society and Wellington Conservancy confirm existing approvals from Ngati Koata and Nelson/Marlborough Conservancy for one further transfer of up to 100 fairy prion chicks in January 2004.
2. That Ngati Koata and Ngati Toa be invited to participate in the transfer.
3. That the ideal dates for locating fairy prion chicks on Takapourewa are 13-17 January, with transfer on or soon after 17 January.
4. That, if possible, all chicks be sourced from the dam paddock on Takapourewa, so that future searches for any transferred chicks that return to Takapourewa can focus on one site.
5. That chicks be selected (based on wing measurements) so that a target of 53 should stay on Mana Island for 1-5 days before fledging, 14 for 6-10 days, 17 for 11-15 days, and 16 for 16-20 days.
6. That top priority be given to chicks heavier than 120 g, and that chicks less than 110 g not be transferred [this may need to be reconsidered on site if there is a poor prion feeding year at sea].
7. That a team visit Mana Island to prepare 100 burrows in advance of the chicks arriving.
8. Ensure the initial feeding teams have sufficient experienced personnel to manage the high work load involved in feeding 100 chicks.
9. Maintain two feeding teams, with three members per team (feeder, holder, runner/measurer), with a seventh team member (the contractor) scribing, training, estimating meal sizes, re-checking wing measurements at key times etc. Refer Appendix 1 for recommended team sizes and staff numbers for 2004.
10. Consider staggering the team crossovers by bringing out three new team members on the Friday night or Saturday morning and taking three old team members off. Then repeat with the remaining numbers on the Sunday night/Monday morning.
11. That the same food preparation and feeding method used for the Brunswick sardine diet in 2002 & 2003 be used for the final transfer (about 300 cans required).
12. That gates be removed from burrow entrances when wing length equals or exceeds 160 mm, but that the gate be present for a minimum of two nights.
13. If continuing to observe pre-fledging emergence behaviour, use 3-stick fences only throughout the project, and consider erecting stick fences at the inside end of the pipe tunnel to provide more concrete evidence of movement (eliminate wind-blown fences).
14. Obtain a wing-rule that is 'stopped' right across the end to make measuring wings easier, more accurate and more consistent, especially for less experienced handlers.

15. Purchase the following equipment:

Crop needles: 3 new 100 mm, 8 gauge, curved crop needles (these needles have a short life span with continual usage and must be discarded when cracks appear on the ball)

Food flask (1 litre): water-bath for food pottles (a second water-bath is required to allow teams to work independently, or to enable the next batch of food to start warming)

Syringes, soft tissues, kitchen towel, notebooks etc.

20. That efforts be made to search for returning banded chicks on both Mana Island and on Takapourewa (at the dam paddock) between September and December each year, starting in 2004*. A total of 193 fairy prion chicks were banded at the dam paddock in 2002 & 2003, of which 131 were transferred to Mana Island.

* Recent information from Otago Peninsula has shown that 0/55 fairy prion fledglings returned within 2 years of fledging, and 3/23 returned within 3 years (Graeme Loh, pers. comm.). If age of return is the same in Cook Strait, then some of the chicks banded and/or transferred in January 2002 should return to Mana Island and Takapourewa in September–November 2004.

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The volunteer feeders were organised and coordinated through the Friends of Mana Island, principally by Colin Ryder. Graeme Taylor provided much technical advice and assistance immediately before the transfer, and Helen Gummer managed the daily work programme for the teams of volunteer feeders, plus participating fully in the daily routine and recording of data. We are greatly indebted to the teams of volunteer feeders, who gave up their time to provide the necessary labour to feed and care for the chicks until they fledged: Ros Bacheler, Andy Collings, Reg Cotter, Barbara Deliere, Barry Dent, Andy Falshaw, Sue Freitag, Ruth Gregg, Annette Harvey, Dee Hudson, Kelvin Hunt, Shelley Meehan, Rhys Mills, Lance Mundy, Merrin Pearse, Luke Rawnsley, Mailee Stanbury and Louise Taylor.

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Appendix 1

FAIRY PRION PROJECT LABOUR (VOLUNTEERS AND STAFF) FOR 2003 AND RECOMMENDATIONS FOR LABOUR IN 2004

DATE	DAY FROM ARRIVAL OF CHICKS	NO. OF CHICKS FED	NO. OF VOLUNTEERS	NO. OF STAFF	STAFF HOURS	RECOMMEND NO. OF VOLUNTEERS FOR 2004 ¹	RECOMMEND STAFF FOR 2004 ^{1,2}
12 Jan	2		4	2 (GT, HG)	8	6	1 (x)
13 Jan	1		4	2 (GT, HG)	8	6 (+ 1 cook)	1 (x)
14 Jan	Arrival		4	2 (GT, HG)	8	6 (+ 1 cook)	2
15 Jan	1	100	5	1 (HG)	15	6 (+ 1 cook)	2
16 Jan	2	100	5	1 (HG)	15	6 (+ 1 cook)	2
17 Jan	3	100	5	1 (HG)	13	6 (+ 1 cook)	2
18 Jan	4	100	6 (5 new)	1 (HG)	14	6 (+ 1 cook)	2
19 Jan	5	100	6	1 (HG)	13	6 (+ 1 cook)	2
20 Jan	6	93	6	1 (HG)	12	6 (+ 1 cook)	2
21 Jan	7	90	6	2 (HG, LA)	11	6 (+ 1 cook)	2 (x off)
22 Jan	8	85	6	2 (HG, LA)	9	6	1 (y)
23 Jan	9	79	6	2 (BB, LA)	11?	6	1 (y)
24 Jan	10	66	6	2 (BB, LA)	10?	3	2 (change)
25 Jan	11	57	8 ³ (6 new)	1 (BB)	12	3	1 (x)
26 Jan	12	48	8 ³	1 (BB)	9	3	1 (x)
27 Jan	13	40	3	2 (BB, HG)	8	3	1 (x)
28 Jan	14	33	5	1 (HG)	8	3	1 (x)
29 Jan	15	22	5 ³	1 (HG)	8	3	1 (x)
30 Jan	16	14	5 ³	1 (HG)	8	3	1 (x)
31 Jan	17	11	3	1 (HG)	8	1	1 (x)
1 Feb	18	6	3	1 (HG)	8	1	1 (x)
2 Feb	19	4	3	1 (HG)	8	1	1 (x)
3 Feb	20	3	1	1 (HG)	8	1	1 (x)
4 Feb	21	1	1	1 (HG)	8	1	1 (x)
5 Feb	22	0	0	1 (HG)	8	1	1 (x)

1 Recommendations based on 100 chicks transferred around similar dates (transfer date likely to be 17 January 2004).

2 Recommendation is for 2 contractors, with one employed for 10 days (days 3-13) only

3 Surplus volunteers (these numbers not essential to achieve the task)

GT = Graeme Taylor, HG = Helen Gummer, LA = Lynn Adams, BB = Ben Barr

Total volunteer effort for 2003 fairy prion feeding on Mana = 139 volunteer days.

Appendix 2

FAIRY PRION CHICK FEEDING EQUIPMENT LIST

Burrow preparation

Hand trowels: 1/person
Spades: 1/person
Spare wooden burrow lids
Paint and small paint brush (numbering lids)
Plastic mesh and thick wire (gates)

Food preparation

Dettol anti-bacterial flowing soap
Large kettle (boiling water for making food, and for hot water at feeding site)
2 × blender
Stainless steel measuring jug
Rubber spatula
Ordinary kitchen knife
Can opener
295 × Brunswick Canadian sardines in soya oil (106 g tin)
21 × Ocean Catch Chilean sardines in natural oil (425 g can)
20 × plastic 350 ml pottles (for carrying blended fish)

Water requirements at feeding site

2 × 2 l thermos flasks of hot (boiled) water per day
Several water containers (total up to 8 l) for cold (boiled) water
Several 20 l buckets of fresh tap water (include one for hand-washing)

Transport to site

Chilly bin with 2–3 freezer packs (for food pottles)
Large plastic box (for sterile feeding equipment)
2 × 10 litre plastic buckets (for rest of food)
3 × 20 litre plastic buckets (dry equipment, flasks and bottles)

Feeding

Dettol anti-bacterial flowing soap or anti-bacterial hand wipes
3 × crop needles (100 mm, 8 g, curved)
50 × 20 ml syringes
Food flask (hot water-bath)
Teaspoon
2 × stainless steel bowls (waste)
2 × plastic tubs for washing out crop needles
3 × shallow plastic containers for disinfecting and rinsing crop needles
500 ml × 5% 'Hibitane' chlorhexidine gluconate solution (5% conc. – mix 20ml/
litre water)
4 × tea towels (for feeder's lap)
6 rolls of kitchen towels
20 × soft paper tissues (boxes)

Weighing and measuring

2 × Pesola balance (300 g)

10 × 250 mm x 300 mm plastic bags (boxes) for weighing

Wing rule (stopped at one end)

Back-up tape measure

2 × waterproof notebooks

Pencils (lots)

Clean up

3 × Johnson's anti-bacterial tablets (30 tablets/box)

Dishwashing liquid, brush, bottle brush

10 litre plastic container (soaking equipment in anti-bacterial solution)

Appendix 3

FLEDGING DATA OF FAIRY PRION CHICKS, MANA ISLAND (2003)

BAND NO.	BURROW	SARDINE DIET	FLEDGING DATE (EVENING)	NO. DAYS ON MANA	NO. NIGHTS GATE OFF BEFORE DEPARTURE	PRE-FEED MORNING WEIGHT (g)	POST-FEED MORNING WEIGHT (g)	FINAL WING LENGTH (mm)
D180401	18	Canadian	20 Jan	6	4	122	134	174
D180404	38	Canadian	30 Jan	16	4	151	158	173
D180405	6	Chilean	29 Jan	15	4	110	132	173
D180406	31	Canadian	23 Jan	9	4	134	142	170
D180407	34	Canadian	28 Jan	14	3	118	127	165
D180408	37	Canadian	24 Jan	10	5	114	120	171
D180409	32	Canadian	24 Jan	10	2	112	128	162
D180411	20	Canadian	23 Jan	9	5	122	136	174
D180413	7	Chilean	31 Jan	17	6	108	128	175
D180414	8	Chilean	22 Jan	8	3	110	122	165
D180415	93	Canadian	29 Jan	15	7	121	126	175
D180416	90	Canadian	31 Jan	17	7	133	138	173
D180418	24	Canadian	31 Jan	17	5	128	140	176
D180419	22	Canadian	28 Jan	14	5	131	135	171
D180420	95	Canadian	28 Jan	14	2	129	132	166
D180421	21	Canadian	23 Jan	9	7	136	142	177
D180422	73	Canadian	26 Jan	12	6	124	132	171
D180424	23	Canadian	25 Jan	11	5	131	143	173
D180425	62	Canadian	26 Jan	12	6	116	118	172
D180426	91	Canadian	21 Jan	7	1	120	140	159
D180427	89	Canadian	24 Jan	10	5	136	144	170
D180429	86	Canadian	27 Jan	13	3	141	146	168
D180430	99	Canadian	29 Jan	15	7	126	134	180
D180431	12	Chilean	25 Jan	11	4	106	138	167
D180432	88	Canadian	21 Jan	7	2	130	152	163
D180433	53	Canadian	21 Jan	7	3	118	120	169
D180434	54	Canadian	30 Jan	16	8	130	142	178
D180435	98	Canadian	23 Jan	9	4	136	144	169
D180436	92	Canadian	28 Jan	14	5	121	129	173
D180437	51	Canadian	29 Jan	15	7	141	146	180
D180438	61	Canadian	28 Jan	14	5	129	133	172
D180439	11	Chilean	19 Jan	5	3	110	126	167
D180440	87	Canadian	24 Jan	10	3	120	128	170
D180441	28	Canadian	19 Jan	5	1	118	132	162
D180442	4	Chilean	22 Jan	8	3	110	122	166
D180443	56	Canadian	29 Jan	15	3	150	161	167
D180444	27	Canadian	19 Jan	5	2	112	122	164
D180445	52	Canadian	22 Jan	8	4	114	134	172
D180448	101	Canadian	25 Jan	11	5	126	140	172
D180450	100	Canadian	19 Jan	5	2	114	128	162
D180451	39	Canadian	26 Jan	12	4	106	114	164
D180452	82	Canadian	25 Jan	11	4	113	123	171
D180453	46	Canadian	19 Jan	5	2	122	126	165
D180455	45	Canadian	25 Jan	11	6	114	120	172
D180456	83	Canadian	28 Jan	14	3	118	133	168
D180457	17	Canadian	19 Jan	5	3	118	128	169
D180458	57	Canadian	22 Jan	8	3	128	150	169
D180460	80	Canadian	28 Jan	14	6	114	119	172

BAND NO.	BURROW	SARDINE DIET	FLEDGING DATE (EVENING)	NO. DAYS ON MANA	NO. NIGHTS GATE OFF BEFORE DEPARTURE	PRE-FEED MORNING WEIGHT (g)	POST-FEED MORNING WEIGHT (g)	FINAL WING LENGTH (mm)
D180461	60	Canadian	23 Jan	9	3	126	130	165
D180462	50	Canadian	27 Jan	13	4	122	127	166
D180463	3	Chilean	23 Jan	9	1	106	130	163
D180464	40	Canadian	1 Feb	18	6	142	144	173
D180465	81	Canadian	2 Feb	19	8	140	143	174
D180466	75	Canadian	28 Jan	14	2	138	144	165
D180467	49	Canadian	22 Jan	8	4	118	132	169
D180468	77	Canadian	26 Jan	12	3	128	145	164
D180469	5	Chilean	24 Jan	10	3	102	133	167
D180470	58	Canadian	25 Jan	11	3	105	114	165
D180471	13	Chilean	23 Jan	9	1	106	112	160
D180472	84	Canadian	2 Feb	19	7	122	127	175
D180473	74	Canadian	20 Jan	6	2	110	122	164
D180474	19	Canadian	20 Jan	6	4	112	126	169
D180475	96	Canadian	21 Jan	7	5	130	144	173
D180476	85	Canadian	21 Jan	7	3	120	128	167
D180477	103	Canadian	22 Jan	8	4	102	112	173
D180479	102	Canadian	1 Feb	18	7	143	145	174
D180480	97	Canadian	19 Jan	5	1	112	123	161
D180481	42	Canadian	31 Jan	17	5	137	146	173
D180482	41	Canadian	4 Feb	21	7	146	148	179
D180483	68	Canadian	3 Feb	20	7	132	136	173
D180484	78	Canadian	26 Jan	12	8	140	155	180
D180485	66	Canadian	24 Jan	10	1	104	112	162
D180486	76	Canadian	27 Jan	13	1	129	139	161
D180487	65	Canadian	27 Jan	13	5	126	132	172
D180488	55	Canadian	28 Jan	14	5	148	152	173
D180490	59	Canadian	29 Jan	15	6	122	132	176
D180491	69	Canadian	23 Jan	9	1	124	126	162
D180492	29	Canadian	28 Jan	14	5	124	130	171
D180493	79	Canadian	27 Jan	13	2	122	131	163
D180494	67	Canadian	24 Jan	10	3	134	150	172
D180495	47	Canadian	25 Jan	11	3	115	124	164
D180496	63	Canadian	30 Jan	16	7	138	142	178
D180498	64	Canadian	23 Jan	9	4	122	128	164
D180499	33	Canadian	27 Jan	13	4	129	138	170
D180500	16	Chilean	29 Jan	15	2	97	126	165
D180501	94	Canadian	27 Jan	13	8	128	138	176
D180502	44	Canadian	26 Jan	12	2	128	134	162
D180503	36	Canadian	31 Jan	17	5	127	136	175
D180504	35	Canadian	25 Jan	11	4	128	133	171
D180505	30	Canadian	26 Jan	12	1	120	130	160
D180507	48	Canadian	23 Jan	9	2	132	140	162
D180508	1	Chilean	29 Jan	15	6	111	137	175
D180512	10	Chilean	28 Jan	14	4	108	130	171
D180513	25	Canadian	23 Jan	9	3	130	136	166
D180514	2	Chilean	24 Jan	10	3	100	128	161
D180515	15	Chilean	23 Jan	9	2	120	140	162
D180516	43	Canadian	23 Jan	9	2	122	136	163
D180517	14	Chilean	24 Jan	10	3	112	122	169
D180519	9	Chilean	25 Jan	11	1	96	113	160
D180520	26	Canadian	26 Jan	12	5	119	128	172
Mean for 84 chicks fed Canadian sardines				11.6	4.2	125.4	134.3	169.6
Mean for 16 chicks fed Chilean sardines				11.0	3.1	107.0	127.4	166.6
Mean for all chicks (n = 100)				11.5	4.0	122.5	133.2	169.2

Appendix 4

EFFECT OF DIFFERENT SARDINE BRANDS ON WING GROWTH OF FAIRY PRION CHICKS ON MANA ISLAND (2003)

BURROW	BAND NO.	WING LENGTH ON 14 JAN (mm)	LAST DATE WING MEASURED	FINAL WING LENGTH (mm)	TOTAL GROWTH (mm)	NUMBER OF DAYS	MEAN GROWTH (mm d ⁻¹)	COMMENTS
Chilean sardines								
13	D180471	127	23/01/03	160	33	9	3.7	Canadian on 16th
9	D180519	126	25/01/03	160	34	11	3.1	
2	D180514	134	24/01/03	161	27	10	2.7	Canadian on 16th
15	D180515	130	23/01/03	162	32	9	3.6	
3	D180463	133	23/01/03	163	30	9	3.3	
8	D180414	139	22/01/03	165	26	8	3.3	Canadian on 16th
16	D180500	110	29/01/03	165	55	15	3.7	
4	D180442	135	22/01/03	166	31	8	3.9	
11	D180439	145	19/01/03	167	22	5	4.4	
5	D180469	137	24/01/03	167	30	10	3.0	Canadian on 16th
12	D180431	132	25/01/03	167	35	11	3.2	
14	D180517	134	24/01/03	169	35	10	3.5	Canadian on 16th
10	D180512	120	28/01/03	171	51	14	3.6	
6	D180405	118	29/01/03	173	55	15	3.7	
1	D180508	123	29/01/03	175	52	15	3.5	
7	D180413	116	31/01/03	175	59	17	3.5	
Mean daily wing growth of chicks fed Chilean sardines:							3.47	
Canadian sardines								
91	D180426	133	21/01/03	159	26	7	3.7	Digging to get out
30	D180505	118	26/01/03	160	42	12	3.5	
97	D180480	146	19/01/03	161	15	5	3.0	
76	D180486	117	27/01/03	161	44	13	3.4	
28	D180441	143	19/01/03	162	19	5	3.8	
100	D180450	144	19/01/03	162	18	5	3.6	
48	D180507	128	23/01/03	162	34	9	3.8	
69	D180491	132	23/01/03	162	30	9	3.3	
66	D180485	125	24/01/03	162	37	10	3.7	
32	D180409	129	24/01/03	162	33	10	3.3	
44	D180502	116	26/01/03	162	46	12	3.8	
88	D180432	138	21/01/03	163	25	7	3.6	
43	D180516	133	23/01/03	163	30	9	3.3	
79	D180493	120	27/01/03	163	43	13	3.3	
27	D180444	149	19/01/03	164	15	5	3.0	
74	D180473	143	20/01/03	164	21	6	3.5	
64	D180498	137	23/01/03	164	27	9	3.0	
47	D180495	121	25/01/03	164	43	11	3.9	
77	D180468	122	26/01/03	164	42	12	3.5	
39	D180451	124	26/01/03	164	40	12	3.3	
46	D180453	148	19/01/03	165	17	5	3.4	
60	D180461	140	23/01/03	165	25	9	2.8	
58	D180470	128	25/01/03	165	37	11	3.4	
75	D180466	113	28/01/03	165	52	14	3.7	Gated 1 night in 74
34	D180407	115	28/01/03	165	50	14	3.6	
25	D180513	133	23/01/03	166	33	9	3.7	
50	D180462	126	27/01/03	166	40	13	3.1	
95	D180420	115	28/01/03	166	51	14	3.6	

BURROW	BAND NO.	WING LENGTH ON 14 JAN (mm)	LAST DATE WING MEASURED	FINAL WING LENGTH (mm)	TOTAL GROWTH (mm)	NUMBER OF DAYS	MEAN GROWTH (mm d ⁻¹)	COMMENTS
85	D180476	144	21/01/03	167	23	7	3.3	
56	D180443	114	29/01/03	167	53	15	3.5	
86	D180429	124	27/01/03	168	44	13	3.4	
83	D180456	116	28/01/03	168	52	14	3.7	
17	D180457	155	19/01/03	169	14	5	2.8	
19	D180474	152	20/01/03	169	17	6	2.8	
53	D180433	145	21/01/03	169	24	7	3.4	
57	D180458	144	22/01/03	169	25	8	3.1	
49	D180467	146	22/01/03	169	23	8	2.9	
98	D180435	144	23/01/03	169	25	9	2.8	
31	D180406	139	23/01/03	170	31	9	3.4	
87	D180440	134	24/01/03	170	36	10	3.6	
89	D180427	138	24/01/03	170	32	10	3.2	
33	D180499	125	27/01/03	170	45	13	3.5	
37	D180408	140	24/01/03	171	31	10	3.1	
35	D180504	129	25/01/03	171	42	11	3.8	
82	D180452	131	25/01/03	171	40	11	3.6	
73	D180422	132	26/01/03	171	39	12	3.3	
29	D180492	120	28/01/03	171	51	14	3.6	
22	D180419	125	28/01/03	171	46	14	3.3	
52	D180445	142	22/01/03	172	30	8	3.8	
67	D180494	136	24/01/03	172	36	10	3.6	
101	D180448	135	25/01/03	172	37	11	3.4	
45	D180455	140	25/01/03	172	32	11	2.9	
26	D180520	129	26/01/03	172	43	12	3.6	
62	D180425	134	26/01/03	172	38	12	3.2	
65	D180487	129	27/01/03	172	43	13	3.3	
61	D180438	121	28/01/03	172	51	14	3.6	
80	D180460	128	28/01/03	172	44	14	3.1	
96	D180475	149	21/01/03	173	24	7	3.4	
103	D180477	143	22/01/03	173	30	8	3.8	
23	D180424	138	25/01/03	173	35	11	3.2	
55	D180488	127	28/01/03	173	46	14	3.3	
92	D180436	129	28/01/03	173	44	14	3.1	
38	D180404	113	30/01/03	173	60	16	3.8	
42	D180481	111	31/01/03	173	62	17	3.6	
90	D180416	118	31/01/03	173	55	17	3.2	
18	D180401	152	20/01/03	174	22	6	3.7	
20	D180411	143	23/01/03	174	31	9	3.4	
93	D180415	125	29/01/03	175	50	15	3.3	
36	D180503	117	31/01/03	175	58	17	3.4	
40	D180464	110	1/02/03	175	65	18	3.6	
94	D180501	138	27/01/03	176	38	13	2.9	
59	D180490	127	29/01/03	176	49	15	3.3	Gated extra 2 nights
24	D180418	119	31/01/03	176	57	17	3.4	
21	D180421	143	23/01/03	177	34	9	3.8	
63	D180496	127	30/01/03	178	51	16	3.2	
54	D180434	128	30/01/03	178	50	16	3.1	
81	D180465	115	2/02/03	178	63	19	3.3	
102	D180479	121	1/02/03	179	58	18	3.2	
41	D180482	106	4/02/03	179	73	21	3.5	
78	D180484	141	26/01/03	180	39	12	3.3	
99	D180430	125	29/01/03	180	55	15	3.7	
51	D180437	129	29/01/03	180	51	15	3.4	
84	D180472	116	2/02/03	180	64	19	3.4	
68	D180483	108	3/02/03	182	74	20	3.7	

Mean daily wing growth of chicks fed Canadian sardines:

3.40

Appendix 5

IMAGES FROM THE FAIRY PRION TRANSFER FROM TAKAPOUREWA TO MANA ISLAND, JANUARY 2003

Plate 1. Aerial photograph of Takapourewa showing location of the dam paddock, where all 100 fairy prion chicks transferred in 2003 were sourced from.

A = Dam paddock,
B = Lighthouse, C = House 1,
D = House 2, E = The Palace,
F = The landing block,
G = Queen's Beach,
H = The Razorback.
Image from Brown [2001].



Plate 2. South face of the dam paddock viewed from main track below The Palace, showing areas from which chicks were sourced for transfer in 2002 & 2003. The area should be systematically searched for returning banded birds in spring each year from 2004 to 2008. Photo: C. Miskelly.



Plate 3. Clinton Purches extracts
a fairy prion chick from its
burrow, dam paddock,
Takapourewa, 10 January 2003.
Photo: C. Miskelly.



Plate 4. Two prion chicks inside
"Kitty Karry" box ready for
transfer.
Photo: C. Miskelly.

