Report on fifth and final transfer of mottled petrel *(Pterodroma inexpectata)* from Whenua Hou/Codfish Island to Maungaharuru/Boundary Stream Mainland Island

June 2018

Prepared for Poutiri Aō o Tāne by C.M. Mitchell

A transferred mottled petrel chick, (*Pterodroma inexpectata,* kōrure), waiting to be fed at Maungaharuru/ Boundary Stream.

Information:

Project Manager: Department of Conservation staff on behalf of Poutiri Aō o Tāne: Ken Hunt, Denise Fastier, Kelly Eaton managed various aspects of the translocation over the five transfer years. Cathy Mitchell managed chick care at the seabird site.

Type of Translocation: 1. Wild to wild. 2. Re-introduction.

Species transferred: Mottled petrel, *Pterodroma inexpectata,* Kōrure
Threat status Relict B (<10% former habitat/>20000 mature individuals), at risk.
Ninety-nine chicks, approximately three months of age, sex unknown, in 2018.

Release site: Maungaharuru – Part Section 4. Block XI. Waitara survey district, Scenic Reserve Conservation land; E1928000, N5665161

1. Summary

Ninety-nine mottled petrel (*Pterodroma inexpectata),* kōrure, chicks were transferred from Whenua Hou/Codfish Island to Boundary Stream Mainland Island on April 16th 2018. This was the fifth and final transfer of mottled petrel to the Boundary Stream seabird site undertaken on behalf of Poutiri Aō o Tāne and supported by Department of Conservation. The primary objective of this project is to establish a self-sustaining population of mottled petrel (and other seabird species) as part of the ecological restoration of the site and the surrounding Maungaharuru Ranges. The project aims to work alongside tangata whenua, local landowners and volunteers to achieve shared conservation objectives and aspirations.

Over four transfer years 460 burrows with hatches have been established on Whenua Hou/Codfish Island. In March 2018 a reconnaissance trip was undertaken and 37 chicks were measured (weight and wing length). From this data the ideal time for collection was determined so that a maximum number of chicks would be available for selection. Burrow occupancy in 2018 was calculated to be 39%, and a total of 99/167 (59%) of available chicks were transferred. Selection criteria based on weight and wing length measurements have been refined over the five transfer years in order to increase the number of chicks transferred without compromising the outcome for these chicks.

The selected chicks were flown between source and release sites by helicopter and fixed wing aeroplane taking a maximum of 11 hours from natal burrow to artificial burrow. At Boundary Stream seabird site the chicks were placed into artificial burrows located under canopied forest. Initially chicks were blockaded into their burrows to give them time to settle; blockades were removed after 5 – 6 days on site to allow normal chick emergence behaviour prior to fledging. A permanent sound system broadcasting the sounds and calls of the mottled petrel colony at Whenua Hou played nightly while chicks were in residence.

All chicks were hand-fed according to individual requirements on an oil-rich blend of tinned sardines in soy oil, water, fish oil and a seabird vitamin/mineral supplement. Meals were usually delivered every third day via syringe and a small diameter crop-tube. Fish oil top ups were given as required to maintain weight or assist regurgitating chicks.

96/99 (97%) of mottled petrel chicks were presumed to have fledged successfully from Boundary Stream in 2018. Three chicks died or were euthanased. Fledging condition of chicks was in line with recommended targets with a mean fledge weight of 360g and mean fledge wing length of 266mm. Chicks were at Boundary Stream seabird site for a mean of 18 days (range 12 - 28 days), and had a mean emergence period of 8 nights (range 1 – 16 nights) prior to fledging.

In total 368 mottled petrel chicks have been transferred to Boundary Stream seabird site over five years and 364 (99%) of these chicks are believed to have successfully fledged. A returning adult was detected on a trail camera at the seabird site in January 2018.

This report details the results of the 2018 transfer of mottled petrel chicks. Recommendations for future transfers of mottled petrel chicks are given based on the knowledge gained from five years of transfers from Whenua Hou/Codfish Island to Boundary Stream Mainland Island.

2. Introduction

2.1 Background

The mottled petrel, *Pterodroma inexpectata,* (kōrure), is a medium (325 gm) gadfly petrel and a member of the Procellariidae family of seabirds; all have distinctive external nostrils encased in a tube on the top or sides of the bill. The mottled petrel is an endemic species and currently only breeds in Southern New Zealand. The largest colony is located on Whenua Hou/Codfish Island where an estimated 3 – 400,000 pairs breed, (Heather & Robertson, 2005; Scofield & Stephenson, 2013). This species has a Threat Status of Relict B (<10% former habitat/>20000 mature individuals) - At Risk, (IUCN, 2010). Its breeding range has declined dramatically since human colonisation having previously bred throughout the North and South Islands (Taylor 2000; Worthy & Holdaway 2000; Worthy et al 2002). All mainland colonies have been extirpated.

The mottled petrel is a colonial, burrow nester, with the female laying a single egg in mid-late December. Incubation is shared by both parents and the chick hatches in early February. It is brooded for about a week and then fed by both parents, approximately every 4 – 10 days, until fledging at 90 – 105 days of age, in late April/May. In the non-breeding season birds migrate to the North Pacific, mainly to the sub-Arctic and Bering Sea.

2.2 Iwi links.

The source site for the current translocation is Codfish/Whenua Hou Island, where 3 – 400,000 pairs are believed to breed. The birds on this island are within the rohe of Ngai Tahu, and the island is managed by Kaitiaki Roopu o Murihiku. The release site is within the rohe of Maungaharuru Tangitu, Ngati Pahauwera and Ngati Hineruru.

2.3. Previous translocations

Translocation of mottled petrels has not been undertaken prior to the Boundary Stream transfers. Initially the current translocation was planned as a joint project between Poutiri Aō o Tāne and Cape Sanctuary. However the number of chicks able to meet the selection criteria for transfer has been less than expected. As a result, it was decided to run the two translocations sequentially to ensure the projects are not compromised due to the transfer of insufficient numbers of chicks. Subsequently, Cape Sanctuary has decided not to proceed with their planned translocation of mottled petrel in the short term at least.

Stage 1 of the Poutiri Aō o Tāne mottled petrel translocation commenced in 2012 with a transfer and feeding trial of ten chicks on Whenua Hou as a joint project with Cape Sanctuary, (Leseberg et al, 2012). This established that mottled petrel chicks could be successfully transferred and raised on an artificial diet. The second stage was a trial transfer of up to 50 chicks to the Hawkes Bay originally planned for 2013, but not undertaken until 2014. The planned in 2013 transfer was postponed as 2013 was a very poor breeding season with both mottled petrel and sooty shearwater chicks failing to thrive, (Hunt et al, 2013).

In 2014, Poutiri Aō o Tāne transferred 45 mottled petrel chicks from Whenua Hou to Boundary Stream, as Stage 2 of the translocation process. The goal was to incorporate findings from the 2013 feeding trial and from the 2014 transfer to establish a feeding regime for this species prior to commencing the Stage 3 transfers of up to 150 chicks per year. It is considered that 45 chicks (100%) successfully fledged in 2014, well within the

target fledging rate of 85% for this trial (Mitchell 2014). Chicks fledged within the weight and wing length range recorded for naturally fledged chicks on Whenua Hou.

Following on from the 2014 transfer, Stage 3 of the translocation proceeded with three further transfers of up to 97 chicks were undertaken in 2015 – 2017. The total number of chicks transferred over this period was less than planned and in 2018 a final transfer of up to 100 chicks was undertaken.

Note: A mottled petrel adult was detected on a trail camera at the seabird site in January 2018 – likely the first transferred chick to return. The bird was detected on 14th January at 1.54am and on 15th January at 12.25am. At this stage there has been no indication that birds have entered burrows (fences intact) or made preparations for nesting (transfer of leaf litter into burrow chambers).

2.4. Establishing mottled petrel at Maungaharuru/ Boundary Stream

Burrowing petrels were formerly keystone species at a number of mainland locations around NZ, providing nutrient-rich habitats for many invertebrates, reptiles and plants. The petrel colonies have long since gone, but there is evidence that large colonies of mottled petrel were widespread along the North Island ranges (Worthy and Holdaway, 2000; Worthy et al. 2002; Imber et al, 2003).

Currently little consideration has been given to seabird colonies away from the coast. Seabirds are needed as much inland as on the coast to transport nutrients from the sea to the land. Nothing remains of the underground 'seabird cities' that were once widespread on inland mountain ranges and we have perhaps lost the most dominant ecological feature of these sites.

The Poutiri Aō o Tāne project is a collaborative project involving DOC, Robertson Foundation, Hawkes Bay Regional Council, Hastings District Council, Iwi, landowners, local communities and restoration programmes as well as volunteers. It seeks to extend the success of Boundary Stream Mainland Island to include private and production landscapes involving a wide scale pest control programme, a change of production land use to a more environmentally sustainable state and to improve social health of the community. One of the key actions is to re-establish 'seabird cities' on the Maungaharuru Range, and specifically to re-establish mottled petrel. This will be the first attempt to establish a new colony of mottled petrel and forms part of the first attempt to restore breeding seabirds to an inland mainland site.

2.5. Release site

An area of 2.9ha has been fenced to create a cell on one of the prominent points within Boundary Stream Mainland Island on the Maungaharuru Range, to create a mammal-free breeding area for burrowing seabirds. (Maungaharuru – Part Section 4. Block XI. Waitara survey district, Scenic Reserve Conservation land; E1928000, N5665161).

The seabird site is at an altitude of 950 metres on the crest of the Range. The summer temperature ranges from 20 - 25° Celsius and winter temperature ranges from 0 - 20° Celsius range. Heavy frosts and snow falls are not uncommon. The vegetation cover is

sub montane cloud forest with native grasses and tussock. The predominant wind is North West and can be strong for extended periods.

As mottled petrel previously bred throughout the ranges of the North Island, the amount of suitable land surrounding the seabird site will be limited by the level of pest control being undertaken. Maungaharuru seabird site is within a large scale predator control operation in which top predators (cats and mustelids) are being controlled within 10000 ha. The seabird site also borders on area of 800 ha of intensive predator control (rats, cats, mustelids, possums) for kokako, kiwi, kaka, kakariki, mistletoe and kaka beak (Boundary Stream Mainland Island).

The soil within the seabird site is deep, friable and conducive to burrowing. Sub alpine, cloud-capped forest along with rank, wind-sheared grassland, interspersed with waist-high shrubs is the predominant vegetation cover at present. Native species within the fence site include; *Griselinia littoralis, Podocarpus totara, Coprosma foetidissima, Pseudowintera colorata, Rubus australis, Fuchsia excorticata, Carpodetus serratus, Aristotelia serrata* and form part of a typical higher altitude association.

It is proposed that the cell may be populated with up to three species of burrowing seabirds. The transfer of Cook's petrels to the site commenced in 2013 and 336 chicks of this species have fledged over the four years of Cook's petrel transfers undertaken. The Cook's petrel burrows occupy a separate area of the seabird site and have small diameter tunnels that exclude entry by mottled petrel. Each area has its own sound system that plays calls for the appropriate species. Cook's and mottled petrel breed close to each other but usually in separate areas on Whenua Hou.

The site is at an inland location (20km from the sea) and approximately 1500km from the closest southern breeding populations of mottled petrel. Recruitment of mottled petrel from other sites is, therefore, unlikely to occur. Growth of the population at Boundary Stream will be solely dependent on the successful return and breeding of transferred birds. For this reason it is important that a good number of birds is transferred to increase the chance that sufficient birds will return to Boundary Stream to establish a breeding population at this location.

2.6. Mottled petrel breeding biology

Adult mottled petrel return to their colonies in late October/November to court and prepare burrows. After a pre-laying exodus a single white egg is laid in early December to early January. The incubation period is 47 – 53 days, the chick is brooded for 2-7 days and then left as the parents forage. The chick is fed by both parents, and is fed approximately every 4 – 10 days. Parents often have a long foraging trip (up to 14 days) followed by shorter trip (3 days). Following a long trip the chick is more likely to be fed crustaceans and oil, following a short trip squid and fish more likely to be fed. The diet of mottled petrel is mainly squid, crustaceans and small fish, probably taken at night, with more fish taken than for other petrel species, (Heather & Robertson, 2005; Scofield & Stephenson, 2013).

Peak chick weight is reached at 20 – 35 days before fledging and can be as high as 700g (potentially double adult weight). Chicks fledge in March/April approximately 90 - 105 days after hatching.

Table 1: Mean fledge weight, mean fledge wing length and ranges recorded for mottled petrel chicks fledging naturally from Whenua Hou in 2014 and 2015.

Year	Number of chicks	Fledge weight - Mean, (g)	Fledge weight - Range (g)	Fledge wing length - Mean, (mm)	Fledge wing length - Range, (mm)	Mean fledge date (range)
2014	24	343	292 - 405	265	257 - 276	
2015	14	332	254 - 384	264	252 - 279	April 26 (21st - 28th)

Adult weight is generally 315 – 355g and wing length is 248 – 270mm (R. Sagar, pers. comm.). Juveniles may return to their natal site to prospect at three years of age and may breed around four years of age.

2.7 Conservation outcomes

The Poutiri Aō o Tāne project is a collaborative project and it seeks to extend the success of Boundary Stream Mainland Island to include private and production landscapes involving a wide scale pest control programme, a change of production land use to a more environmentally sustainable state and to improve social health of the community. One of the key actions of the project is to restore seabirds to the site.

The objectives of the current mottled petrel transfers to Maungaharuru are:

- To establish a viable colony of mottled petrel in a mammal-free site on the Maungaharuru Range, Hawke's Bay,
- To re-establish mottled petrel on the mainland, and to increase the known number of breeding locations,
- To re-build a diverse community of burrowing seabirds on Maungaharuru Range in a site the birds would probably have formerly occupied,
- To work alongside tangata whenua, Cape Sanctuary staff, local Tutira landowners and volunteers to achieve shared conservation objectives and aspirations.
- To test techniques for translocating mottled petrel specifically and seabirds generally to an inland mainland site.

It is proposed that these objectives will be achieved by undertaking the transfer of up to 500 mottled petrel chicks over a 4 year period (up to 50 chicks in 2014, followed by three further transfers of up to 150 chicks in 2015, 2016 and 2017).

By the conclusion of the 2017 season, 279 mottled petrel chicks had been transferred over 4 years, of which 278 are believed to have successfully fledged. As the number of chicks transferred is less than originally proposed (279 cf. 500) a fifth and final transfer of mottled petrel chicks was undertaken in 2018 and is detailed in this report.

2.8 Operational targets

Operational targets are as below:

- Stage 1: Feeding trial on Codfish Island in 2012 – completed
- Stage 2: Transfer of up to 50 mottled petrel chicks to Boundary Stream Mainland Island in 2013 with 85% fledging success – delayed one year, completed in 2014 with 100% fledging success
- Stage 3: Transfer of up to 150 chicks/year for three years – completed in 2017. A total of 269 chicks transferred over the four years with 99.6% fledging success
- Final additional transfer of up to 100 chicks in 2018 in order to boost the number of birds fledging from the site and thus increasing the number of returning adults
- Stage 4: Chicks return as adults 5 – 10 years post-transfer and breeding is established with chicks hatching and fledging from the site
- Stage 5: A self-sustaining population of mottled petrel is established within the seabird site and in the surrounding areas of the Maungaharuru Ranges.

3. Methods

Collection, site and burrow preparation and food preparation and cleaning methods generally followed those outlined in Best practice techniques for the translocation of small *Pterodroma* petrels (Gummer et al, 2014a), and, Translocation field guidelines for burrow-nesting petrels and shearwaters, (Gummer et al, 2014b). Specific methods used in the current year mostly followed those used in the previous transfer years (Mitchell, 2014; Mitchell 2015; Mitchell 2016; Mitchell 2017).

3.1 Site Preparation

A total of 116 artificial burrows are available for mottled petrel chicks at Boundary Stream seabird site. Prior to the arrival of the chicks, leaf litter in the burrows was replaced with fresh dry leaf litter. Internal blockades (metal slides) and external blockades (mesh) were installed so that chicks would be confined to the nest chamber on arrival, in order to provide a settling in period before chicks could emerge.

In 2016 a number of burrows had become wet internally resulting in wetting of the tail and wing feathers of the chicks. Various modifications to the lids had been trialled in 2016 in order to prevent water entering the burrows. It was felt that the water was entering the burrow where the lid contacted the top of the chamber and then running down the inside burrow wall. Prior to the 2017 transfer the majority of the burrow lids were covered in a sheet of plastic which was stapled to the lid margin. The burrow number was written onto the plastic with Twink pen. This modification appeared to have been successful in maintaining dryness of the burrows and the chicks.

Recommendations made for management at the seabird site in order to assist fledging chicks were carried out prior to the arrival of the chicks in 2016 and maintained/extended in 2017 and 2018.

1. Dense vegetation which was present around burrows and suitable climbing trees was removed.
2. Pathways were cleared through long grass to high points at the site. Pathways through the grass were also cleared on the slopes down towards the fence and the fence line itself was cleared
3. Ramps, potential fledging points, had been installed prior to the 2015 transfer. These consisted of a treated timber fencing post with a sloping piece of 4 x 2 timber attached to a horizontal piece of 4 x 2 fixed to the top of the post. Small pieces of timber were fixed across the long plank to assist with grip for chicks climbing the ramp.
4. Wooden burrow chambers and lids were placed beside the fence to offer a daytime refuge for wandering chicks. The boxes were moved to sections of the fence that fledging mottled petrel were most likely to come up against. The boxes had two entrances, aligned so that each entrance was beside the fence. Thus the box could be entered from either direction as chicks were most likely to encounter the box by walking parallel to the fence. The boxes were filled with leaf litter to provide an attractive refuge for any lost chicks. The boxes were checked daily for the presence of chicks during the daily fence line checks.
5. Prior to the 2018 transfer, refuges of drain coil were also placed around the site. These refuges were modified and improved after the arrival of the chicks as time allowed. The refuges were placed close to the fence so that the openings were against the mesh to increase the likelihood that wandering chicks would

encounter them. Drainage holes were drilled into the underside of the tubes to prevent water accumulation. The tubes were wired to the ground and leaf litter was placed inside them. In this way, along the 'high risk' sections of the fence, there was a refuge available to chicks every 10 metres or so. Refuges were also placed on the flat area above the mottled burrows (near the speaker) and on the flat area across from and behind the feeding shed.

(Note: The high risk fence sections were considered to be from the top corner above the entrance gate down and across the lower, eastern, section to the southern end. These fence sections are bordered by open grass areas or banks cut for fence installation and are the sections located below the higher areas of the site that the chicks most likely to fledge/attempt to fledge from).

The food preparation area at base was restocked with chick food supplies and other sundry items needed (eg. paper towels, dishwashing liquid etc). All equipment was checked and disinfected in accordance with Best Practice recommendations. The feeding shed at the seabird site was also cleaned and restocked as needed. A supply of dry leaf litter was stored in the feeding shed so it was available if needed to top up burrows.

The solar-operated sound system was checked before the arrival of the chicks. It was set to play mottled petrel calls during the night from dusk to dawn to assist with chick bonding to the site.

3.2. Source, composition and capture methods of transfer population.

In order to ensure bonding to the transfer site, mottled petrel chicks are transferred at approximately three months of age. Chicks are selected to be as mature as possible to reduce the time required for artificial feeding at the release site. This will reduce the time chicks are on an artificial diet that is less nutritious than that supplied by parents and also reduce the input needed to feed the chicks before they fledge. At the same time the chicks should be sufficiently immature that they have not yet started emerging from their burrows as this emergence period is considered to be an important time for chick bonding to the release site.

Mottled petrel chicks at the ideal stage for transfer will be approximately three months of age. Strict selection criteria are applied to the chicks to ensure that they are within the ideal maturity range and are also of good weights (underweight chicks are less likely to successfully fledge and return as adults). The sex of the selected chicks is unknown but is assumed to be approximately equal numbers of male and female.

Study burrows have been established at the source colony – that is the burrows are in known locations, are identified by number and have study lids installed in order to reach the chick. Over the four transfer years the number of study burrows has been increased so that a total of 460 burrows were theoretically available in 2018. However, a number of burrows are no longer used by breeding birds, in some cases due to damage to the burrows. Burrow lids are constructed of non-tanalised plywood and they therefore deteriorate over time. Chicks are hand captured on Whenua Hou via the study lid.

3.3. Reconnaissance trip

A two person team carried out a reconnaissance trip on Whenua Hou on March 24th 2018. The team members (R. Sagar and Cheri Hemsley, both DOC) were working on

Whenua Hou, thus travel to and from the island was not required. The purpose of the reconnaissance trip was to collect data from as many chicks as possible so that the ideal timing for the collection trip could be determined.

The reconnaissance team located and measured 37 chicks. Wing length data obtained from the measured chicks was entered into an Excel spreadsheet. Using a wing growth rate of 3.6mm/day, chick maturity as indicated by wing length, was plotted against date. In this way, the dates at which the maximum numbers of chicks were likely to meet the transfer wing length criteria were determined. Two collection trips were planned to be undertaken in 2018 in order to maximise the number of chicks transferred.

3.4. Chick selection and collection trip

3.4.1 Teams and transport to Whenua Hou.

On 5thth April a team of four people (K. Eaton, R Sagar, J Welsh and E. Leask, all DOC and experienced with this project), travelled to Whenua Hou by fixed wing plane from Invercargill. The team operated from the Whenua Hou field base, approximately one hour's walk from the known mottled petrel burrows. The 460 marked burrows are located 10 – 15 minutes walk from the helipad.

3.4.2 Chick selection criteria

The selection criteria for transferred chicks have been extended over the four transfer years in order to increase the number of chicks transferred. Criteria have been adjusted as the outcome for transferred chicks has been assessed each year and following consultation with Graeme Taylor (DOC seabird scientist). The long term outcome for any of the transferred chicks will not be known until birds return to the seabird site. The criterion used to select chicks in 2018 was based on the 2017 recommendations and are given in the table below. The selection weight is the lighter of two measurements taken 3-4 days apart in order to obtain the base, unfed, weight of the chick (chicks can receive up to 100g of parental food per night).

Table 2: Selection criteria for mottled petrel chicks transferred from Whenua Hou to Boundary Stream seabird site in 2018.

Priority Group	Wing length (mm)	Weight (g)
Priority 1	210 - 250	≥ 420
Priority 2	190 - 210	≥ 470
Priority 3	250 - 260	≥ 500
Priority 4	210 - 250	≥ 400
	190 - 210	≥ 450

Less mature chicks (190 – 210mm wing length) have a higher selection weight in order to ensure that they have reached a good peak weight prior to transfer. More mature chicks (250 – 260mm wing length) also have a higher selection weight to reduce the risk

that these chicks have emerged prior to transfer as chicks are less likely to emerge at weights >500g.

3.4.3. Chick selection

On April 5th and 7th the collection team checked all burrows for occupancy and gathered data on the chicks located. All burrows containing chicks were flagged so they could be easily relocated.

The data gathered in the first day was used to draw up a shortlist of chicks potentially suitable for collection. The short-listed chicks and some additional chicks that were not located previously were re-measured on April 9th. These preliminary measurements indicated that a good number of chicks were within the selection weight and wing length criteria. The transfer could not go ahead as planned on April 10th and any borderline chicks and those with only one prior measurement were re-measured on April 11th.

From the data obtained a list of chicks for collection on April 13th was drawn up. A small number of borderline chicks were re-measured again prior to collection to ensure they met the criteria.

3.4.4. Chick Collection and transfer.

Two additional team members (D. Fastier, DOC, and A. MacBride, National Geographic scholar) flew to Whenua Hou on 11th April. On collection day, April 13th, the team left the hut at 5.30am (still dark) and were at the burrows by 6.30am. Chick collection commenced at 6.30am and was completed by the time the first helicopter arrived at 9.20am. A number of borderline chicks were re-measured on collection day.

The chicks selected for transfer were placed into corflute cat carry boxes (425mm length x 240mm width x 310mm height) with holes punched along the sides to allow air movement. Newspaper to absorb excrement and any regurgitant, covered with non-slip matting, was placed in the bottom of each box. The boxes had black corflute dividers taped into them so that two chicks could be transported in each box. The Whenua Hou burrow number of each chick was recorded in Vivid marker above its section of the box and any additional data, eg weight, time of collection etc, also noted.

The boxes containing the chicks were then carried by hand to the helipad. Two Squirrel helicopters fitted with pods were scheduled to arrive by 9.30am. The boxes containing the chicks were loaded into the helicopters – five boxes in each pod and the remainder stacked in the side compartments and cabin. Three of the team members flew off with the chicks. The three team members remaining on the island packed up the hut gear and flew off by fixed wing aeroplane later the same day.

A fixed wing aeroplane, based in Napier, had flown down to Invercargill the preceding day. The chicks were transferred to the fixed wing aircraft and flown to Napier airport, a 4 - 5 hour flight, with a stop-over in Timaru to refuel. From Napier airport it was planned to fly the chicks by helicopter to the Boundary Stream seabird site (the alternative is a 60 minute drive on a winding road). The weather up at the Boundary Stream site can be wet and clouded in at times, so a vehicle was on stand-by in Napier as a contingency in case the helicopter was unable to fly to the seabird site. In the event, the weather was good and the chicks were loaded onto the helicopter and flown directly to the seabird site, arriving at approximately 3pm.

3.4.5. Burrow maintenance on Whenua Hou

Any spare time on Whenua Hou was used to upgrade the study burrow lids and burrow markings, a continuation of work commenced in 2017. Burrow lids are constructed of untreated plywood – use of treated plywood was not allowed under the permit conditions. The untreated plywood of many burrow lids was deteriorating to the point where burrow integrity was compromised and replacement was needed. The opportunity was also taken to upgrade the burrow markers with permanent stakes and triangles.

The old rotting lids were replaced with new 18mm untreated plywood. Pink triangles had burrow numbers marked on with a soldering iron and felt pen. Plastic standards were cut to length and had the marked triangles attached with Ziploc ties. The standards were then driven into the ground beside the appropriate burrow as permanent identification.

3.5. Chick arrival at the release site

3.5.1. Chick arrival in Napier and at the seabird site.

On transfer day the chicks arrived at Napier Airport at approximately 2.30pm. They were welcomed by a group that included iwi representatives, Air Napier staff and DOC staff. The boxes containing the chicks were loaded into the helicopter and flown directly to the seabird site, arriving at approximately 3pm. The helicopter departed as soon as the chicks were unloaded. The boxes were then transferred to the feeding shed. Processing of the chicks (weighing, fluid administration, data transfer and BSMI burrow allocation) commenced at 3.30pm. A group of 12 people (DOC staff and volunteers) were on hand to assist.

3.5.2. Chick installation into artificial burrows.

Chicks were removed from their transport boxes one at a time. The data from each chick was transferred from the box to its individual daily record sheet (Whenua Hou burrow number, Boundary Stream burrow number, time of collection and other notes). The chick was weighed (transfer weight) and the eyes were checked – down was removed from some eyes as needed. Note: at Whenua Hou chicks were weighed using a catch bag and Pesola scales; at the release site chicks were weighed by placing them into a box on electronic scales.

All chicks were then given oral fluids to assist with hydration after the stress of transfer and also as an introduction to the passage of the crop feeding tube. Sodium lactate (Hartmann's) solution ("Compound Sodium Lactate Intravenous Infusion B.P.", Baxter Healthcare Pty Ltd, NSW, Australia) 15ml was given orally via a relatively small diameter 14Fg crop tube to reduce the risk of regurgitation.

Following fluid administration the chicks were then carried by hand to their burrows, which were filled sequentially. The chicks were placed into individual numbered burrows and left to settle for the night. As there were surplus burrows available the chicks were placed into the more accessible burrows – Burrows 14 - 112 inclusive.

3.6. Hand feeding

Chick feeding, including food preparation, cleaning of equipment, feeding procedure etc, followed methods outlined in Gummer et al, 2014b.

3.6.1. Crop feeding equipment

The 14Fg crop tube, rather than a standard seabird crop tube, was used throughout the rearing period as mottled petrel are prone to regurgitation and have been found to cope better with the smaller flexible tube. The chicks seem able to accept this tube, (5mm external diameter), more easily than the standard crop tube, (8mm external diameter). There have been no problems experienced with syringabilty of the food mix through this smaller tube.

The crop tube used was a 14Fg, Unomedical PVC feeding tube obtained from Shoof Veterinary, P.O. Box 522, Cambridge, NZ, Product number 211350. The 80cm tube was cut into appropriate lengths (110mm) and tube ends were bevelled with a scalpel blade and quickly passed through a flame. This was done to ensure that there were no sharp edges that could potentially result in irritation to the oesophagus as the tube was passed. The tube was then attached directly to a 35ml syringe for feeding.

3.6.2. Chick feeding programme and diet.

The day after transfer, Day 2, all chicks were brought to the feeding station, weighed, had wing length measured (transfer wing length) and were given a health check. Chicks were then fed an introductory meal of 25ml watery food mix administered via the small diameter crop tube and syringe.

On Day 3 all chicks were weighed and given their first full-strength feed of 30ml regular food mix.

After the initial three day feeding introduction the chicks were split into two groups. The first group of 50 chicks, Burrows 14 – 63 inclusive, were fed on Day 5 two days after their previous feed. On the following day, Day 6, the remaining 49 chicks from Burrows 64 – 112 were fed, three days after their previous feed. This was done so that approximately half of the chicks were fed each feeding day.

Thus the chick feeding programme was as below;

April 13th	Transfer day, Burrows 14 – 112, weighed (transfer weight), 15ml Hartmann's solution.
April 14th	Day 2, all chicks weighed, health check, wing measured (transfer wing length), 25ml watery mix.
April 15th	Day 3, all chicks weighed, 30ml full strength mix.
April 16th	Day 4, no chicks fed, all chicks banded
April 17th	Day 5, Burrows 14 – 63, fed full strength mix to individual requirements.
April 18th	Day 6, Burrows 64 - 112, fed full strength mix to individual requirements.
April 19th	Day 7, no chicks fed.

As in previous years, chicks were fed every third day from April 18th. Some chicks were fed or given oil top-ups on non-feeding days as needed for weight maintenance. When chick numbers dropped due to fledging the 17 remaining chicks were blended into one group on May 5th.

The food formulas used were;

Watery mix	1 tin sardines in oil, 100ml boiled water, 1/3 Mazuri Vita-Zu seabird tablet
Standard mix	1 tin sardines in soya oil with the oil poured off (approx 20ml of oil), 33ml fish oil, 50ml boiled water, 1/3 Mazuri Vita-Zu seabird tablet

Products used were;

1. Sardines in soya oil, ("Brunswick Sardines in Soy Oil", Freedom Nutritional Products, Taren Point, NSW, Australia: "Pams® Canadian sardines in soya oil" Pams Products Ltd, Mt Roskill, Auckland: mixed 1:2 as the Pam's sardines blend more easily).
2. Mazuri® Vita-zu™ seabird vitamin/mineral supplement (product code: Small 5M25).
3. Nutralife® Omega 3 Fish Oil Liquid plus Vitamin D in 500ml bottles, purchased via an online Health Store.

From Day 5 following transfer food volumes were adjusted for each chick on an individual basis taking into account the weight of the chick and its proximity to fledging. Proximity to fledging was assessed based on wing length, change in wing length (for the majority of chicks wing length growth had ceased by the time of fledging) and emergence behaviour. Chicks were fed up to 30ml + 5ml fish oil in any one feed.

Feeding frequency as well as feed volume was tailored to the needs of each chick as required. As chicks approached fledging a number of strategies were used to maintain chick weight/prevent excess weight loss without overfilling the crop. Chicks are less likely to fledge with a full crop so a balance needs to be achieved between maintaining adequate weight without compromising successful fledging. Strategies included feeding smaller volumes two out of three days and feeding oil with or between feeds to provide additional fluid and energy in a small volume feed. Chicks that were reluctant feeders or prone to regurgitating were returned to their burrows and then fed at the burrow at the end of the feeding session. This gave the chick a chance to settle before being quietly lifted from the burrow, fed and then immediately placed back into the burrow.

A shortlist of chicks needing an extra feed or special check the following day was drawn up each evening. A suggested food volume was entered in the daily record for each chick prior to the feeding day for easier decisions on the day. These decisions were finalised based on the actual weight and wing length of the chick immediately prior to feeding.

3.6.3. Chick handling and management on feeding days

Mottled petrels are relatively feisty species and will often bite when being carried. Those carrying the chicks often wore gloves to reduce injuries and increase handler confidence. Gloves used were Showa brand gardening gloves which have been found to provide protection without compromising the ability to 'feel' the chick and are easily washed for good hygiene. Thick leather or rubber gloves are not considered suitable for chick handling.

All of the carriers were volunteers and some found the chicks difficult to handle even when using gloves. The use of gentle confident handling is important to reduce stress/agitation in the chicks and this was emphasised to those handling chicks. Mottled

petrel chicks are prone to regurgitation after feeding and this has been noted to be more likely if the chick is agitated.

In 2018, plastic toolboxes were used to carry the chicks to and from the feeding shed for all feeding days. The weather was often wet or damp and the toolboxes were essential in these conditions to ensure that chicks remained dry. Though use of the toolboxes resulted in some double handling of the chicks, they were also used on days with good weather as they gave the following advantages:

- The chicks appeared to be quieter when carried in the toolboxes, and thus were more settled and easier to feed with fewer regurgitations
- It was easier for those handling the chicks. When lifting from or returning to the burrow the handler could kneel beside the burrow and complete the transfer. This removed the need to stand up or kneel down while holding a bird, especially for the less nimble volunteers many of whom were older.

Care needed to be taken that wings and legs were contained within the toolbox before the lid was closed.

On wet days the feeding shed was split into a wet and dry side. An umbrella was held over the burrow as the chick was lifted from its burrow into a toolbox and on return to the burrow. An extra person worked inside the shed on the dry side - passed the chick to scales, to a pillow case for wing measurement and then held the chick for feeding. Carriers (wet side) placed their toolbox on a table dividing the shed and lifted the box lid so the dry person did not get their hands wet handling the toolbox. A similar system was also used on dry days. Toolboxes were lined with newspaper which was replaced and the box was cleaned with Trigene if a chick regurgitated or defaecated. The newspaper was removed and the boxes were cleaned with Trigene and left to air-dry at the end of each feeding session.

A burrow manager was allocated each feeding day. This person assisted the carriers when needed (eg lifting and replacing the burrow lids, holding an umbrella over the burrow during rain), checked burrow condition, passed an alkathene pipe up the tunnel to ensure that it was empty and re-erected the stick fences. Each carrier had their own coloured block, matched with the colour of the toolbox. The block was placed beside the burrow before the chick was lifted to provide a double check that the chick was returned to the correct burrow after feeding.

3.6.4. Feeding guide

A table was drawn up in earlier years to assist those making feeding decisions, especially later in the rearing period when less experienced personnel were feeding the chicks. In 2017 and 2018 the guide was not used as feeding was carried out for the entire rearing period by an experienced feeder, Cathy Mitchell, DOC seabird contractor.

3.7. Banding

All chicks were banded at the seabird site on April 16th, by Level 2 bander, Cathy Mitchell (NZNBBS 0377); under Level 3 bander, Rachael Sagar, (NZNBBS 0252).

3.8. Managing/ monitoring chick emergence and fledging

3.8.1. Blockade removal.

The first group of chicks (Burrows 14 to 63) had their burrows unblocked after feeding on April 15th and the second group (Burrows 64 to 112) on April 16th, five and six days after

transfer day. Thus all burrows were unblocked and fences were erected before the chicks were returned to their burrows after being fed. Chicks are more settled in their burrows after feeding and are less likely to emerge prematurely.

All unoccupied burrows were also unblocked in order to provide a refuge for wandering chicks. Fences were erected on these burrows and the burrows were checked daily for the presence of chicks.

3.8.2. Monitoring emerging chicks.

Once burrows were unblocked stick fences were erected. Bamboo kebab sticks were used as fences as they are convenient, strong and provide a good visual indication of fence status due to their pale colour. Care was taken to ensure that stick fences were inserted into loosely packed earth and could be easily knocked down by emerging chicks.

Once blockades were removed, fence status was checked and recorded daily to indicate whether chicks had emerged the preceding night and burrows were checked daily for the presence of the chick. A piece of alkathene pipe was passed up each tunnel daily to check for the presence of a chick - either the burrow occupant or any wandering chicks. The stick was passed up the tunnel even when even when the fence was intact as chicks have been recorded leaving a burrow despite an intact fence. Additional, unoccupied burrows that were left open to provide refuge for possible wandering chicks were also checked daily. A field notebook was used to record the fence status and occupancy of all unblocked burrows.

The perimeter of the predator-proof fence and paths within the site were walked daily to check for lost chicks. The refuges placed around the fence and within the site were checked for the presence of chicks at the same time.

3.8.3. Night visits to the site

The site was visited at night occasionally when a chick/s had been identified as needing fledging assistance. During these visits entry to the burrow area was kept to a minimum and lighting was kept low. This was to reduce disturbance to emerging chicks and to reduce the risk of a chick becoming lost and unable to relocate its burrow.

On every evening visit the open areas of the site, the fence and the refuges were checked for the presence of chicks. If a chick had become lost it was felt that there would be a good chance of locating the chick after dark when it had emerged from its daytime refuge.

3.8.4. Fledging chicks

Where a chick was of fledging weight and wing length, had been emerging regularly and was absent it was presumed that the chick had successfully fledged. Occasionally chicks were found in burrows other than their own or in refuges and these chicks were returned to their own burrow.

3.8.5. Other tasks

A number of tasks were undertaken at the site as time allowed. The drain coil tubes were placed against the fence to increase the chance that wandering chicks would find them. They were secured to the ground with wire and made a more attractive refuge by the addition of leaf litter and drainage to prevent water build-up.

3.9. Chick health

3.9.1. Health check

Chicks had their general health checked on Whenua Hou before transfer. All chicks were given a health check on Day 2 at the seabird site. Chicks were assessed for their general demeanour and legs and wings were checked for normal movement and for fractures.

3.9.2. Eyes

Eyes were checked for injury/down on the transfer day and the following day. It has been noted in the past that a number of chicks have had down present in the eyes on arrival at the seabird site. Affected eyes tend to be closed/semi closed. Down in these cases is found to be located medially between the third eyelid and the conjunctiva of the lower eyelid. Where down was present it was carefully removed with a clean finger and this was noted on the data sheet for that chick. If the eye appeared inflamed Chlorsig 1% eye ointment (Aspen Pharma Pty Ltd, Australia) was instilled. Eyes of affected chicks were checked again in the days following treatment.

3.9.3. Plumage

A number of chicks had dirty, possibly oiled, plumage on arrival due to spillage or regurgitation of food. In the majority of cases the soiling appeared to be confined to the surface of the feathers, but in the case of five chicks it could be seen that the feathers were oiled down to the skin. The plumage of chicks was tested for water-proofing with a light spray of water onto the affected feathers – failure of the water to bead indicated that the water-proofing was lost.

If water-proofing was lost affected plumage was washed in warm detergent solution to restore its condition. A solution of Eco brand dishwashing detergent was used for two warm washes (40˚C), 20% for the first wash and 10% for the second wash. The feathers were then rinsed twice in warm water. Two full washes were carried out at the field base by Pam Turner, a bird rehabilitator trained in the procedure who was volunteering at the site. Three other chicks had neck and/or breast feathers washed at the seabird site by C. Mitchell.

3.9.4. General health

Chick demeanour was assessed every day, including non-feeding days. On non-feeding days burrow lids were lifted and chicks were checked for normal posture and response, particularly if there were any health concerns. Burrow condition was also checked at that time.

Chick data sheets were checked every evening for chicks which may need particular assessment the following day. For example a light weight chick that would benefit from an extra feed on a non-feeding day for its feeding group. Chicks which had emerged regularly but stopped emerging were also given a full health assessment as this behaviour can indicate a health problem or injury. Similarly, chicks which had not yet emerged despite being of emerging weight and wing length were also given a health check. This assessment included weight, limb check and check for wounds.

3.10. Post release Monitoring

Any absent chicks of fledging weight and wing length when last measured were presumed to have successfully fledged. The first chicks are not expected to return to the

site for 3 – 5 years after fledging, and one such chick was recorded on a trail camera in January 2018.

The seabird site and fence will be maintained as usual once transfers are complete, with regular checks to ensure that the fence is intact and there is no tree fall over the fence that could compromise fence integrity. Heavy snowfalls have lead to damage within the site and to the fence in the past and thus checks of the site when these events occur should be given high priority.

The sound system will continue to play mottled petrel calls from October to May when adult birds could be expected to return and this also includes the time that chicks are in residence.

Monitoring the site for returning birds is undertaken by several means which have been in place for four years and will be continued. Once all the chicks have departed burrows are unblocked and stick fences erected. The stick fences are checked during routine site checks and burrow chambers are checked if fences are down. It has been noted that fences are knocked down on occasion by digging blackbirds. Petrels however are the only other species likely to do so at the seabird site – for example, at other projects kiwi have been recorded entering petrel burrows but there no kiwi are present within the Boundary Stream seabird enclosure.

Trail cameras have been placed in the areas of the site where burrows are located in the hope of detecting returning birds. Paths through the site are targeted for camera placement as they are likely to be used by birds moving through the area. SD cards and cameras are checked at regular intervals and the batteries replaced as needed.

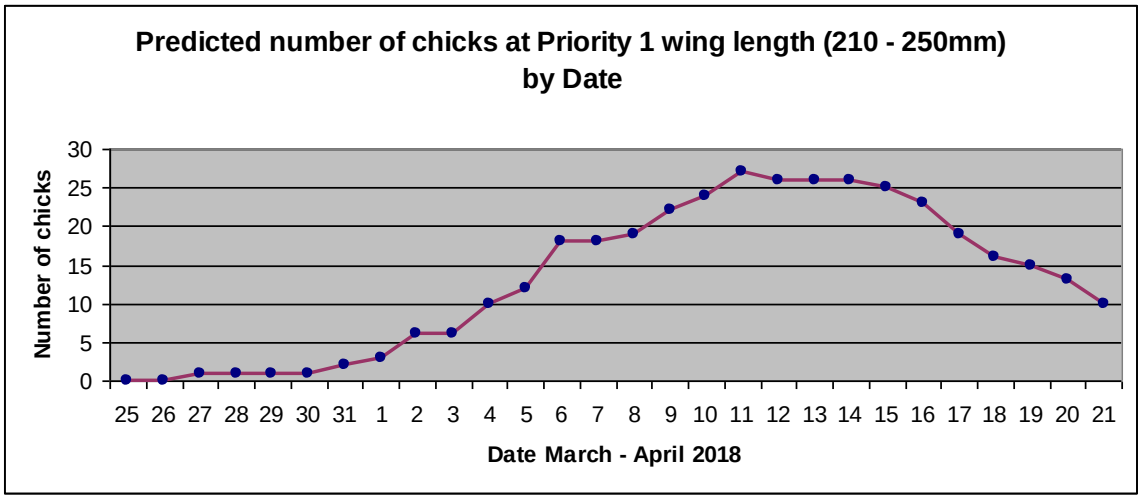
The open areas should be maintained to allow for easy movement of returning birds – weed eating of grassy paths, removal of tree falls within the burrow areas and ensuring that burrow entrances are clear.

4. Results

4.1. Reconnaissance trip

Thirty-seven chicks were measured on the reconnaissance trip on March 24th. Numbers of chicks that would be at Priority 1 wing length each day were estimated based on growth rate of 3.6mm/ day.

Graph 1: Number of mottled petrel chicks predicted to be at wing length 210 – 240mm (Priority 1) by date, March – April 2018



A peak number of 27/37 chicks (73%) were predicted to be at Priority 1 wing length on April 11th. Good numbers of chicks (26 - 25) were also predicted to be at ideal wing length on April 12th – 15th. From this data it was decided that the first chick transfer in 2018 should be planned for April 10/11th, followed by a second transfer one week later.

4.2. Weather impacts on the collection trip.

The collection trip was impacted by weather events in 2018. Chick measurements were only able to be undertaken every second day due to rain – chicks cannot be safely handled in the rain due to the risk of damage to their plumage.

In addition, a two day window of fine weather is needed for the transfer. The fixed wing aeroplane is based in Napier, so good weather is needed for the flight down on one day and the return flight with the chicks the following day. The planned transfer date was 10th April but due to poor weather the actual transfer was delayed until 13th April with the aeroplane flying to Invercargill on 12th April.

The combination of these two circumstances meant that chicks were weighed every second day and that some chicks had their last selection measurement taken up to four days prior to transfer. These events also highlight the need for flexibility and contingency planning for long distance transfers of chicks over several islands.

4.3. Selection, collection and transfer of chicks.

4.3.1. Actual versus predicted wing length growth rate

Data was available for 33 chicks that had their wing lengths measured on the reconnaissance trip (March 24th) and again 12 days later on the collection trip (April 5th).

Actual wing length growth for the chicks ranged from 36 to 60mm over the 12 day period and averaged 4.0mm/day (range 3.0 to 5.0mm/day).

Predicted wing length growth over that period was based on a growth rate of 3.6mm/day and therefore underestimated the actual wing length in 29/33 chicks. The difference between predicted and actual wing length on April 5th ranged from -4.8 to +19mm for individual chicks. Mean actual wing length on April 5th was 7mm greater than the mean predicted wing length. Thus, though the predicted wing length underestimated actual wing length, the mean difference represented only one to two day's growth and the difference was quite variable for individual chicks.

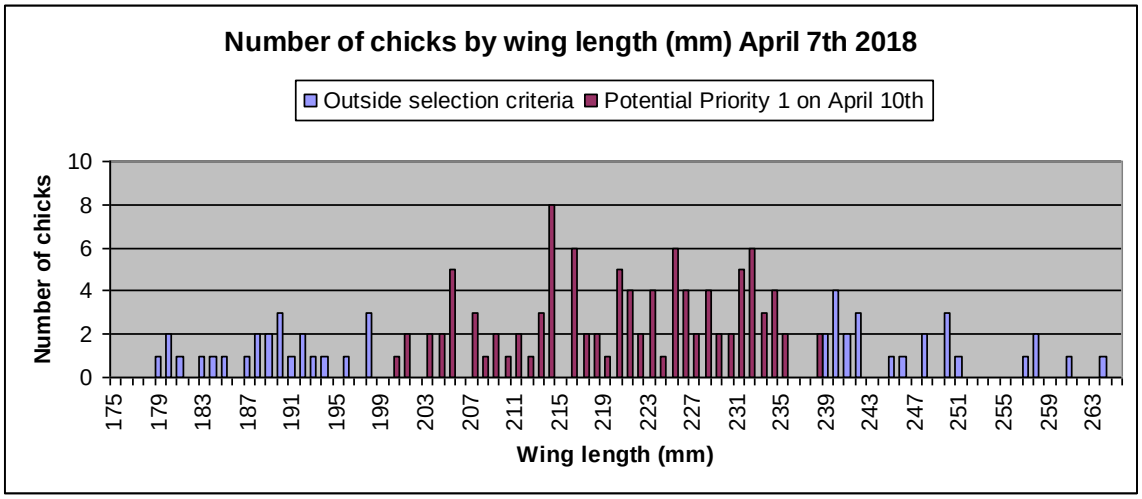
4.3.2. Burrow occupancy and percentage of available chicks collected

On Whenua Hou, 460 burrows had been previously established, however in 2018, 30 of these burrows were unavailable – the burrows had collapsed, had been removed or the chamber was no longer reachable. Thus 430 burrows were available in 2018 and these burrows contained 166 chicks. Burrow occupancy was 166/430 (38.8%) and 99/166 (59.6%) of the available chicks were selected for transfer.

4.3.3. Chick wing length range

Actual and estimated wing lengths of 150 chicks on April 7th are plotted in Graph 2 below. Estimated wing length was based on growth of 3.8mm/day. Note: Eleven chicks are not included in this data as they did not have wing measurements taken (out of reach, deformed or too light).

Graph 2: Number of chicks by wing length (mm) for 150 chicks on Whenua Hou, April 7th 2018.



Notes: **1.** Five very immature chicks (wing lengths 76 – 163mm) are not included in the graph.
2. Potential selection; Assuming wing length growth was 10mm over 3 days, chicks at wing length of 200 – 240mm on April 7th would be at Priority 1 wing length on April 10th.

Of the 156 chicks measured on April 7th, 102/156 (65%) were predicted to meet the Priority 1 wing length selection criteria on April 10th (the date that transfer was originally planned to take place).

4.3.4. Reasons for non-selection of chicks

Of 166 total chicks available for transfer to Boundary Stream, 99 chicks were selected. Two Priority 2 and 18 Priority 3 chicks were among those selected for transfer (compared with one Priority I and one Priority 2 chick selected in 2017).

Thus 67 chicks (40% of available chicks) were not selected. Reasons for non-selection of chicks were; too immature 6 chicks (4% of non-selected chicks), too mature 7 chicks (4% of non-selected chicks), too light for their wing length group 38 chicks (58% of non-selected chicks), 16 chicks were out of reach, deformed or not collected for unrecorded reasons. Of the 38 light chicks, 16 (42%) were at Priority 1 wing length, 5 (13%) were at Priority 2 wing length and 14 (37%) were at Priority 3 wing length on collection day, April 13th. (Three light chicks did not have their wing length measured on the collection trip).

Eight potentially suitable chicks were not transferred. These chicks all met the Priority 1 wing length criteria and were at selection weight. It is likely that most of these chicks were re-measured and were too light on collection day but this data was not recorded.

4.3.5. Outcome for chicks selected at < 420g

It was recommended in 2017 that Priority 1 chicks be could be selected at weights down to 400g in future transfers of mottled petrel chicks and this was implemented in 2018. Ten chicks were selected for transfer with one pre-selection weight of <420g. The outcome for these chicks is presented in Table 3 below.

Table 3: Selection, transfer and fledge weights of mottled petrel chicks selected for transfer with one or more pre-transfer weights of 400 – 420g in 2018.

Whenua Hou burrow number	Boundary Stream burrow number	Selection Weights (g)		Transfer Weight (g)	Fledge weight (g)
		First	Second		
441	15	415	475	475	351
387	30	415	530	448	355
278	34	475	410	368	323
414	51	400	485	413	343
177	63	480/420	410	397	345
428	68	405	570	475	364
353	82	415	490	498	363
201	100	430	405	401	338
284	108	410	455	385	319
259	110	415	440	465	310

Note: Selection weights <420g are highlighted.

Five of the ten chicks with a selection weight <420g arrived at Boundary Stream at >420g weight, that is they had received a parental feed prior to transfer. Note however that the selection weights were measured up to 6 days prior to transfer. The ten chicks had a mean transfer weight of 432.5g (range 368 – 498g) compared to 468.1g (range 360 – 634g) for all chicks. There were no rearing or health issues for the ten chicks.

The chicks had a mean fledge weight of 341.1 g (range 310 – 364g) compared to 360.1g (range 308 – 447g) for all chicks.

4.3.6. Chick collection, transfer to Napier and welcome.

On April 13th the first chick for transfer was collected at 6.30am and the last by 9.10am. The chicks in their boxes were transferred in two helicopters to Invercargill airport as planned, arriving at 10:00am. The chicks were then flown by fixed wing aeroplane to Napier airport arriving at 2.30pm.

A group of 18 was on hand to welcome the chicks at Napier Airport – 10 iwi representatives, the Air Napier pilot and secretary, and 6 DOC staff. Trevor Taurima, Maungaharuru Tangitu, performed a karakia and welcomed the chicks. Two chicks were taken from their boxes so that those present could see them close at hand. These two chicks were named. Trevor Taurima named one chick 'Te Whetu o te ata' (Chick 17). Kuia Hinei Reti, Maungaharuru Tangitu, named the second chick 'Rangimarie' (Chick 16).

Once the blessing was complete the chicks in their boxes were loaded into a helicopter and were flown directly to the seabird site, arriving at approximately 3pm. The helicopter departed once unloading was complete.

4.3.7. Arrival and processing of chicks at Boundary Stream seabird site

The chicks were carried by hand down to the feeding shed. Processing of the 99 chicks (weighing, oral fluid administration and completion of the daily data sheets) commenced at approximately 3.30pm.

Chicks were placed into their BSMI burrows once fluid administration was complete and all chicks were in their burrows by 7.30pm. As there was a surplus of available burrows the chicks were placed into the most accessible burrows, that is Burrows 14 - 112 inclusive.

The transfer period, from Whenua Hou burrow to Boundary Stream burrow, ranged from 6.5 to 10.5 hours for individual chicks.

4.3.8. Chick weight change during transfer.

Five chicks their weight recorded prior to collection on transfer day on Whenua Hou and again on arrival at Boundary Stream. The 5 chicks lost a mean of 11.8g (range 4 to -25g) over the transfer period of 8.5 to 13 hours.

4.3.9. Outcome for chicks arriving at the release site at weights below 400g

Seven of 99 chicks (7%) arrived at Boundary Stream at weights below the 2018 Priority 1 selection weight minimum of 400g.

Table 5: Transfer and fledge weight and wing length and selection weights, dates and weight loss for mottled petrel chicks arriving at Boundary Stream seabird site at weight <400g in 2018.

Boundary Stream burrow number	Transfer weight (g)	Transfer Wing Length (mm)	Selection Weights (g)	Selection dates, April	Selection/ transfer weight loss (g)	Fledge Weight (g)	Fledge Wing Length (mm)
34	368	220	475, **410**	5, 11	42	323	268
37	399	257	505, 555	5, 9	156	363	269
45	395	251	495, 525	5, 9	130	330	271
63	397	244	480, 420, **410**	5, 11, 13	13	345	267
65	394	264	460, 430	5, 11	36	347	269
78	360	224	495, 470	5, 9	110	321	269
108	385	225	**410**, 455	5, 11	70	319	253

Three of the seven chicks, (43%) had one selection weight of <420g. In contrast, three of the chicks were well above selection weight (>460g) at both selection measures. Apart from one chick, selection weights were measured at least 2 – 4 days prior to transfer due to the poor weather and transfer delay. In some cases there was significant weight loss between selection and transfer. Mean weight loss between the last selection weight and transfer weight for these chicks was 78g (range 13 – 156g) over 0 to four days. The weight loss experienced was greatest for those chicks last measured on April 9th, four days before transfer.

These chicks had a mean transfer weight of 385g and mean transfer wing length of 241mm compared with 465g and 245mm respectively for all chicks. The seven chicks had no rearing issues and had a mean fledge weight of 335g and mean fledge wing length of 267mm compared with 360g and 266mm respectively for all chicks.

4.3.10. Chick maturity at transfer.

Chicks in 2018 were relatively mature at transfer (as indicated by wing length). Mean transfer wing length was 245mm, compared with ≤ 390mm for all previous years. Eighteen chicks were at Priority 3 wing length at transfer – that is, assuming 5mm wing growth over the first day; they were ≥ 256mm transfer wing length measured on Day 2. This number includes one chick (Burrow 103) that did not fledge for reasons unrelated to selection – see 4.7.3 below for more details on this chick. Table 6 presents data for 17 chicks that arrived on site at Priority 3 wing length and that subsequently fledged. The main risk with transfer of mature chicks is that they will have emerged at the natal site prior to transfer and thus not bond to and return to the release site.

Table 6: Selection and transfer data, emergence period, days on site and timing of first emergence for 17 chicks that were Priority 3 on arrival at Boundary Stream, 2018.

Boundary Stream burrow number	Selection weight (g)	Selection wing length (mm)	Selection Date April	Transfer weight (g)	Transfer wing length (mm)	Emergence period (nights)	Time on site (nights)	Emerged first night unblocked
16	450	243	9	409	256	7	16	
17	470	243	9	451	264	8	13	
18	460	240	11	440	257	2	10	
37	555	240	9	399	257	4	8	Y
38	460	230	9	515	256	6	21	
39	460	233	9	452	258	10	21	
48	575	241	9	480	263	7	13	
50	520	256	11	479	263	4	10	
56	500	245	11	431	257	10	15	
64	430	244	11	473	258	8	15	
65	430	257 (13th)	11	394	264	1	6	Y
66	560	253	11	530	266	8	20	
67	645	241	9	585	258	12	17	Y
76	560	233	11	515	257	13	23	
80	540	238	9	499	258	8	16	
85	535	253	11	485	269	5	14	
88	490	240	9	449	263	10	16	

This group of chicks fledged at mean weight of 370.1g and mean fledge wing length of 269.9mm compared with 360.0g and 266.0mm for all chicks. They were on site for a mean of 15 days and had a mean emergence period of 7.2 nights compared with 18 days and 7.6 nights respectively for all chicks.

The majority of these chicks were of Priority 1 wing length (<250mm) on the last measurement before transfer, however these measures were taken 5 – 3 days prior to transfer. Seven chicks of this group met the Priority 1 weight criteria at their last measure but were likely to be below Priority 3 weight at time of selection.

Chick 65 had wing length measured as 257mm on Whenua Hou on transfer day, but was not weighed that day. It was transferred despite being at low weight on April 11th as it was badly oiled and needed to be washed prior to fledging. The chick emerged from its burrow and did not return the first night the tunnel was unblocked. It is possible that this chick was emerging prior to transfer.

Chick 37 had relatively rapid weight loss (156g) and wing length growth (17mm) over the 4 days prior to transfer, thus reached emergence weight/wing length immediately prior to transfer. The chick emerged as soon as the burrow was unblocked but had a good

emergence period of four nights and fledged after eight days on site. It is also possible, but less likely, that this chick had emerged at the natal site.

It is likely that two chicks were above Priority 3 wing length (> 260mm) on transfer day – Chicks 66 and 85 were wing length 266 and 269 on Day 2 but had high transfer weights (530 and 485g) and were on site for 14 and 20 days respectively, thus are unlikely to have been emerging prior to transfer. All remaining chicks in this group were unlikely to have emerged prior to transfer as they had good emergence periods and number of days at Boundary Stream seabird site.

4.3.11. Condition of chicks at transfer

The majority of chicks were not measured on Whenua Hou on collection/transfer day and the first measurements taken after arrival at the seabird site were recorded as the transfer measurement. Consequently, transfer weight was the weight on the evening of arrival at the Boundary Stream seabird site. Transfer wing length (measured by Cathy Mitchell) was the wing length measured the following day. This data set is consistent over the five transfer years of 2014 to 2018.

In 2018, 99 mottled petrel chicks had a mean transfer weight of 468.1 +/- 51.2g (range 360 - 634g) and mean transfer wing length of 244.6 +/- 12.9mm (range 212 - 269mm).

4.4. Weather impacts at release site

The chicks had been scheduled to arrive at Boundary Stream seabird site on 10th April. This planned date was changed to 13th April due to weather conditions over the country meaning that flights could not go ahead as planned. Two transfers had been planned initially for 2018, but fortunately sufficient chicks met the selection criteria so that only one transfer was needed on April 13th.

Snow fell over the Maungaharuru Ranges on 10th April and vehicular access to the seabird site was not possible for two days. The seabird site was checked for damage on 12th April and a branch was found to be down over the fence creating a bridge over the fence, both into and out of the enclosure. The branch was removed and all traps and tracking tunnels within the site were set. The traps and tracking tunnels were left set until the first burrows were unblocked on 17th April, a period of five days. There were no trap catches and the only tracking recorded was of mice (the fence is not mouse-proof so this is expected). The tracking tunnels were re-set for a short time when a dropping was found in the site – once again only mice were recorded and the dropping was likely from a large mouse rather than a rat.

Trail camera footage was reviewed after the last chick had departed the site. A stoat was recorded on one frame on 12th April at 11am, approximately two hours before the fallen branch was removed. In the absence of any further stoat sign or any chick predation it is likely that the stoat entered and left the site via the branch before it was removed.

The site will be monitored again for the presence of predators using tracking tunnels and in addition a predator dog will check the site. Traps will be re-set. This work will be undertaken well before any returning birds are expected at the site in mid-October.

4.5. Hand feeding.

4.5.1. Introduction to hand feeding

Mottled petrel chicks regurgitate more readily than chicks of some other petrel species. On transfer day seven chicks spilled a small volume (1 – 2ml) of fluids as they resisted and/or vocalised on passage or removal of the crop tube. Three chicks actively regurgitated the oral fluids plus parental oil, up to 5ml, on transfer day.

Chicks were noted to be livelier on Days 2 and 3 as they recovered from the stress of transfer. Some chicks resisted the passage of the feeding tube and others vocalised and resisted (pulling back) as the crop tube was removed – this tends to open the upper larynx and pharynx and increasing the chance of food loss. On Day 2 feeding of 20ml was initially attempted but the first two chicks spilled 5ml of food and the amount was reduced for subsequent chicks to 15ml. One further chick had spilled and five regurgitated on Day 2. On Day 3 five chicks spilled and six regurgitated. In all cases the volume lost was estimated as being 3 - 8ml of food +/- parental oil except for one chick that lost 15ml. Chicks retained the majority of the feed and these chicks fed well for the remainder of the rearing period.

4.5.2. Feeding strategies and diet

A number of chicks were difficult to feed and spilled or regurgitated later in the rearing period. Strategies such as feeding smaller volumes, fish oil top-up on non-feeding days and feeding at the burrow were effective at ensuring that chicks received the food volumes needed to ensure good fledging weight. The affected chicks were often noted to be feisty and/or vocal which may have predisposed them to regurgitation. Chicks in 2018 generally appeared to be more settled than previous years.

The diet of the chicks appeared to work well to ensure that chicks fledged in optimal condition. Higher volumes were fed early in the rearing period when chicks accepted food more readily. It can be difficult to predict fledging date for individual chicks due to variation in emergence periods and fledge wing lengths. Proximity to fledging was indicated by slowing or cessation of wing length growth, chick emergence and reluctance to feed. In 2018 maintenance of chick weight as fledging approached was less of an issue than in previous years and chicks in 2018 had a high mean fledge weight.

4.6. Burrow condition

Burrow condition was assessed daily during the daily check of chicks. The plastic lid covers appeared to be effective in reducing the ingress of water into burrow chambers and burrow condition remained good through the rearing period, even during periods of rain. Burrows were topped up with leaf litter when needed, for example due to the occasional chick digging into the litter and exposing the gravel base of the burrow.

4.7. Chick emergence.

Chicks emerged from their burrows at varying times once their burrows were unblocked. In the majority of cases the timing of emergence reflected the maturity of the chicks.

4.7.1. Chicks emerging as soon as burrows unblocked.

Eight chicks emerged on the first night their burrows were unblocked. These were Chicks 37, 45, 54, 59, 65, 67, 79 and 87. This group of chicks emerged at weights ranging from 347 – 552g and wing lengths ranging from 244 – 269mm. One chick was

relatively immature (wing length was 22mm less than fledge wing length) but the remainder were within 0 - 9mm of their eventual fledge wing length. All except one chick, Chick 65, emerged for 4 – 16 nights before fledging, so had good emergence periods while at Boundary Stream. Chick 65 did not return to its burrow, was not found and is likely to have successfully fledged (see 4.5.2 below).

4.7.2. Chicks absent at their first emergence.

Eight chicks were absent from their burrows after their first emergence. Four of these chicks were found in other locations and returned to their own burrows. These were Chick 27 (found in Burrow 12), Chick 59 (found under tree), Chick 96 (found in tunnel 94) and Chick 106 (found at blocked tree).

Three of the chicks absent at their first emergence were not relocated - these chicks were: Chick 65: This chick was both light and mature when transferred. It had oiled feathers and was transferred so that it could be washed before fledging even though it was outside the selection criteria. The chick was washed, emerged the first night that its burrow was unblocked and was absent, presumed fledged, at 347g/269mm.
Chick 104: This chick emerged at 423g weight and 265mm wing length after 10 nights on site. Wing length growth for this chick had slowed (4mm over the previous 3 days) and it is likely to have fledged after some weight loss.
Chick 107: this chick emerged at 372g weight and 257mm wing length after 12 nights on site. Wing length growth for this chick had almost ceased (2mm growth over the previous 7 days) and it is likely to have fledged after some weight loss.

4.7.3. Chicks found in locations other than their own burrow.

1. Chicks found in burrows other than their own. Four chicks were found in burrows other than their own: Chick 16 was found in an unoccupied burrow, Burrow 13, after its first emergence and was returned to its own burrow. The chick returned to Burrow 13 the following night and was left there, did not emerge for 3 nights, then fledged following two further emergences from Burrow 13.
Chick 27 was found in an unoccupied burrow, Burrow 12, at its first emergence. It was returned to its own burrow and emerged from and returned to that burrow until it fledged.
Chick 36 was found in the chamber of Burrow 35 (Chick 35 was in the tunnel). The chick was returned to its own burrow and continued to emerge from and return to that burrow until it fledged.
Chick 96 was found in the tunnel of Burrow 94 (Chick 94 was in the chamber) and was returned to its own burrow – see 4.6.1 for more details on this chick.

2. Chicks found within the burrow site: Chick 59: This chick first emerged on 17th April at 406g/256mm and did not return. A large cavity with three possible entrances was noted under a tree close to the burrow of the chick but investigation did not reveal the presence of the chick. Stick fences were erected around the cavity. On the following two mornings the chick could not be found at the site or under the tree but the tree fences were down. The site was visited on the evening of 21st April and the chick was found under the tree cavity with the fences still intact. The chick was measured, given 5ml fish oil and returned to its own burrow and blocked in. The entrances under the tree were blocked with mesh so the chick could not re-enter as it could not be found and cared for in this location. The chick was found in Burrow 60 on its next emergence (Chick 60 had already fledged) on the morning of 23rd April and was returned to its own burrow. The chick was found in Burrow 60 on 24th April and was left there. The chick was absent, presumed fledged, on the morning of 25th April at 347g/260mm.

Chick 106 was found at the same tree under a small overhang on 25th April but could not enter the cavity as it was blocked. It was returned to its own burrow and emerged and returned to that burrow the following night. The chick was absent, presumed fledged, on the morning of 27th April at 359g/262mm.

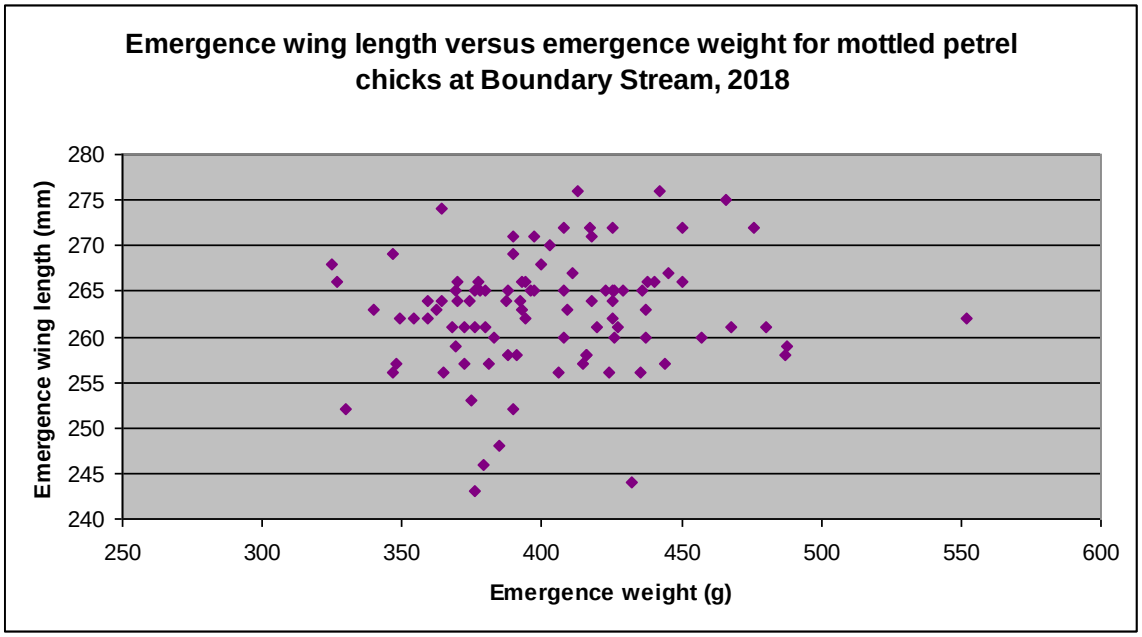
3. Chicks found in refuges: Chicks 35, 57, 75, 61 and 109 were found in refuges beside the fence. These chicks were all returned to their own burrows and Chick 75 was assisted to fledge (see 4.6.1 below).

4. Chicks found in the open: Three chicks were found in the open on night visits to the seabird site. These were Chicks 20, 29 and 39, all of which were assisted to fledge (see 4.6.1 below).

4.7.4. Emergence for all chicks.

Chicks first emerged at a mean weight of 402g (range 325 – 552g) and mean wing length of 262mm (range 243 – 276mm). Chicks emerged for a mean of 6.9 nights. This compares with a mean emergence period of 7.6 nights (range 1 - 16 nights) due to many chicks emerging intermittently after their first emergence. For example Chick 34 emerged on the night of 25th April, did not emerge on the nights of 26th, 29th and 30th April and fledged on 4th April at its 6th emergence.

Graph 3: Wing length versus weight at first emergence for mottled petrel chicks at Boundary Stream, 2018



In 2018, 90/97 of chicks (93%) emerged at ≥255mm, and 73/97 of chicks (76%) emerged at ≥260mm. Four chicks emerged at less than the Priority 1 selection wing length (<250mm). One of these chicks was within the selection weight criteria for that wing length (>400g).

Nineteen chicks emerged at Priority 3 wing length (250 – 260mm) and all were outside the Priority 3 selection weight at emergence (>500g). The weight of these chicks ranged

from 330 – 488g at first emergence, and the majority (17/19) were ≤440g in weight. No chicks emerged at Priority 2 wing length (190 – 210mm).

Thus only one of 97 chicks emerged within the selection weight/wing length criteria. This chick was 432g/244mm at its first emergence, its wing length increased by 22mm between emergence and fledging and it emerged for 16 days before fledging – the chick is unlikely to have emerged prior to transfer.

4.8. Chick fledging.

4.8.1. Fledging difficulty and assisted fledging

A number of chicks appeared to have difficulty fledging and the majority of these chicks were offered fledging assistance. Fledging assistance consisted of taking chicks to a windy location (though winds were very light on some nights) and placing them on a ramp. If this was not successful some chicks were held in a more elevated position in flattened hands to try and catch more wind. Lights were turned off to assist vision and chicks were allowed to settle and take their time to fly.

1. Two chicks were found away from their burrows, were returned to their burrows and fledging assistance was attempted the following night. Neither of these chicks fledged and each was returned to its own burrow. Both chicks fledged without assistance later the same night assisted by rising wind during the night.

Chick 61: This chick first emerged on 26th April at 415g/256mm. The chick emerged seven more times and it was absent, presumed fledged on the morning of 3rd April. There was rain off & on during the night of 2nd/3rd April. The chick was found in a refuge beside the fence on the morning of 4th April at 357g/263mm. The chick was returned to its burrow and blocked in for the day. That evening the chick was taken to a ramp but made no attempt to fly (there was no wind) and was returned to its burrow and unblocked. The following morning, 5th April, the chick was absent, presumed fledged, at 357g/263mm.

Chick 96: This chick was absent from its burrow on the morning of 30th April at 374g/264mm – its first emergence. The chick was found in the tunnel of Burrow 94 (Chick 94 was in the chamber) on the morning of 3rd April, three days later. The chick was measured, fed, returned to its burrow and blocked in for the day. That night the chick was noted to be very feisty, was taken to a ramp but made no attempt to fly (there was no wind). The chick was returned to its burrow. The following morning, 4th April, the chick was absent, presumed fledged, at 336g/266mm.

2. Five chicks were assisted to fledge

Chick 20: This chick first emerged on 26th April at 418g/266mm. The chick emerged 4 more times and was absent from its burrow on the morning of 1st May. It was noted that the weather was damp with periods of rain on the night of 30th April/1st May. The chick was found on a night visit to the site early on the evening of 2nd May. The chick was attempting to climb a low spindly bush up by the speaker and was very wet. The chick was returned to its burrow and blocked in so that it could dry out. The chick was measured and given a small meal on 3rd May and returned to its blocked burrow. That evening the chick was taken and placed on the ramp by the speaker system. The night was calm and the chick made no attempt to flap or fly. The chick was held up on flattened hands and flew off strongly on 3rd May at 352g/268mm.

Chick 29: This chick first emerged on 2nd May at 393g/264mm. The chick emerged 4 more times and its burrow was empty on the morning of 7th May. It was calm initially then the wind came away on the night of 6th/7th May. The site was visited that night and the chick was found near the top of a bank beside the fence, a location it would have had difficulty fledging from. The chick was measured, taken to the ramp by the speaker and fledged on 7th April at 344g/264mm.

Chick 32: This chick first emerged on 4th May at 390g/266mm. The chick emerged five more times and was absent from its burrow on 10th May. On a visit to the site that night the chick was found close to its burrow (the fence was still intact so the chick had not re-entered the burrow). The chick was measured then taken to the ramp near the speaker and sat there for 15 – 20 minutes. The chick then flew off strongly with no preliminaries on 10th May at 350g/267mm.

Chick 39: This chick first emerged on 25th April at 364g/274mm. The chick emerged 8 more times, wing length growth had ceased and the weight had dropped to 322g by 2nd May. The chick was given a small feed on 2nd May and the burrow was blocked. That evening the chick was taken to a ramp, but the wind was light, the chick made several flapping attempts and dropped to the ground. The chick was returned to its burrow which was unblocked. Periods of rain were noted on the night of 2nd/3rd May. The following morning, 3rd May, the chick was absent from its burrow. The site was visited that evening and the chick was found at the high, flat area across from the Cooks site, in long grass and scrub. The wings and tail were wet and the chick was returned to its burrow and blocked in. The chick was given 6ml fish oil the following day and the burrow was left blocked. On the evening of 4th May the chick was taken to the open, held up in open hands and flew off strongly with good elevation at 308g/274mm.

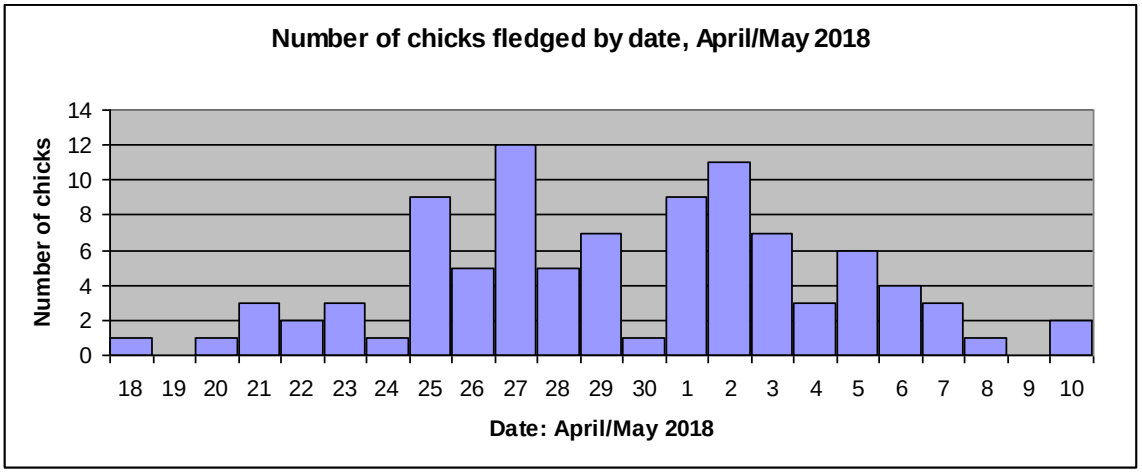
Chick 75: This chick first emerged on 24th April at 479g/260mm. The chick emerged 7 more times and was absent from its burrow on the morning of 2nd May. Damp, drizzly and calm weather was noted on the night of 1st/2nd May. The chick was found in a refuge beside the fence on a night visit to the site on the evening of 2nd May. The chick was dry, fit, weighed 401g and was returned to its burrow. It did not re-emerge that night and was given a small feed the following day. The chick was absent from its burrow the next morning, 4th May, but was found in a refuge beside the fence. The chick was returned to its own burrow and blocked in for the day. That evening the chick was taken to the ramp by Burrow 1, where there was a light breeze. The chick had a good attempt at flying but landed in a flax bush across and down from the ramp. The chick was taken back to the ramp and then flew off strongly, circling back up overhead before leaving the site, on 4th May at 388g/261mm.

3. One chick appeared to fledge successfully but was later found deceased close to the fence – see 4.7.3 below for more details on this chick.

4.8.2. Timing and condition of chicks at fledging

The first chick to fledge left the site on April 18th, and the last two chicks to fledge left on May 10th. Peak fledging was on 26/27th April, with 12 chicks absent that morning; a second peak departed on 1st/2nd May with 11 chicks absent that morning. Both of these nights were initially calm but became windy later on and the night of 1st/2nd May was noted to have had periods of rain. Mean fledge date was 29th April.

Graph 4: Number of chicks fledged by date for mottled petrel chicks fledging from Boundary Stream seabird site, 2018.



Ninety-six chicks fledged at a mean weight of 359.98g +/- 26.4g (range 308 – 447g) and a mean wing length of 266.11 +/- 5.3mm (range 253 – 276mm). The mean time at Boundary Stream for the 96 chicks was 17.6 +/- 4.6 days (range 6 - 28 days).

4.9. Chick health.

4.9.1. General health and eyes

All chicks were considered to be in good condition on arrival at Boundary Stream seabird site. A health check carried out the day after arrival showed no abnormalities. This check included palpation of both legs and wings in order to detect injuries should they be present.

On arrival down was noted to be present in one or both eyes of 18 chicks, located between the third eyelid and lower conjunctiva. The down was removed with a clean finger and the affected eye in most cases was normal within one to two days. In two cases the eye appeared mildly inflamed and Chlorsig ointment was instilled. The eyes of both chicks improved within two days.

4.9.2. Chick plumage

The plumage of five chicks was noted to be dirty when the chicks arrived or in the early days after arrival. Two of these chicks (Chicks 65 and 79) were oiled to the skin over a large area and were taken down to the field base for a full wash on 15th April, Day 3. The chicks were washed then held at the base in a corflute box overnight to dry. The chicks were fed at base that evening. The following day feather waterproofing was checked, found to be good and the chicks were returned to their burrows.

Three chicks had oiled necks and/or heads and these were washed at the feeding shed on 19th April. These were Chicks 14, 26 and 47. The chicks were returned to their burrows after being held in boxes in a warm area for an hour. Waterproofing was checked the following day and was good.

4.9.3. Deceased chicks.

Three of ninety-nine chicks were euthanased or died after transfer to Boundary Stream in 2018.

Two chicks were found to have a fracture of the femur and were euthanased. Note that these fractures will have occurred after the health check on April 11th, Day 2. The chicks were:

Chick 44: This chick was found to have fracture of the right femur when its band was checked on 20th April. The fracture was likely to have occurred 3 - 4 days previously as a callus had formed at the fracture site; however it was not present when the chick was banded on 16th April.

Chick 103: This chick was found to have a fracture of the right femur during banding on 16th April. The fracture was fresh and likely to have occurred on the day it was found.

Following on from these two discoveries all legs of all chicks were re-checked for injury but none were found. Chicks were checked again if they didn't emerge or stopped emerging as expected.

See Discussion 7.2.11 below.

Chick 109: This chick first emerged on 21st April at 409g/257mm. The chick emerged five more times and its burrow was empty on the morning of 26th April. This was noted as a calm, fine period of weather. The chick was found in a refuge beside the fence that day, was weighed (368g), reluctantly took 5ml oil and was returned to its burrow. The weather was calm initially with wind later on the night of 26th/27th April. The following morning, 27th April, the burrow was empty and it was presumed that the chick had fledged successfully. The chick was found dead close to the fence two days later on the morning of 29th April after a night of rain. The body was very wet but there were no external injuries visible. The chick was sent to Massey University for post-mortem examination. This indicated 1. Possible oil aspiration, and 2. Hepatic lipidosis. See Appendix 3 for the full postmortem report and Discussion in 7.1.8 below.

4.10. Four year comparison

Results over the four transfer years are compared in the tables below.

Table 5: Comparison of number of burrows, number of chicks and burrow occupancy for mottled petrel on Whenua Hou, 2014 to 2018.

Year	Total number of burrows	Number of burrows of known status	Number empty	Number of chicks located in known status burrows (inc Study chicks)	Burrow occupancy (%)
2014	350	304[1]	150	154	51
2015	402	347[2]	196	151	44
2016	455	402[3]	252	150	37
2017	460	455[4]	249	206	45
2018	460	430[5]	263	166	39

Notes: 1. 2014; Data from April 2nd, 46 burrows had no status recorded - it could not be assumed they were empty as a number of chicks were collected from them on April 11th, and thus the 'no status' burrows were not used to estimate occupancy

2. 2015; 52 new burrows were established, all contained chicks (therefore were not a random sample in terms of burrow occupancy) and they were not used to estimate burrow occupancy

3. 2016; 53 new burrows containing 32 chicks (60%) occupancy were established; previous burrows only were used to estimate burrow occupancy

4. 2017; 5 new burrows, all containing chicks, were established and were not used to estimate burrow occupancy

5. 30 burrows were unavailable – collapsed, chamber out of reach, etc.

Table 6: Comparison of number of available chicks and number and percentage of mottled petrel chicks transferred from Whenua Hou to Boundary Stream, 2014 to 2018.

Year	Total number of chicks [1]	Number of Study chicks	Number of chicks available for Boundary Stream	Number of chicks selected for transfer (number selected Transfer 1) [2]	Percentage of available chicks selected (percentage selected Transfer 1)
2014	168	48	120	39 [3]	33
2015	206	69	137	82 (61)	60 (45)
2016	183	69	114	45	39
2017	211	0	211	97 (68/201)	46 (34)
2018	166	0	166	99	60

Notes: 1. Number of chicks in this table does not directly relate to those in Table 5 as only burrows of known status were used to estimate occupancy in Table 5
2. Selection criteria differed for each of the five transfer years
3. Does not include six Study chicks that were transferred in 2014

Table 7: Transfer weight and wing length of mottled petrel chicks transferred from Whenua Hou to Boundary Stream, 2014 to 2018.

Year	Number of chicks	Transfer weight, Mean (g)	Transfer weight, Range (g)	Transfer wing length, Mean (mm)	Transfer wing length Range (mm)	Transfer Date
2014	45	491	419 - 607	236	222 - 249	April 13th
2015	82	468	375 - 553	239	223 - 261	April 11th and 16th
2016	45	459	359 - 540	239	223 - 263	April 13th
2017	97	461	385 - 629	238	306 - 432	April 10th and 16th
2018	99	469	360 - 634	245	212 - 269	April 13th

Note: Transfer weight was measured at Boundary Stream on transfer day; Transfer wing length was measured the day after transfer (by C. Mitchell each transfer year).

Table 8: Mean emergence weight, wing length and emergence period and ranges for mottled petrel chicks transferred from Whenua Hou to Boundary Stream, 2014 – 2018.

Year	Emergence weight, Mean (g)	Emergence weight, Range (g)	Emergence wing length, Mean (mm)	Emergence wing length, Range (mm)	Emergence period, Mean (days)	Emergence period, Range (days)
2014	395	315 - 450	261	251 - 272	7	1 - 15
2015	385	334 - 475	263	250 - 275	7	1 - 15
2016	390	336 - 488	263	252 - 276	8	1 - 15
2017	393	324 - 514	262	245 - 275	8	2 - 14
2018	402	325 - 552	262	243 - 276	8	1 - 16
All years	393	315 - 552	263	243 - 276		

Table 9: Mean fledge weight and wing length, days on site and ranges for mottled petrel chicks transferred from Whenua Hou to Boundary Stream, 2014 to 2018.

Year	Fledge weight, Mean (g)	Fledge weight, Range (g)	Fledge wing length, Mean (mm)	Fledge wing length, Range (mm)	Days time at Boundary Stream (Mean)	Days at Boundary Stream (Range)
2014	350	302 - 427	264	253 - 274	20	14 - 27
2015 [1]	341	291 - 408	266	254 - 276	17	8 - 29
2016	354	312 - 422	266	258 - 278	18	10 - 28
2017	348	306 - 432	266	255 - 279	20	12 - 28
2018 [2]	360	308 - 447	266	253 - 276	18	6 - 28

Note: [1] Excludes 1 deceased chick
[2] Excludes 3 deceased chicks

Table 10: Target and actual number of mottled petrel chicks transferred and number and percentage of chicks fledged over five transfers from Whenua Hou to Boundary Stream, 2014 to 2018.

Year	Goal for transfer	Number transferred	Number fledged	Percent fledged
2014	50	45	45	100
2015	150	82*	81	98
2016	150	45	45	100
2017	150	97*	97	100
2018	100	99	96	96
Total	**500**	**368**	**364**	**99**

**Note: ***Two transfers were undertaken in 2015 and 2017.

4.11. Consultation and community relations over five transfer years

Iwi of both Whenua Hou/Codfish and Maungaharuru have been involved at all stages of the translocation. Consultation was undertaken prior to and during the translocation

process. Trips by the Project Managers based in Hawkes Bay were taken down to Invercargill to meet with iwi, to address any concerns and give progress reports. Similar meetings were held in Napier. The chicks were accompanied from Invercargill up to the seabird site by a member of Ngai Tahu for the first transfer. Kaumatua of Maungaharuru Tangitu have welcomed and blessed the birds as they have arrived at the Boundary Stream site every transfer year. Iwi members have been involved in the collection trips and feeding of chicks most years.

A range of publicity opportunities have been utilised. Articles have regularly appeared in local newspapers. Television coverage includes an article on Maori TV in 2016 and a segment on One National News in 2018 **(https://www.tvnz.co.nz/one-news/new-zealand/shifting-sea-birds-inland-hawkes-bay-shows-results**). Regular postings have been made on the Poutiri Facebook page. The 2018 transfer was covered by a three-part blog posted by DOC (**https://blog.doc.govt.nz/2018/05/09/99-birds-wing-their-way-to-hawkes-bay/**).

Volunteers have had a large input into all stages of the project. This input includes; manufacture and installation of artificial burrows, assistance with reconnaissance and collection trips, feeding and assistance with managing chicks at the seabird site, food preparation and clean up of equipment. Volunteers have mostly come from the Hawkes Bay area but a number have travelled from further afield. Volunteers have come as individuals interested in conservation and also groups such as Rotary and tramping groups. Many have returned to help year after year and all have appreciated the opportunity to be involved in this unique project.

5. Other observations

All observations are covered in Results

6. Costs

7. Discussion, Recommendations and Summary

7.1. Discussion of 2018 transfer

7.1.1. Reconnaissance and collection trips

The 2018 transfer of mottled petrel chicks to Boundary Stream proceeded well. The timing of the collection trip was based on the data from 37 chicks at the reconnaissance trip and confirmed that chick collection would be best undertaken on April 10th. Chick collection was delayed to 13th April due to weather. However, chicks in 2018 were in good condition and 99 chicks were able to be transferred in a single trip.

Collection was planned for 10th April and chick wing lengths measured on the collection trip confirmed that this was the ideal time. It was estimated that 69% of available chicks were at Priority 1 wing length on 10th April. Only 19% of chicks that were not selected were either too immature (<190mm) or too mature (>260mm), also indicating that collection was ideally timed.

7.1.2. Non-selected chicks

The percentage of chicks that were selected in 2018 was among the highest over all five years, particularly as these were moved in a single transfer. Of the chicks available in 2018 41% were not selected. The main reason for non-selection was that chicks were too light for their wing length grouping (57% of non-selected chicks).

7.1.3. Chick selection criteria

Chick selection criteria worked well to ensure that chicks arrived at Boundary Stream in good condition. Minimum selection weight for Priority 1 chicks was reduced to 400g, as had been trialled for the second transfer in 2017. Use of this criterion resulted in the selection of ten additional chicks in the weight range of 400 – 420g in 2018. The chicks selected in this weight range all fledged successfully, at a lower mean weight than for all transferred chicks, but all were within fledging parameters recorded for naturally fledged chicks on Whenua Hou. It is considered that the use of this lower selection weight was justified as the number of chicks transferred was increased without compromising fledging success.

7.1.4. Chick transfer

Chick collection and transfer was delayed by two days due to poor weather – two days of fine weather is needed for the fixed wing and two helicopter flights. On transfer day the Whenua Hou team made an early start so that the large number of chicks could be transferred off the island as early as possible. Transfer from Whenua Hou Island to the mainland and up the country proceeded smoothly and the chicks arrived at Napier Airport by mid-afternoon. Weather conditions permitted the helicopter to fly directly to the seabird site without the need to utilise the contingency plan of driving a utility vehicle. This in turn meant that chicks were settled in their burrows by early evening on the day of transfer. Thus, the chick transfer on 13th April proceeded very smoothly and was completed in good time despite the large number of chicks transferred.

7.1.5. Condition of chicks on arrival at Boundary Stream

Many chicks had their second measurement 2 – 4 days prior to transfer and this resulted in a number of chicks arriving outside selection criteria. Seven of 99 chicks (7%) arrived at weights below 400g (minimum selection weight for Priority 1 chicks). These chicks had no problems during rearing and all fledged within normal parameters, though at a lower mean weight than all chicks in 2018.

Perhaps of more concern is the number of relatively mature chicks (wing lengths >255mm for 16 chicks and > 260mm for two chicks the day after transfer) that arrived at

Boundary Stream in 2018. This came about in part because of the weather conditions around the time of transfer which meant that the chicks could not be measured at the ideal times and also that the transfer was delayed. The main risk with mature chicks is that they will have emerged at the natal site prior to transfer. Chicks that are transferred at light weight and long wing length, that emerge at the first opportunity and that are at the release site for short periods are more likely to have emerged prior to transfer.

In 2018 two mature chicks (Chicks 37 and 65) fledged relatively quickly. It is possible that both of these chicks emerged prior to transfer. Note that Chick 65 was transferred for the welfare of the chick despite knowing that it had possibly emerged at the natal site. The remaining chicks in this group are unlikely to have emerged before they were transferred; the majority were a good weight at transfer (≥ 470g), chicks did not emerge at the first opportunity and all were at the release site for 10 – 21 nights. Though there were more Priority 3 chicks transferred in 2018 than in previous years the majority of these chicks are unlikely to have emerged prior to transfer.

7.1.6. Hand feeding of chicks

This proceeded smoothly following procedures put in place over the previous transfers. Once chicks were through the initial three-day feeding programme they were moved to feeding every third day, with the exception of the occasional light chick that was fed on days in between. Chicks were split into two approximately equal-sized groups that were fed on different days. Thus a group of chicks was fed on two out of every three days. The two groups were blended into one when chick numbers reduced as chicks fledged. As in previous years the mottled petrel chicks were observed to be more likely to spill or regurgitate at feeding but this did not impact on the fledging weights of the chicks and chicks in 2018 had higher mean fledge weight than for the previous four years (360g c.f. 341 – 354g).

7.1.7. Chick emergence and fledging difficulty

Eight chicks emerged from their artificial burrow the first night it was unblocked. However this emergence was at the 5th to 6th night on site for these chicks and all except one emerged for 4 to 16 nights and were at Boundary Stream for between 12 and 17 days. It is very unlikely that these chicks had emerged prior to transfer.

For the most part chicks emerged and returned to their own burrows successfully. Fourteen chicks became ‘lost’ during their emergence period, being found in burrows other than their own, in the refuges placed around the seabird site or in two cases in the open near the chick’s own burrow. This is the highest number of ‘lost’ chicks recorded over the five transfer years.

In 2018 chicks emerged at a higher mean weight than chicks in other years (402g c.f. ≤ 395g in the preceding years), which may have contributed to fledging difficulty. The twelve chicks found in locations away from the burrow site had attempted to fledge on nights that were noted to be calm and/or wet, both of which would have made fledging more difficult. In 2018 some of the chicks that were found may have successfully fledged unassisted with the loss of more weight, but a proactive approach was taken to give the chicks the best chance of fledging successfully. Search effort for lost chicks was also higher in 2018 with the entire site being searched on night visits and more refuges placed around the site increasing the chances of ‘lost’ chicks being found.

Five chicks were assisted to fledge in 2018. Fledging assistance involved taking the chick to a windy area of the site and placing them on a ramp or holding them in the hand in an elevated position. Two other chicks that did not appear interested in flapping/flying were returned to their burrows and fledged successfully without assistance later the same night – possibly assisted by increased wind later on those nights.

7.1.8. Deceased chicks

Three chicks died or were euthansed in 2018. Two chicks were euthanased due to femoral fractures caused by handling errors – see Discussion 7.2.11 below.

One chick had difficulty fledging and post mortem indicated possible oil aspiration and hepatic lipidosis. If oil aspiration occurred it is likely to have been at or shortly after the last oil feeding administered on 27th April, when the chick was first found close to the fence. No problems were noted at the time although it was noted that the chick was reluctant to feed. The chick was not given a full feed as it was of good weight (368g) and potentially needed to lose weight in order to fledge; it was returned to its own burrow and not handled again prior to its death. The lipidosis will have occurred as the chick lost weight prior to its death. It was at still at a good fledging weight when it died despite the lipidosis seen at post mortem (355g, compared with mean fledge weight for all chicks over five transfer years of 341 – 360g).

The chick was noted to have completely wet feathers when found which would have led to loss of body heat and prevented it from fledging. It is possible that the chick rapidly mobilised its energy reserves in an attempt to maintain body temperature as it attempted to fledge. The death of this chick is likely to have occurred as a result of it being unable to successfully fledge. Chicks found close to the fence in 2017 at similar weight/wing length to this chick were returned to their burrows and subsequently fledged successfully. However, after the death of this chick, any further chicks found close to the fence in 2018 were offered fledging assistance.

7.2. Discussion and recommendations for future transfers of mottled petrel chicks based on five transfers to Boundary Stream.

7.2.1. Burrow occupancy on Whenua Hou

Over the five transfer years additional managed burrows have been installed with the result that the number of burrows increased from 350 to 460, but these reduced to 430 burrows in 2018 due to burrow deterioration.

Occupancy of managed burrows on Whenua Hou has varied over the five years between 37% and 51% (mean occupancy was 43%). Occupancy dropped over the first three transfer years but then improved as new burrows were installed prior to the 2015 and 2016 transfers. Burrow occupancy once again dropped between 2017 and 2018 as burrows aged. Falling occupancy in the managed burrows was due to a combination of natural attrition and burrow damage occurring as a result of deteriorating study lids and human disturbance.

A number of the deteriorating burrow lids were replaced in 2017 and 2018. Due to the use of untreated plywood for the lids this work will need to be ongoing to maintain burrow integrity. Burrows are well marked with stakes and triangles and GPS locations were taken to assist with locating burrows in future transfer years.

Recommendation: Maintenance of burrows on Whenua Hou is undertaken whenever possible so that burrows continue to have high occupancy rates and therefore continue to be available for future transfers of mottled petrel.

Recommendation: If future translocations occur some time after the current series, extra time will need to be allocated for relocation of burrows and burrow refurbishment. Ideally this would be a separate trip, prior to the start of the breeding season. It is also likely that additional study burrows may need to be installed in order to locate sufficient chicks to obtain the numbers planned for transfer.

7.2.2. Timing of reconnaissance and collection trips

Over the five transfer years the reconnaissance trip has been carried out from 9 to 32 days prior to collection. An earlier reconnaissance trip allows more flexibility to bring the collection trip forward to an earlier date if this is needed, particularly given the logistics involved in these translocations.

The timing of the collection trip aims to coincide with the time when the peak number of chicks is at Priority 1 wing length of 210 – 250mm. Mean wing length growth rate between the reconnaissance and collection trips has varied from 4.0mm/day over 19 – 21 days in 2016, 3.8mm/day over 11 days in 2017 and 4.0mm/day over 17 days in 2018. Use of a wing length growth rate of 3.6mm/day in 2018 underestimated wing length by a mean of 7.0mm. This, however, represents approximately two day's growth and thus did not significantly impact on the predicted ideal collection time.

Recommendation: Reconnaissance trips would ideally be undertaken 3-4 weeks prior to the planned collection trip, that is 12th – 22nd March.

Recommendation: As many chicks as possible should be measured on the reconnaissance trip (ideally 50 chicks) and a wing length growth rate of 3.8 – 4.0mm/day should be used to calculate the ideal timing for the collection trip.

Recommendation: The time of transfer of mottled petrel from Whenua Hou has been consistent over all five years. Future transfers of mottled petrel should initially be planned for April 10/13th if one trip is planned. If two transfers are likely the first trip should be planned to take place slightly earlier on April 9/10th and the second a week later. A final decision on transfer dates would then be made on the basis of the data obtained on the reconnaissance trip.

Recommendation: The logistics of transferring chicks off islands and across the country can be complex. Contingency plans need to be in place in the event that transfer can not go ahead as first planned.

7.2.3. Number of chicks transferred

Factors that contributed the higher number of chicks transferred in some years were;

- Number of available burrows, see 7.2.1 above
- Reductions of selection weight and wing length criteria. See 7.2.5 below.
- Number of located chicks that were available for transfer. In the transfer years 2014 to 2016, 48 – 69 chicks were enrolled in a Masters and PhD study and thus were not available for transfer.

- Number of transfers per year. More chicks (99) were transferred in 2018 than any of the preceding transfer years. The two other years when numbers transferred have been high were 2015 (82 chicks) and 2017 (97 chicks), however in both of those years this was achieved using two transfers each year.
- Breeding season variations. In 2013 the transfer of mottled petrel chicks was not undertaken as chicks were in very poor condition. By contrast, 2018 was a good breeding season for mottled petrel on Whenua Hou and a good number of chicks were able to be selected for a single transfer.

Recommendation: Ideally sufficient numbers of chicks can be obtained in a single transfer; this will reduce the costs and logistics of transfer. If two transfers are undertaken in a single year, a smaller number of chicks will be available for the second transfer. Use of two collection trips may need to be included in trip planning, particularly if it is planned to transfer higher numbers of chicks..

7.2.4. Percentage of chicks collected and number of managed burrows needed

Over the five transfer years the percentage of available chicks collected has ranged from 33 – 59% for a single collection, with 2018 having the greatest number of chicks selected. Alteration of selection criteria has assisted in an increase of the percentage of chicks transferred. However, to a large extent the percentage transferred is dependent on the condition of the chicks in any one season and this cannot be altered.

For future transfers, the percentage of chicks suitable for a single transfer is likely to be around 42% (the median percentage of chicks selected for a single transfer over the five transfer years) but could be as low as 33% depending on the season.

Recommendation: Sufficient occupied burrows need to be located in order to have sufficient numbers of available chicks to obtain the target number of chicks for transfer. For example: if it is planned to transfer 100 chicks in a single transfer, then 554 burrows would be needed to give 238 available chicks and 100 selected chicks (based on the mean burrow occupancy of 43% and the mean selection of 42% of available chicks as recorded over five transfer years to Boundary Stream).

7.2.5. Selection criteria

1. Chick emergence:

Emergence weight and wing length has implications when selecting chicks for transfer as chicks may not return to the release site if they have emerged prior to transfer. Emergence data for chicks has not been recorded on Whenua Hou, so emergence data recorded at Boundary Stream can be used as a guide for appropriate chick selection criteria. Mean emergence weight over five transfer years for chicks transferred to Boundary Stream was 393g (range 315 – 552), and mean emergence wing length was 263mm (range 243 – 276mm).

Emergence data recorded for chicks transferred to Boundary Stream indicates that the selection criterion is appropriate to ensure that chicks have not emerged prior to transfer. Over the 5 transfer years only 2 chicks (0.5% of all transferred chicks) have emerged within the selection criteria. Both of these chicks were within the Priority 1 criteria being >400g weight and < 250mm wing length. Over the five transfer years, 38 chicks (10% of all transferred chicks) have emerged at Priority 3 wing length (250 – 260mm). All of these chicks have been less than Priority 3 selection weight (≥500g). Over the five

years 320 chicks (88% of all transferred chicks) have been ≥260mm at their first emergence.

Thus, emergence data recorded at Boundary Stream indicates that the criteria used when selecting chicks for transfer is appropriate to ensure that chicks have not emerged prior to transfer.

2. Selection criteria adjustment:
Selection criteria have been adjusted every transfer year. Selection weight for every Priority grouping has been reduced over the five years. In 2017 Priority 1 wing length was reduced from 220mm to 210mm. The outcomes for chicks selected at the adjusted criteria have been detailed each year and the use of these lower weights and wing lengths appears to have had no impact on fledging success. The outcomes for chicks arriving at Boundary Stream outside selection parameters (mostly at lower weights) have also been detailed each year. These chicks also appear to have fledged successfully.

Both groups of chicks (low selection weight and low transfer weight) have had lower mean fledging weights than the mean for all transferred chicks. However both individual and mean fledging weights and wing lengths have been within the fledging parameters recorded on Whenua Hou for naturally reared chicks. The long term outcome for these lighter chicks will not be known until transferred birds return as adults.

The primary motivation for altering selection criteria has been to increase the number of chicks transferred. Greater numbers of chicks in a transfer cohort increases the likelihood that good numbers of birds will return as adults. Changing the selection criteria was successful in increasing the number of chicks transferred – for example, ten additional chicks selected at 420 – 450g in 2016 and 10 additional chicks selected at 400 – 420g for the second transfer in 2017.

Recommendation: For future transfers consider using selection criteria set out in Table 10 below. Priority 4 chicks can be selected particularly if more chicks are needed to meet the target numbers for transfer - these are Priority 1 and 2 wing length chicks selected at lower weights. It is not recommended to reduce selection weight for Priority 3 chicks as some of these chicks will be at emerging wing length but should not be emerging if weights are high (>500g). The higher weight requirement at a stage when chicks are naturally losing weight means that very few Priority 3 chicks have been transferred to Boundary Stream for most transfer years - eight Priority 3 chicks were selected in 2014 – 2017, compared to 18 in 2018.

Table 10: Recommended selection criteria for future transfers of mottled petrel chicks. Note: weight is the lighter of two weights measured 3 – 4 days apart in order to obtain the unfed weight of the chick.

Priority Group	Wing length (mm)	Weight (g)
Priority 1	210 - 250	≥ 420
Priority 2	190 - 210	≥ 470
Priority 3	250 - 260	≥ 500
Priority 4	210 - 250	≥ 400
	190 - 210	≥ 450

Recommendation: Identification of birds returning to Boundary Stream should be obtained where possible. This will indicate the selection criteria that are positively correlated with successful return rates of fledging chicks. This in turn may lead to modification of the selection criteria for future translocation projects.

7.2.6. Reasons for non-selection of chicks.

When selecting chicks, wing length is the first selection criteria considered. If this falls within one of the Priority ranges then weight is assessed. The primary reason that chicks were not selected in any transfer year was because they were too light for their wing length grouping (80% of non-selected chicks in 2017 and 57% in 2018). The weight of chicks is a reflection of the breeding season and cannot be altered.

Use of a second collection trip in two of the transfer years meant that many Priority 2 chicks could then be reconsidered for transfer as they had now reached Priority 1 wing length with a lower weight requirement.

7.2.7. Weight loss over transfer

Forty-six chicks over five transfer years have been weighed on transfer day prior to transfer and again on arrival at Boundary Stream up to 13 hours later. Mean weight change for these 46 chicks over the transfer period was 18.2g (range 1 – 78g). The majority of chicks (41/46, 89%) had weight loss ≤ 30g. Chicks with higher weight loss are likely to have regurgitated during handling or transfer. The majority of chicks, therefore, do not suffer significant weight loss over the transfer process. However it should be kept in mind that a small proportion of chicks may lose up to 75g of a high-value, parental feed during transfer.

Recommendation: Chicks of marginal weight should be weighed on transfer day and not collected if their weight is below 400g as weight loss up to 30g frequently occurs over the transfer period and losses up to 75g may be experienced by some chicks.

7.2.8. Hand feeding of chicks

Hand feeding of mottled petrel chicks over the five transfer years has been very successful. Methods and diet used for other species have proved to apply equally well to this species. No particular problems were encountered during rearing and the majority of chicks fledged successfully.

Mottled petrel chicks do appear to be more prone to regurgitation during feeding than chicks of other species. Use of the smaller diameter, less rigid 14Fg crop tube was found to greatly reduce the incidence of regurgitation. Other strategies as outlined in Section 4.5.2 also proved helpful to ensure chicks received the volume of food they required.

One of the main challenges when feeding these chicks was predicting fledge dates of individual chicks. This in turn affected decisions on feeding rates so that weight loss was not excessive just prior to fledging.

The approach to feeding mature chicks took into account four factors – wing length, emergence, wing length growth rate and the chick's response to feeding. The range of fledge wing lengths (255 – 278mm) and emergence periods (1 – 14 days) are relatively wide and thus neither measure could be used alone to predict imminent fledging.

The slowing or cessation of wing growth was used to assess proximity to fledging but this also was variable. Some chicks reached maximum wing length for up to 14 days prior to emergence or fledging and for the majority of chicks wing growth had almost ceased at the time of first emergence (mean emergence wing length was 264mm compared with mean fledge wing length of 266mm). Reluctance to feed or regurgitation, particularly in a chick that had previously fed well, was taken to indicate that the chick was close to fledging.

The approach used was to feed at higher levels until the chick was assessed to be approaching fledging. The maximum feed given as a single meal was 30ml food plus 5ml fish oil. The occasional very heavy chick (>480g) was fed less to allow for gradual weight loss. For the majority of chicks feeding in the later stages of the rearing period was directed at maintenance of chick weight. Very few transferred chicks needed to lose weight at this stage in order to fledge.

Recommendation: Mottled petrel chicks should be fed with the methods and diet used as standard for other seabird species. A small diameter crop tube should be used for feeding this species which is more prone to regurgitation than chicks of other species.

7.2.10. Assisted fledging

The majority of mottled petrel chicks have fledged from Boundary Stream with no apparent problems. Over the five transfer years a number of mottled petrel chicks have been found close to the predator fence in locations that they would have had trouble fledging from. A summary of the number of chicks found by year is: In 2014 one deceased chick was potentially a mottled petrel chick (but could also have been a Cook's petrel chick); in 2015 two chicks (one of which was deceased); in 2016 one chick; in 2017 five chicks; in 2018 eight chicks (one deceased). Factors that may have led to the increasing number of chicks found in these locations over the five years may include weather conditions, increasing numbers of chicks on site and increasing search effort.

In 2017 it was decided to take a more proactive approach by assisting chicks to fledge where needed and this was repeated in 2018. Three chicks were assisted to fledge in 2017 and five chicks in 2018. All chicks that were assisted fledged readily and flew away strongly. In retrospect one chick that failed to fledge in 2018 may have benefitted from fledging assistance (this occurred early during chick rearing). All similar chicks in 2018 were offered assistance though two chicks subsequently fledged independently.

Recommendation: With fenced enclosures place secure daytime refuges against the fence, particularly at the lower sections, so that chicks that have failed to clear the fence can enter from either direction. Check these refuges and the fence line daily once chicks have been unblocked from their burrows. This will increase the chance that that chicks will be located and can be managed as appropriate to assist fledging.

Recommendation: Consider providing fledging assistance to the following chicks:

- Chicks that are taking longer than expected to fledge (wing length growth has ceased, chick emerging > 9 nights, chick weight < 330g, chick reluctant to feed)
- Chicks that have been absent for one or more days and then relocated
- Chicks that are found in locations they will not be able to fledge from (for example, close to the fence).

7.2.11. Deceased chicks and safe chick handling

In 2018 two mottled petrel chicks were found to have a fracture of the femur necessitating euthanasia of these chicks. The fractures were not present on Day 2 as all limbs of all chicks were checked prior to feeding on that day. It appears that these fractures occurred at similar times, possibly on the same day. The first fracture was fresh, was found as the chick was banded and had likely occurred when the chick was lifted from its burrow that morning. The second fracture was not detected until it was several days old and may have occurred on the banding day when the chick was returned to its burrow. It is believed that the fractures occurred due to poor handling by one of the first-time volunteers resulting in an unrestrained leg catching on the edge of the toolbox or the burrow as the chick was lowered into place.

This is the first time this type of injury has occurred at Boundary Stream, with 364 mottled petrel chicks and 336 Cook's petrel chicks having been successfully reared to fledging over six years. Careful explanations regarding methods used and reasons for the use of these methods have been given every year to those handling the chicks. Those present have also been advised that if they are having difficulty or are cold or tired to let managers know so that steps can be taken to mitigate this. Safety of the chicks has also been emphasised. Over the six years of translocations of seabirds to Boundary Stream a large pool of experienced and keen volunteers has built up.

Note that the involvement of volunteers has been critical to the success of the Boundary Stream transfers:

- The volunteers have proved invaluable at all stages of the translocation in completing the work needed to successfully rear seabird chicks – a relatively labour-intensive process.
- It is a great way to introduce community members to the specific species, and thus seabirds in general, which many would otherwise not get to see.
- It serves as a way to introduce community members to the important role that seabirds play in functioning land-based ecosystems.

Recommendation: A lesser number of chicks should be transferred in the first transfer year. This will allow time for the training of those inexperienced with handling seabirds and increase the pool of experienced personnel for future years. It will also give time to ensure infrastructure and management protocols specific to the individual transfer site are in place prior to a large number of chicks arriving.

Recommendation: Use of toolboxes to carry chicks improves safety and also has the advantage of calming chicks (Note: toolboxes must always be used in wet conditions to keep chicks dry). Use of toolboxes means that less nimble handlers do not need to stand up or kneel down while holding a chick (sometimes on sloping and slippery ground). The chick can then be lifted from burrow or box once the handler is in the kneeling position. The wings and legs of the chick must be restrained before the chick is lifted. The need for care when shutting the lid of the burrow or box to avoid wing injury needs to be emphasised, especially for more feisty chicks that are more likely to bite and lift their wings.

Recommendation: A minimum of two experienced personnel needs to be on site on feeding days. One person in the shed supervises and/or undertakes chick measurements, makes feeding decisions and carries out the feeding of chicks. The second experienced person operates at the burrow site as burrow manager. This person assists the handlers as required, checks burrows and tunnels while the chick is away for feeding and ensures that chicks return to the correct burrow. If the handler is having trouble lifting chicks the burrow manager should offer guidance and carry out this task if necessary.

Recommendation: Be aware of conditions at the site and have breaks as necessary so that personnel do not become tired or cold, particularly on the longer days when all chicks are fed.

7.2.12. Fledging condition of chicks transferred to Boundary Stream

Mottled petrel chicks transferred to Boundary Stream have had good fledging success. Of 368 chicks transferred over five years, 364 (99%) are believed to have successfully fledged. Chicks have all fledged within the parameters recorded for naturally reared chicks fledging from Whenua Hou. Mean fledge weights and wing lengths over the five transfer years have been at target levels and in each transfer year have been equal to or greater than those recorded on Whenua Hou.

*7.2.13. Ongoing work at Boundary Stream seabird site – **Recommendations***

1. The Boundary Stream seabird site will require ongoing maintenance. The integrity of the predator proof fence will need to be assessed regularly as this is essential to provide safety for returning and breeding birds, eggs and chicks. Fence checks should also be carried out when adverse weather events, such as high winds and snow, have occurred. In the event of fence breaches, trapping and monitoring will need to be initiated to ensure that no predators are present within the seabird site. If predators are detected measures need to be put in place to eliminate these predators. Specifically during 2018, the site will need to be checked for the presence of predators following the incursion during the snowfall in March. This work will need to be undertaken prior to the prospecting periods of September (Cook's petrels) and October (mottled petrels).

2. Tracks within the burrow areas and through the grassed areas will need to be maintained to allow birds to move easily through the site and to provide access to take off areas. Tree falls and overgrown vegetation may need to be cleared within the burrow site to allow birds to move easily through the area and to give easy access to climbing trees.

3. The sound system will need regular checks to ensure it is operational, particularly through the prospecting and breeding times - October to late May - as this provides an important cue for returning birds.

4. Burrows are constructed of tanalised timber so should retain their integrity for many years. Burrow integrity should be improved as a result of the addition of the plastic covers in 2017. It is recommended that burrows are inspected prior to the expected arrival of prospecting adults. Nest chambers should be dry and waterproof. Tunnels should be checked for blockages at the entrances and up the tunnel. Earth on the uphill wall of the burrow should be tightly packed to reduce water ingress at the earth/timber junction.

5. It is recommended that the majority of the leaf litter is removed from the burrows at the end of the breeding season and scattered around the site. Some leaf litter should be left inside the burrow chambers to provide olfactory cues for returning birds. It is helpful to leave the central nest area clear of leaves so that nest building by returning birds can be seen, (G. Taylor, pers. com.).

6. The site should be monitored for returning birds. Stick fences erected at the tunnel entrances will indicate the presence of returning adults. If fences are down, the burrow chamber should be checked for the presence of returned birds. The leg band numbers of any returned birds should be noted and feather samples taken for DNA sexing. Continued use of trail cameras will indicate returning birds and should also be checked for predator incursions.

7.3 Summary

The translocation of mottled petrel chicks from Whenua Hou/Codfish Island to Boundary Stream Mainland Island is the first time a transfer of this species has been undertaken and it can be considered a success. Chicks have been reared using standard methods used with other seabird species, with the exception of the use of a small diameter crop tube for feeding. No problems have been encountered during rearing and chick health has been excellent. Chicks have fledged at weights and wing lengths within the parameters recorded for naturally reared chicks on Whenua Hou. In total 368 mottled petrel chicks have been transferred over five years (2014 to 2018) and 364 (99.0%) of these chicks are believed to have successfully fledged.

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- The many volunteers that assisted and gave of their time with all stages of the project – artificial burrow construction, installation and preparation prior to transfer, assistance with food preparation, cleaning of equipment, assistance with feeding. Particular mention goes to:
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    - Pam Hunt for her many hours at Boundary Stream helping with food preparation, cleaning of equipment, record keeping and washing of oiled chicks.
    - Helen McLean and her tramping group for their dedication in returning year after year to assist with feeding the chicks, often in less than ideal weather.

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Appendices

Appendix 1: Transfer, emergence and fledging data for 99 mottled petrel chicks transferred to Maungaharuru/Boundary Stream from Whenua Hou/Codfish Island, April 2018.

Appendix 2: Post mortem report conducted on mottled petrel chick; Band Number Y-19059 (Burrow number 109), April 2018.

Appendix 1: Transfer, emergence and fledging data for 99 mottled petrel chicks transferred from Whenua Hou/Codfish Island to Maungaharuru/Boundary Stream, April 2018.

Whenua Hou burrow number	Boundary Stream burrow number	Band number	Transfer weight (g)	Transfer wing length (mm)	Fledge weight (g)	Fledge wing length (mm)	Emergence period (nights)	Total days at Boundary Stream	Fledge date
73	14	Y19034	483	232	349	263	3	17	29-Apr
441	15	Y19035	475	232	351	266	7	17	29-Apr
407	16	Y19036	409	256	339	271	7	16	28-Apr
57	17	Y19037	451	264	362	273	8	13	25-Apr
116	18	Y19038	440	257	387	262	2	10	22-Apr
151	19	Y19039	521	218	387	265	13	25	07-May
91	20	Y19040	498	233	352	268	8	20	02-May
376	21	Y19041	467	255	392	270	7	13	25-Apr
121	22	Y19042	434	247	360	256	5	15	27-Apr
440	23	Y19043	412	236	329	276	11	19	01-May
420	24	Y19044	491	244	393	260	6	14	26-Apr
424	25	Y19045	417	240	352	255	8	18	30-Apr
356	26	Y19046	508	253	406	270	7	13	25-Apr
173	27	Y19047	500	241	372	260	5	15	27-Apr
167	28	Y19048	474	255	394	274	5	13	25-Apr
275	29	Y19049	472	248	344	264	6	24	06-May
387	30	Y19737	448	246	355	269	6	16	28-Apr
56	31	Y19738	499	235	364	268	5	25	07-May
339	32	Y19739	491	219	343	267	6	20	02-May
411	33	Y19740	463	247	343	267	8	19	01-May
278	34	Y19741	368	220	323	268	9	21	03-May
183	35	Y19742	471	221	331	257	9	21	03-May
454	36	Y19743	470	253	353	271	8	19	01-May
269	37	Y19744	399	257	363	269	4	8	20-May
111	38	Y19745	515	256	349	270	6	21	03-May
437	39	Y19746	452	258	308	274	10	21	03-May
399	40	Y19747	537	245	391	264	11	21	03-May
288	41	Y19748	444	252	343	267	9	15	27-Apr
75	42	Y19749	405	229	325	259	13	19	01-May
314	43	Y19750	403	236	334	261	7	19	01-May
392	44	Y19751	474	251	Did not fledge				
395	45	Y19752	395	251	330	271	11	15	27-Apr
98	46	Y19753	404	252	336	258	10	20	02-May
99	47	Y19754	460	248	381	269	8	13	25-Apr
459	48	Y19755	480	263	381	276	7	13	25-Apr
418	49	Y19756	438	227	324	262	10	24	06-May
67	50	Y19757	479	263	403	262	4	10	22-Apr
414	51	Y19758	413	239	343	269	5	15	23-Apr
166	52	Y19759	474	237	356	260	7	19	01-May

Whenua Hou burrow number	Boundary Stream burrow number	Band number	Transfer weight (g)	Transfer wing length (mm)	Fledge weight (g)	Fledge wing length (mm)	Emergence period (nights)	Total days at Boundary Stream	Fledge date
187	53	Y19760	508	253	353	262	11	23	05-May
350	54	Y19761	450	235	342	266	16	20	02-May
241	55	Y19762	460	255	343	270	7	15	27-Apr
251	56	Y19763	431	257	338	269	10	15	27-Apr
344	57	Y19764	490	251	324	269	9	19	01-May
397	58	Y19765	476	241	377	267	9	17	29-Apr
185	59	Y19766	440	251	347	260	7	11	23-Apr
68	60	Y19767	431	254	374	269	3	9	21-Apr
34	61	Y19768	503	222	372	263	9	20	02-May
304	62	Y19769	453	248	368	257	5	15	27-Apr
177	63	Y19770	397	244	345	267	6	13	25-Apr
383	64	Y19771	473	258	381	270	8	15	26-Apr
206	65	Y19772	394	264	347	269	1	6	18-Apr
211	66	Y19773	530	266	392	276	8	20	02-May
41	67	Y19774	585	258	447	267	12	17	29-Apr
428	68	Y19775	475	252	364	271	6	16	28-Apr
191	69	Y19776	543	248	372	258	6	22	04-May
192	70	Y19777	605	240	375	264	7	28	10-May
72	71	Y19778	509	244	359	267	7	14	26-Apr
224	72	Y19779	418	250	340	263	9	15	27-Apr
246	73	Y19780	634	232	369	276	7	28	10-May
222	74	Y19781	532	263	408	276	7	15	27-Apr
216	75	Y19782	560	237	388	261	11	22	04-May
217	76	Y19783	515	257	353	273	13	23	05-May
434	77	Y19784	530	227	397	267	5	20	02-May
435	78	Y19785	360	224	321	269	3	20	02-May
117	79	Y19786	412	260	348	266	4	9	21-Apr
154	80	Y19787	499	258	389	268	8	16	28-Apr
337	81	Y19788	539	255	390	276	14	23	05-May
353	82	Y19789	498	246	363	266	12	20	02-May
410	83	Y19790	478	226	356	266	8	25	07-May
340	84	Y19791	500	238	376	258	10	19	01-May
442	85	Y19792	485	269	393	272	5	14	26-Apr
311	86	Y19793	410	244	353	271	7	17	29-Apr
341	87	Y19794	410	237	331	262	8	13	25-Apr
334	88	Y19795	449	263	360	268	10	16	28-Apr
406	89	Y19796	423	249	331	264	6	14	26-Apr
405	90	Y19797	469	254	359	276	8	17	29-Apr
375	91	Y19798	432	212	340	263	10	20	02-May
374	92	Y19799	588	220	418	262	10	24	06-May
270	93	Y19800	485	249	363	264	11	21	03-May
8	94	Y19801	450	219	346	272	13	26	08-May
14	95	Y19802	440	246	336	263	2	23	05-May
38	96	Y19803	451	237	336	266	5	21	03-May

Whenua Hou burrow number	Boundary Stream burrow number	Band number	Transfer weight (g)	Transfer wing length (mm)	Fledge weight (g)	Fledge wing length (mm)	Emergence period (nights)	Total days at Boundary Stream	Fledge date
106	97	Y19804	477	246	370	261	14	22	04-May
101	98	Y19805	496	240	366	271	16	23	05-May
139	99	Y19806	429	234	339	264	9	19	01-May
201	100	Y19807	401	245	338	259	8	15	27-Apr
136	101	Y19051	565	245	395	271	10	20	02-May
137	102	Y19052	508	232	385	265	2	24	06-May
54	103	Y19053	455	257	Did not fledge				
169	104	Y19054	497	251	423	265	1	9	21-Apr
29	105	Y19055	427	223	356	266	9	17	29-Apr
158	106	Y19056	433	239	359	262	2	13	25-May
265	107	Y19057	432	255	372	257	1	11	23-Apr
284	108	Y19058	385	225	319	253	2	12	24-Apr
262	109	Y19059	491	255	Did not fledge				
259	110	Y19060	465	255	310	262	8	15	27-Apr
415	111	Y19061	436	236	350	265	7	15	27-Apr
160	112	Y19062	490	247	344	266	9	23	05-May

	Transfer weight (g)	Transfer wing length (mm)	Fledge weight (g)	Fledge wing length (mm)	Emergence period (nights)	Total days at Boundary Stream
Mean	468.09	244.59	359.98	266.11	7.63	17.60
Standard deviation	51.22	12.92	26.15	5.33	3.25	4.64
Minimum	360	212	308	253	1	6
Maximum	634	269	447	276	16	28

Appendix 2: Post mortem report conducted on mottled petrel chick; Band Number Y-19059 (Burrow number 109), April 2018.

School of Veterinary Science

Pathology Report

Submitter Ref.: Date Sent: 03/05/2018 Accession No.: 55808
To: Kelly Eaton
Department of Conservation
59 Marine Parade
Napier
Email: keaton@doc.govt.nz

Report Sent: 11/07/2018
Copy To: Species: Avian-WL Breed: Mottled Petrel
Age: Juvenile Sex: Female
Owner: Type: Post Mortem
ID: Prev. Accn.:
Submitted: 1 At Risk: Affected: 1 Dead: 1

History

Found dead by fence on 29/4/18. Prior to this:
13/4/18 transfer from Whenau Hou to BMSI;
regurged 7ml (mainly parental oil) on 15/4/18. Banded.
18/4/18. regurged 15ml
26/04/18 found in box at fence. weight good, reluctant to take oil, returned to own burrow
27/4/18 absent - presumed fledged
29/4/18 Found dead in grass beside fence, no obvious injuries. Weather was wet and relatively calm on the nights of 28th and 29th.
rearing was uneventful and the chick appeared in good health

Gross Findings

The post mortem was conducted on the thawed body of the bird, which weighed 355g at post-mortem and which was identified by band number Y-19059. The sex was determined as female.
Post mortal changes were minimal although tissues will have been effected by freezing.
The petrel was found to be in excellent body condition with abundant fat reserves and good pectoral muscle contour.
There were no gross post mortem abnormalities found. Samples placed in formalin included kidney, liver, lung, spleen, small intestine, ventriculus, heart and pectoral muscle.

Histopathology

Lung: multiple parabronchi contain large amounts of homogenous pale eosinophilic material admixed with numerous clear vacuoles, up to 150 microns in diameter. Freeze-thaw artifact precludes further evaluation.
Liver: at least ~50% of hepatocytes contain either a single large or multiple smaller, clear, discrete intracytoplasmic vacuoles, likely lipid.
Bearing in mind the freeze-thaw artifact, sections of heart, spleen, kidney, proventriculus, intestine and pancreas show no obvious abnormalities.

Diagnosis
Possible oil aspiration
Hepatic lipidosis

Comments
On histology of the lung, many of the air-spaces contained what appeared to be fluid admixed with lipid droplets so I wonder if this bird has accidentally aspirated proventricular oil into her lungs.
Hepatic lipidosis refers to the build-up of lipid within the cells of the liver. This can occur when an animal goes into a negative energy balance and starts to mobilise body fat reserves (via the liver) as a source of energy.

Date: 03/05/2018 Pathologists: S A Hunter
Students: Nigel Dougherty