Agreement on the Conservation of Albatrosses and Petrels

First Meeting of the Population and Conservation Status Working Group

La Rochelle, France, 29 – 30 April 2013

Best practice techniques for translocations of burrow-nesting petrels and shearwaters

New Zealand

SUMMARY

This paper provides a draft set of detailed technical best practice guidelines for the translocation of burrow-nesting petrel and shearwater species, building on extensive experience in New Zealand for certain species (particularly species of the genus *Pterodroma*). Aspects of the guidelines where further drafting or input is required have been identified by comments and highlighted text.

RECOMMENDATIONS

The Working Group is requested to:

1. decide whether the proposed structure and level of detail contained in these draft guidelines is appropriate and useful for a global audience.
2. identify other information that should be included in the finalisation of the guidelines.

Técnicas de las mejores prácticas para el traslado de petreles y fardelas que anidan en madrigueras

Este documento proporciona un proyecto de directrices técnicas detalladas de las mejores prácticas para el traslado de petreles y fardelas que anidan en madrigueras, basadas en la amplia experiencia de Nueva Zelandia en relación con determinadas especies (especialmente la especie del género *Pterodroma*). Se identificaron con comentarios y texto resaltado aquellos aspectos de las directrices que requieren una mayor redacción o aportes.

RECOMENDACIONES

Se solicita al Grupo de Trabajo que:

1. determine si la estructura propuesta y el nivel de detalle incluido en el presente proyecto de directrices son adecuados y útiles para un público internacional.

2. identifique otra información que pueda incluirse al finalizar las directrices.

Bonnes pratiques techniques à adopter lors de la translocation de pétrels et de puffins nichant dans des terriers

Ce document fournit une première liste détaillée des bonnes pratiques techniques à adopter lors de la translocation des pétrels et des puffins nichant dans des terriers. Ces lignes directrices s'inspirent de la vaste expérience de la Nouvelle-Zélande s'agissant du déplacement de certaines espèces (en particulier des espèces du genre *Pterodroma*). Les points qui feront l'objet d'un débat ont été mis en exergue (commentaires et texte mis en évidence).

RECOMMANDATIONS

Le Groupe de travail est appelé à :

1. décider si la structure proposée et les détails contenus dans ces lignes directrices sont appropriés et peuvent être utiles à un large public.
2. identifier d'autres informations qui devraient être reprises dans ces lignes directrices.

Best practice techniques for translocations of burrow-nesting petrels and shearwaters

Version 1: Draft. February 2013.

Report prepared by Helen Gummer for the New Zealand Department of Conservation, Wellington, New Zealand.

Contents

1. Introduction

1.1. Purpose

This document is intended as an **advisory document for those planning the translocation of burrow-nesting petrels and shearwaters**.

Procedures and techniques described here are based on methods that have been trialled, developed and established for at least eight different species from the family *Procellariidae* (genera *Pterodroma*, *Pelecanoides*, *Pachyptila* and *Puffinus*) in New Zealand over the last two decades (Miskelly et al. 2009). They are considered to be current best practice techniques for the species involved and are aimed to achieve the level where health issues are minimal and all transferred chicks fledge in optimum condition at fledging parameters reflecting those of naturally raised chicks, or even exceeding the quality of naturally-raised chicks. The techniques documented here will evolve further as information from future translocation projects becomes available.

Important note: The use of translocation (refer to Section 17. Terminology and definitions) as a technique for establishing new seabird populations is a relatively recent development. This best practice has been developed to improve the likely success of the transfer (refer to Section 17. Terminology and definitions) phase of a translocation project (i.e. short-term success). There are not yet any projects in New Zealand that have yet successfully established a self-sustaining seabird population (i.e. long-term success is yet to be achieved).

This document can be used as a starting point for planning translocations of species which have never been translocated before. It must be noted that bird behaviour and reaction to capture and translocation can vary between species, locations, seasons and years.

...METHODS IN THIS DOCUMENT CAN BE ADAPTED FOR APPLICATION TO A RANGE OF SPECIES, THE FACT THAT THE DIET USED IN NZ CAN BE USED FOR FISH, SQUID AND KRILL FEEDERS, ETC...

.. THE APPROACH WITHIN EACH GROUP OF SPECIES THAT ARE CLOSELY RELATED AND SHARE SIMILAR BIOLOGICAL TRAITS CAN BE TO USE VERY SIMILAR METHODOLOGIES.

... DIFFERENT APPROACHES ARE REQUIRED FOR MIGRATORY VERSUS NON-MIGRATORY SPECIES, PELAGIC VERSUS COASTAL FEEDERS, WINTER NESTERS VERSUS SUMMER NESTERS, EMERGING SPECIES VERSUS NON-EMERGING SPECIES...

Comment [ID1]: Important points to be covered up front somewhere in these guidelines

1.2. Source of information

This document was compiled by Helen Gummer—Seabird Translocation Specialist, under contract to the New Zealand Department of Conservation (DOC).

The information in this document has mostly been drawn from two detailed reports commissioned by DOC, concerning translocation techniques for gadfly petrels in New Zealand (Gummer et al 2012b, c). These two reports, together with a companion guide suitable for use by community groups in New Zealand (Gummer et al 2012a) are available online at http://www.doc.govt.nz/xxxxx. Information on translocation techniques for other species in New Zealand has been gained from Gardner-Gee & Gummer (2009), Gummer & Adams (2010), Miskelly & Gummer (2004) and Miskelly & Taylor (2004).

2. Background information

2.1. Methods for establishing burrow-nesting seabird colonies

The key methods employed to establish new colonies of burrow-nesting seabirds are:

- **Acoustic attraction**—broadcasting ground and/or aerial calls of the target species via a sound system, which is positioned in suitable habitat and where birds passing by (at sea) can hear it. The exact positioning of the speakers is often dictated by the cable length distance to the solar panels required to provide power for the system.

  Acoustic attraction is often trialled first (before translocation) for one or more years, in conjunction with the provision of artificial burrows, to see if a colony can be established with minimal effort and cost. It is only likely to succeed if there are large numbers of birds regularly flying in the vicinity of the sound system.

  Further references to this technique can be found in Gummer (2003a).

  Note: Acoustic attraction should be employed at translocation release sites to maximise the chance of chicks returning as adults finding the exact site, i.e. to draw in returning birds; and to provide a social stimulus for retaining recruiting birds.

- **Provision of artificial burrows**—located near to an acoustic attraction sound system and of a design well-suited and attractive to the target species.

  Note: If chick translocations are to be considered in the future, then artificial burrows need to be of a superior design to safely accommodate chicks during artificial rearing, with easy access (by humans) into all parts of the burrow.

- **Translocation**—chicks are translocated from the nearest suitable population and housed at the artificial burrow site until they fledge. Translocations involve large numbers of birds and are costly and labour-intensive. Techniques are constantly evolving, especially with regard to artificial diet. There are usually a set of associated risks for each project at different locations.

  Translocation is likely to be the only effective way of starting a new colony in a location which is far from the usual flight-path of a species, i.e. where birds would be highly unlikely to colonise by acoustic attraction and provision of artificial burrows alone.

2.2. Translocation objectives

Long-term outcomes for translocations of seabirds to specific release sites are primarily aimed at one or more of the following:

- Establishing an additional self-sustaining population of a Threatened or Vulnerable species at a safe location with the aim of increasing the long-term security or recovery of the species.
- Enhancing biodiversity at a release site, usually as a progression towards an ecological restoration goal (such as establishing a seabird-influenced coastal forest ecosystem typical of lesser modified islands in the region); and/or to restore seabird nutrient cycles to degraded ecosystems
- Providing public access and education (where possible) and seabird conservation advocacy opportunities

2.3. Species groups

2.3.1. Gadfly petrels

Chatham, Cook's and Pycroft's petrels are Procellariiformes in the family Procellariidae and grouped within the Genus *Pterodroma,* frequently termed gadfly petrels. Translocation projects involving these three species are approached in the same way, as the species are closely related and share the following biological traits:

- Foraging behaviour—pelagic feeders; fish and squid diet
- Size and morphology—small-sized species ranging from 150–200 g, with similar body shape and wing structure
- Strong migratory behaviour—all three species migrate to the north Pacific and/or eastern Pacific Ocean during their non-breeding season
- Pelagic foraging behaviour— feed far from the coast in deep oceanic water where they predate fish, squid and crustaceans, and on bioluminescent species during nocturnal foraging
- Breeding habitat requirements—excavate burrows under forest or shrub canopy (usually coastal and also at higher altitudes); tree-climbing ability (for take-off)
- Colony visitation patterns—strictly nocturnal; seasonal with breeding season visitation during the austral summer (September–May), although Cook's petrel occasionally visits during the non-breeding period (likely pre-breeding juveniles)
- Breeding biology—highly synchronised first arrival at colony between mated pairs; long pre-laying exodus period (30+ days) when no visitation, or only male visitation of breeding burrow occurs; single egg; long incubation shifts (10–16 days) by each parent and long incubation phase (45+ days)
- Chick-rearing behaviour—short brood phase; long chick rearing period (approximately 70–80 days); chick fed at irregular intervals (not nightly); chick weight peaks at up to double the average adult weight; parental desertion period prior to chick fledging (on average 6–10 days)
- Chick emergence behaviour—exercising; finding take-off points; site-fixing

Comment [H2]: This section requires more thought and restructuring. Currently it is about 3 small gadfly petrel species. I have also included the similar section for 2 of NZ's large gadfly species (grey-faced petrels and taiko). However, we need to work out the best way to list the biological traits, and also create new sections for the other groups (shearwaters, prions, diving petrels etc. and possible storm-petrels – the last group is only just being trialed in NZ).

At the moment these sections are detailed and relate to NZ species. The boilogical traits of the different groups need summarizing briefly and somehow key areas that help define translocationg methodologies used need to be highlighted in some way.

It's complicated grouping all these birds, because within each group there are migratory and non-migratory species, winter and summer nesters, species with different feeding habits/requirements etc.

- Strong site fidelity—returning to fledging burrow (or nearby burrow) as adult

The grey-faced petrel is a Procellariiform in the family Procellariidae and grouped within the Genus *Pterodroma*, frequently termed gadfly petrels. Key biological traits for grey-faced petrels are as follows:

- Size and morphology—medium-sized species ranging from 500–600 g (average is around 550 g).
- Non-migratory behaviour—grey-faced petrels travel long distances to the Tasman Sea (East Australia) and South Pacific. Unlike the migratory gadfly petrels, grey-faced petrels forage across all waters within their known range at sea and are thus considered highly dispersive rather than migratory, i.e. they do not have two distinct foraging zones during and outside the breeding season.
- Pelagic foraging behaviour—feed far from the coast in deep oceanic water where they prey on squid and fish, and bioluminescent species during nocturnal foraging; generalist surface feeders.
- Breeding habitat requirements—excavate burrows under coastal forest or shrub canopy; tree-climbing ability (for take-off) when required.
- Colony visitation patterns—nocturnal; seasonal with breeding season visitation (April–December) commencing during the austral winter.
- Breeding biology—first arrival at colony between mated pairs is not as synchronised as for migratory gadfly petrels; long pre-laying exodus period (up to 60 days) when no visitation of breeding burrow occurs (males return earlier); single egg; long incubation shifts (8–23 days) by each parent and long incubation phase approximately 55 days.
- Chick-rearing behaviour—short brood phase (1–3 days); long chick rearing period (approximately 108–128 days); chick fed at irregular intervals (not nightly); chick weight peaks at up to double the average adult weight; parental desertion period prior to chick fledging usually only from when/if chick declines food.
- Chick emergence behaviour—exercising; finding take-off points; site-fixing.
- Strong site fidelity—returning to fledging burrow (or nearby burrow) as adult.

Chatham Island taiko share many of the above biological traits with grey-faced petrels, although the key difference is the time of year when each species is breeding. Translocation projects involving taiko are largely approached in a similar way, although because taiko are rearing chicks at a very different time of year, it appears they respond to transfer and hand-feeding differently to grey-faced petrels (refer to Section 10.3.1. History of diet development).

Taiko have a body weight of 450–550 g (average is around 475 g). Like grey-faced petrels, they are also considered to be highly dispersive, mainly travelling to the eastern Pacific Ocean during their non-breeding season. They visit the colony during the austral summer (September–May). They have a pre-laying exodus of up to 50 days and incubate eggs for approximately 55 days. There is a short brood phase of 1–

3 days, and the chick-rearing period is slightly shorter than for grey-faced petrels. Parents may desert up to 23 days before fledging (Johnston et al. 2003), or they may continue to visit the burrow until the chick has departed.

2.3.2. ADD FURTHER SECTIONS ON SHEARWATERS, PRIONS, ETC.?

2.4. Animal welfare requirements

Relevant animal welfare provisions (for example, the Animal Welfare Act 1999 and its welfare codes within New Zealand) must be met when handling wildlife. Note that this best practice has been written to improve the likely success of translocations, promoting a high level of care of the birds (i.e. minimum standards relating to provision of shelter, food and water are covered) and thus a consideration of general animal welfare. However it does not attempt to address each of the minimum standards in welfare codes.

Projects trialling new techniques for seabird translocations (including changes to the diet) may require approval by an Animal Ethics Committee.

3. Composition of transferred group

3.1. Age of birds

Burrow-nesting seabirds are highly philopatric (refer to Section 17. Terminology and definitions), with most adults returning to the vicinity of their natal nest site when they are ready to breed. Translocation of adults is not feasible as they would always return to their source colony.

Chicks that have never ventured outside the natal burrow can be successfully translocated to a new colony location. Burrow-nesting seabird chicks are thought to gain cues from their surroundings following emergence from the burrow shortly before fledging. Site-fixing (or locality imprinting) is considered to develop during this emergence period. (Note: Colony sounds and odours may also play a role in chicks imprinting on their natal colony.) Transferred chicks making their first emergence at the release site are tricked into regarding the new colony as their natal site, and will return to the new site as adults.

NEED TO ADD RECENT PUBLISHED INFO ON THE DISCOVERY OF FAIRY PRIONS THAT HAVE RETURNED TO THE SOURCE COLONY BUT HAD NEVER EMERGED THERE, I.E. OTHER CUES ALSO INVOLVED FOR THIS SPECIES.

Comment [H3]: The ref will be Miskelly & Gummer (2013?)

3.2. Timing of chick transfer

As a general rule, the optimum time to transfer a cohort of chicks tends to be prior to the peak fledging time (known or predicted) for the species at a particular location, so that translocated chicks fledge at the same time as the bulk of chicks at the source colony. Late-fledging chicks may be compromised in terms of survival, especially if chicks rely on oceanic productivity that may decline later in the season.

The timing of transfer within the each individual chick's rearing period is critical.

- Moving chicks **too close to fledging** has the following implications:
  - Chicks may have already emerged at the source colony in which case they are more likely to return to the source colony as adults—even chicks that have only been to the burrow entrance on one night are considered unsuitable for transfer.
  - Chicks may be so close to emerging from their natal burrow that they are more prone to stress by being confined in a burrow at the release site for a night or more of acclimatisation to the new surroundings. This can result in chicks disappearing on their first night out at the release site with unknown outcome.
  - For lighter-weight chicks which are about to fledge there is not enough time for them to regain condition following transfer, and such chicks can end up fledging at less than desirable weights.
- Moving chicks **prematurely** has the following implications:
  - The parent birds may perceive breeding failure and this can have the effect of disrupting the parental pair bond. A pair divorce may result in a missed breeding season for one or both birds while they find new mates. This can have a significant negative impact on rare and endangered species.
  - The current artificial diet presented in this document is currently not ideal for hand-feeding chicks for longer than roughly one-third to half the total chick-rearing period and chicks can develop health problems if hand-fed for longer periods.
  - Projects can become unnecessarily lengthy, labour-intensive and costly if chicks need to be fed at the release site for greater than, for example, 1 month.

To ensure chicks are taken at the right age, they must meet a specific set of wing-length and weight criteria for the species on the day of transfer (refer to Section 8.2. Transfer criteria).

3.3. Number of transferred birds per translocation project

For seabird translocation projects, it is preferable for large numbers of chicks to be moved over several years to account for:

- A naturally high mortality rate out at sea, prior to birds reaching maturity. Only 30–50% of burrow-nesting seabirds tend to survive after fledging, to return to the colony as adults (G .Taylor, pers. obs.). After post-fledging mortality, there needs to be a big enough pool of birds of both genders arriving at the colony site each season to facilitate pairing. Note that there is a slight compromise to this in the first year of any project, when cohort sizes tend to be smaller while project logistics are being fine-tuned (refer below to Section 3.4. Number of transferred birds per year).

- A higher than average mortality rate in a particular season that might be attributed to unfavourable weather (e.g. severe storms around or after time of fledging) or poor food supply at sea.

Transferring a minimum of 200 birds over a 3–4 year period has now been trialled on several projects in New Zealand, and the results of these projects so far show that up to 20% (to date) of the gadfly petrels are returning to the new colony site as adults (H.Gummer and G. Taylor, pers. obs.).

Comment [H4]: Would need to update with return rates for shearwaters, prions etc. from various sources.

With increased confidence in techniques, it is now considered advantageous to move more chicks to increase the pool of birds returning to the new colony site each year, and/or to implement supplementary transfers in later years.

3.4. Number of transferred birds per year

It is usually recommended that fewer chicks are transferred in the first year of any new project, even if the species has been transferred before. Subjecting fewer birds to potential risk makes sense while logistical issues are ironed out for the new site, new personnel are trained, etc. In addition stakeholder, public and cultural involvement tends to be greatest the first time chicks are transferred from a source colony to the release site. Ceremonial protocols take time and sometimes this can generate issues that the transfer team will need to plan for, with respect to timing on the day of transfer (If for example it is likely to adversely impact on the length of time chicks are held in transfer boxes or the time of day chicks are transferred to burrows at the release site). It may be more appropriate to transfer fewer chicks in the year the ceremonial protocol takes place.

In New Zealand, the recommended number of chicks to transfer to a new site, in the **first year** of a project is only 50 chicks if the team is new to seabird translocations, and/or there are anticipated logistical issues to iron out and/or the species has never been translocated before.

A maximum of 100 chicks is considered appropriate to transfer in any **subsequent year (in particular the second year)**. A larger cohort size than this could lead to logistical issues, particularly during:

- Burrow searching and chick collection trips (source colony). In general, at least twice the number of chicks required for transfer need to be found, in order to find the target number of chicks suitable for transfer on a single date. For example, up to 300 burrows may need to be inspected to find 200 burrows containing chicks, of which only 100 are likely to meet transfer criteria on a single transfer date.
- Post-transfer management at the release site. A feeding and monitoring regime for more than 100 chicks can be extremely intense, especially if chicks require daily hand-feeding, and also if projects are reliant less-experienced personnel. There may also be a delay in finding and addressing serious problems. These issues may result in the welfare of chicks being compromised.

3.5. Genetics and gender

Due to the numbers of birds taken, it is generally considered that the genetic diversity of transferred birds is broad, and that both genders will be included.

However, new populations of the threatened or endangered species may need close screening to ensure genetic composition is adequate given the small size of the source population and the associated higher risk of inbreeding depression.

For source populations that exhibit low genetic diversity, consultation with a geneticist may be recommended prior to any translocations, in order to maximise the genetic diversity of translocation stock sourced from the population.

Sexes appear identical in the chicks of most burrow-nesting seabird species; chick DNA sexing using blood or feather samples would be required for gender analysis. Cost and logistics may prohibit gender identification during chick translocation operations.

Note: The sex of adults can be determined in a variety of ways when they return to the release site if considered necessary, e.g. vocalisation, DNA sexing. However, the balance of gender will become apparent during subsequent breeding seasons. Advice should be obtained from a seabird specialist if there are no breeding attempts at a new colony well beyond when birds are expected to breed. Birds can be DNA-sexed at this point (by collecting feather samples), to check if there is a bias towards one gender returning to the colony (refer to Section 16.4.7. DNA sexing of returning adults).

3.6. Supplementary translocations

Supplementary translocations (refer to Section 17. Terminology and definitions) may need to be considered at some sites for some species if the population is not considered to be self-sustaining. Supplementary transfers are likely to be recommended by seabird specialists if:

- All potential causes for lack of population growth have been thoroughly investigated prior to further translocations, e.g. potential predator or competitor threats, habitat suitability, gender imbalance.
- The period when all transferred birds are expected to have returned has passed. While the majority of birds return as soon as they reach maturity (i.e. 3–4 years old), it should be noted that some individuals of the small gadfly petrels were not recovered at the release site until as late as 6 years after transfer (i.e. Chatham petrel; Gummer 2011b), and some even for the first time at 10 years old (i.e. Gould's petrel [*Pterodroma leucoptera leucoptera*] N. Carlile, New South Wales Department of Environment, Australia, pers. comm. 2010).

Supplementary transfers (e.g. an extra 200 birds) may be useful after the first transfer to top-up the population at the new colony site (refer below to Section 4. Translocation sequence and timetable). Returning birds from a supplementary translocation will find the release site particularly attractive if it already has breeding pairs present. Supplementary translocations will also provide a mix of non-natal recruits to pair with birds reared at the release site that are returning as adults, and could help with genetic enhancement.

4. Translocation sequence and timetable

The sequence of events involved in a translocation project is as follows, with an approximate timetable:

Comment [H5]: This is the relevant process for ecological restoration projects – the process is not given here for endangered species with only one or few source colonies and limited release site options.

Year 1:
- Project manager of release site seeks expert advice on its suitability for seabird communities and which species are appropriate, if an ecological restoration plan is not already available to address this matter.
- Project manager seeks expert advice on appropriate source colony.
- Translocation proposal is developed in consultation with key stakeholders, then submitted for any required approvals.
- Basic breeding ecology studies undertaken if no information for the species, or existing research/study data analysed to obtain transfer criteria and fledging data.

Year 2:
- Sound system installed at release site if not already in place for acoustic attraction.
- Artificial burrows installed at the release site if not already in place to complement an existing sound system—preferably >6 months before any transfers (refer to Section 9.3. Installing artificial burrows at release site).
- Reconnaissance (Recce) trip if necessary (refer to Section 6.2.1. When is a Recce trip required?), to assess chick availability and confirm breeding dates.
- First chick transfer.

Year 3:
- Second chick transfer.
- Post-release monitoring commences for species that may return to the colony at 1 year of age) and continues annually/seasonally.

Year 4:
- Third chick transfer.
- Post-release monitoring commences for species that may return to the colony at 2 years of age) and continues annually/seasonally.

Year 5:
- Fourth and final chick transfer of the original translocation (if required).
- Post-release monitoring commences for species that may return to the colony at 3 years of age) and continues annually/seasonally.

Year 6:
- Post-release monitoring commences for species that may return to the colony at 4 years of age) and continues annually/seasonally.

Year 7:
- Post-release monitoring commences for species that may return to the colony at 5 years of age) and continues annually/seasonally.

Year 8:
- Post-release monitoring commences for species that may return to the colony at 6 years of age) and continues annually/seasonally.

Year 9:
- Post-release monitoring commences for species that may return to the colony at 7 years of age) and continues annually/seasonally.

Year10:
- Supplementary transfers considered for species that reach maturity at approx. 3 years of age and where all birds translocated in first set of transfer are likely to have returned. (A new translocation proposal is likely to be required in the year prior to this).

Year 15:
- Supplementary transfers considered for species that reach maturity at approx. 7 years of age and where all birds translocated in first set of transfer are likely to have returned. (A new translocation proposal is likely to be required in the year prior to this).

5. Source population

When choosing the source site, the following aspects need be given careful consideration:

Comment [H6]: Relevant to ecol restoration projects involving more common species; less relevant to endangered species.

- Access practicality and logistics (safety, cost, consultation, etc.)
- Whether there will be damage to the habitat (including impacts on other species)
- Impact of chick harvest on the source population
- Distance to transport the chicks from source to release site

5.1. Geographic location

For species with limited distribution and range, there may be few choices in terms of source populations. In many cases, these colonies are already the subject of basic breeding ecology studies.

Comment [H7]: Again, this whole section applies to moving more common species in ecol restoration projects.
For endangered spe cies there is often just a single population to source birds from.

For more common and/or widely distributed species, usually the nearest colonies with the greater number of breeding pairs (1000s of pairs) are chosen as a source of chicks. Small colonies (of a few 10s or 100s of pairs) tend to be avoided as a source of chicks for translocation, on the basis that the colonies themselves are vulnerable and/or recovering.

Comment [H8]: Not relevant for endangered species, only common species.

The logistics of accessing any source colony also influences choice of colony site.

5.2. Assessing the source colony

The assessment of a source colony is made at two different levels:

- Study trip—an expedition made to a potential source colony one or more years in advance of a proposed translocation project (first chick transfer) to gather information on one or more of the following:
  - Breeding biology if not known for the species
  - Data needed for accurate planning of translocation timing and to ensure successful outcomes (if not known for the species), including: chick meal size and feeding frequency by adults; parental abandonment period; number of emergence nights before fledging; fledging dates; and chick growth rate and size at fledging (weight and wing-length)
  - Determine suitability of the source island in terms of access, population size, burrow occupancy, etc.

- Recce trip—an expedition made if required (refer below to Section 6.2.1 When is a pre-transfer Recce trip required?) to the chosen source colony in the same breeding season as the planned first chick transfer, to meet the objectives set out below in Section 6.2.2 Objectives of pre-transfer Recce trip.

The following information about Recce trips is for species for which detailed breeding biology is already known. A Recce trip would not normally be the first visit to a colony; data on breeding biology and habitat should already have been previously collected on a study trip.

Important note: The collection of data for a species that has never been studied in detail or translocated before is not considered to be a component of a Recce trip, but should be collected in a study trip prior to the transfer year.

5.2.1. When is a pre-transfer Recce trip required?

Recce trips are usually made to assess a source colony if:

- The colony has been used as a previous source of chicks for transfer but has not been visited for many years, i.e. availability of chicks in recent years is not known, and the timing of peak fledging needs to be reassessed.
- The colony has never been used before as a source of chicks for a translocation project.

  Note: If the colony has never been used before as a source of chicks for a translocation project, then a Recce trip may be required in not just the first transfer year, but potentially in subsequent transfer years as well.

5.2.2. Objective of pre-transfer Recce trip

The primary objectives of a Recce trip are to:

- Determine availability of chicks at the source colony for transfer in the same season. Chick availability may fluctuate between years for a variety of reasons. For example, burrows in some colonies can be susceptible to flooding in heavy rain and this has potential to significantly affect overall colony productivity for the season.
- Locate and mark as many burrows containing suitable chicks as possible, to enable easy recovery of chicks on the collection trip. Note: Not all the chicks found during a Recce trip will still be present or suitable at the time of the collection trip, so additional search time always needs to be factored in on the later collection trip.
- Identify the safest routes to use on the island in terms of minimising burrow damage.
- Collect data on chick size (wings only) to assist with planning the transfer date. Wing measurements collected on the Recce trip can only offer a rough guide to the likely transfer date because:

- There may be high variance in growth rate within an individual, i.e. growth spurts may be associated with recent parental provisioning, or rates may slow during lengthy periods between meals.
- Wing growth rates can vary considerably between different chicks (e.g. due to varying foraging efficiency between adults).
- Overall chick growth rates at a colony can vary between seasons depending on the adult food provisioning rate related to food supply at sea.

The optimum transfer date tends to be refined after data collection over one or more years at the source colony, and after the first one or two transfer operations.

Note: For species that have not been translocated before, unless the exact wing growth rates in the early phases of the chick rearing period are known for the species, wing measurements will offer only a rough idea for predicting transfer date.

- Assess all logistics in terms of collecting the chicks, e.g. team size, transport logistics, etc.
- Train (or up-skill) staff and volunteers in all relevant tasks (e.g. burrow inspections, chick handling etc.).
- Preserve fragile and damaged burrows containing birds (refer to Section 6.3. Managing burrow damage at the source colony). Some burrows may be damaged either accidentally, or when inspection holes are made to access chambers.

5.2.3. Timing of Recce trip

Recce trips are timed to occur as follows:

- After the majority of chicks at the source colony are predicted to have hatched, thus avoiding disturbance of incubating adults
- When chicks are robust enough (i.e. not too young) to be handled/measured, and to withstand any impacts of burrow damage
- When chicks are big enough to be effectively measured in relation to potential transfer dates (e.g. for gadfly petrel chicks, this would be no earlier than 1 month before the potential transfer date)

5.2.4. Searching for burrows on the Recce trip

Detailed protocols for inspecting natural burrows at the source colony need to be provided, including protocols on:

- Searching for occupied burrows
- Inspecting natural burrows (includes creating study/inspection holes where required)
- Safely extracting and processing chicks at natural burrows (including methods to avoid and deal with incidences of regurgition which can have fatal impact on chicks)
- Numbering and mapping burrows for future reference

The time (e.g. number of person hours) it takes to find each suitable chick for transfer varies at different source colonies, and depends on:

- Whether or not the source colony already has marked burrows, i.e. has or has not been the subject of research in recent years or provided chicks for previous translocations
- The experience levels of personnel
- The terrain (including its vulnerability to damage)
- The nature of the burrows used by the species (stability, depth etc.)

Note: Burrow occupancy rates will not only differ between species, but may also differ between different source colonies of the same species.

5.3. Managing burrow damage at the source colony

5.3.1. Burrow damage repair

All consideration must be given to minimising and managing the impacts of burrow damage on the source colony during each visit. Burrow damage can be accidental or deliberate (for chamber access).

It is essential to take appropriate materials for effective burrow damage repair for all species that could be encountered. Every effort must be made to ensure damaged burrows are made light-proof and water-proof. All methods employed require discussion with relevant parties prior to the trip.

5.3.2. Installing artificial burrows at the source colony

Artificial burrows are usually only installed at burrow sites at the source colony in the following circumstances:

- At burrows of endangered species, because the species is regularly monitored and/or managed. Burrows may also need to be accessed for regular chick translocations.
- For immediate management of badly damaged burrows, particularly in friable soil, i.e. to repair broken burrows or preserve extremely fragile ones.
- At some sites in extremely fragile areas, there they may be an investment for projects involving multiple transfers in installing artificial burrows. This is because there is a high chance that a stabilised burrow is reused by the same pair in subsequent years; all future inspections of the burrows will be safer and easier, and the burrows are more likely to remain productive.

6. Transfer date

6.1. Single or multiple transfers

Whether a transfer is undertaken on a single date or multiple dates depends on several factors:

- The proximity of both source and release sites (and costs and logistics involved in transport). Projects involving sites that are relatively close (with minimal transport costs and logistics) can transfer chicks on an individual basis, or in small groups, when they meet optimum transfer criteria—this is the ideal scenario.
- The size of the source colony and ease at which chicks can be collected on a single day. There may be welfare issues regarding the duration of the transfer, if it takes a long time to collect the birds, which mean it would be preferable to undertake transfers on multiple dates.
- The number of chicks that will meet the transfer criteria on a given day. Sometimes chicks of suitable age and size are spread over several weeks and two transfers (on different dates) will result in more chicks of the correct size becoming available (refer to Section 7.3. Wing-length estimates to predict transfer dates).
- The resources available to cater for chicks for extended periods at the release site (i.e. with two or more transfers the total feeding period will be extended).

6.2. Previous transfer dates

Once an optimum transfer date is established for a project, future dates tend not to deviate too much from the optimum. However, teams need to build flexibility into each transfer operation so that:

- They allow for potential delays (usually weather related)
- If they arrive at a site for chick collection and find a poor season in progress, they can return later (e.g. up to a few weeks later) to collect chicks when they have developed a little further. At any source colony, there may be a 'poor season' for all chicks where parents have difficulty provisioning chicks because of poor food supply at sea. This can result in chick growth being retarded and chicks taking longer than expected to develop to the size required for transfer and successful fledging.

6.3. Wing-length estimates to predict transfer dates

Using the wing measurements obtained from chicks on the Recce trip and the known or estimated wing growth rates for a species, record the number of days (both min. and max.) each chick has to grow to meet the optimum transfer wing-length criteria (shown in Table 3). For each chick, there will be a date range (calculated from the min. and max. growth rate) for when it will meet transfer criteria.

This information can be used to:

- Decide the optimum transfer date, when the greatest number of chicks will fit the transfer criteria.
- Identify the time needed and labour requirements for the collection trip, i.e. depending on how many additional chicks might need to be found over those already marked on the Recce trip.

Note: Under normal circumstances (in a good chick provisioning year), for most species wing growth accelerates with age up to a point fairly close to fledging, then

slows in the days leading up to departure. There is a need to use minimum and maximum wing growth rates rather than average wing growth rates, as growth rates vary between individuals, and can vary within an individual in relation to provisioning behaviour of parents.

7. Selecting, collecting and transferring chicks

7.1. Objectives of the selection / collection / transfer trip

The length of the selection / collection / transfer trip is dependent on the size of the team. The primary objectives of the trip are to:

- Revisit and inspect all burrows marked on the Recce trip as containing chicks (or marked in the previous season if no Recce trip was required). Even if some chicks are predicted to be the wrong size for transfer during the Recce trip, all burrows will probably need to be checked at the start of the collection trip because it can be hard to identify individual burrows in a dense colony without tracks or highly detailed maps.

  Note: All burrows containing chicks should have been marked on the Recce trip (e.g. with flagging tape).

- Weigh and measure all chicks to determine those that are suitable for transfer—prior to the transfer day and then on the transfer day.

  Note: On the transfer day, re-weigh (highest priority) and re-measure all chicks destined for transfer to ensure suitability.

  Note: Chick weigh bags need to be a size that will ensure wing feathers are not damaged and allow space for potential regurgitation within the bag, i.e. birds in small bags could get covered in their own regurgitation which could be fatal. (For essential information on regurgitation, refer to Section 12.7.1. Regurgitation.)

- Band all chicks that are potentially suitable for transfer.
- Mark burrows of suitable and marginal chicks accordingly so they can be collected easily on the transfer day (or re-assessed).
- Search for additional chicks (i.e. in unmarked burrows) if necessary to reach the target number of chicks for transfer.
- Use stick-fences to help determine which chicks are fed by their parents the night before the transfer day (to help plan feeding schedule at release site) if time permits and relevant.

7.2. Transfer criteria

Transfer criteria must be set to only include chicks that will have an excellent chance of fledging and surviving and returning to the release site.

Chicks are selected for transfer if they meet the following criteria **on the transfer day**:

- **Wing-length** falls between a pre-set range—to avoid transferring chicks that are too young or too close to fledging. This wing-length range is usually divided up into wing-length groupings that also have a minimum weight requirement.
- **Weight** exceeds a minimum set for each wing-length grouping—to avoid taking chicks that are too light for their age. Heavier chicks can better tolerate the relatively slow (but necessary) transition onto the artificial diet without fledging condition being too compromised. In addition, if they disappear prematurely from their burrows (before plumage is fully developed) and can no longer be fed, they still have a good chance of fledging within the target fledging weight range.

  Important note: Extremely heavy chicks that have been very recently fed prior to transfer must be transferred with extreme caution as there is a high risk they may overheat and/or regurgitate during transfer. For essential information on regurgitation, refer to Section 12.7.1 Regurgitation.
- **Have not yet emerged** at the source colony—any chicks suspected as having emerged, even if their wing-lengths are within the pre-set ranges, should not be taken. The maximum wing-length criterion should account for the fact that it is not always easy to determine if a chick has emerged (refer below to Section 8.2.2. Chick emergence at the source colony).

Note: Minimum weight criteria tends to be increased for the more advanced birds because there is less chance that a chick has emerged if it is particularly heavy (and still has a reasonable amount of down cover). This strategy allows enough time at the release site to block such chicks into their burrows for a minimum acclimatisation period before they begin to emerge, without causing too much stress (refer to Section 11.2. Burrow acclimatisation period).

7.2.1. Wing-length and weight criteria

The fluctuations relating to large, irregularly delivered meals can make it difficult to detect the exact base-weight (pre-feed weight) of individual chicks. For example, two gadfly petrel chicks (same species) that are identical in weight on one handling day may have completely different base-weights: one may be a chick with a light base-weight that is slowly digesting a very large meal fed on the previous night; while, the other may be a chick with a heavy base-weight that has not been fed for many days and is awaiting its next meal.

There are two strategies for developing transfer day weight criteria which are used for different species. Either:

- Transfer day weight criteria can be developed to incorporate the fluctuations discussed above. Rather than setting weight criteria that can only be applied to chick base-weights, the criteria can be applied to chicks that have been recently fed as well as to those that have not received a parental meal for a while. OR
- Transfer day weight criteria can be based on the BASE or PRE-FEED WEIGHT of a chick (refer to Section 17. Terminology and definitions). To determine base weights, all chicks must be weighed on two occasions over a 3 or 4 day period, with the second weight taken on the transfer day. The lowest weight gives an

Comment [H9]: For critically endangered species where all birds are move, there is no criteria!

For some species, the impacts of moving chicks that fall below minimum wings and weights can be fatal. For others not so dramatic. There's a bit more to explain regarding the daily-feeding species with different kind of weight fluctuations.

indication of the base weight of the chick (while the higher weight would represent a post-feed weight 1 or more days after a parental meal has been delivered).

All chicks must be weighed on the transfer day if they have not been weighed the day before the transfer. This is important (especially for marginal chicks) even if after first handling their wings are predicted to fall well within the wing-length criteria at transfer—to see if they have:

- Reached the minimum weight criterion, i.e. some chicks are slowly gaining weight, may be awaiting a large parental meal, and might just be right on the day; or
- Dropped below the minimum weight criterion because they have not received any further meals from parents since first weighed, and hence must not be taken.

Table 3: Example transfer day wing-length and weight criteria for Chatham, Cook's and Pycroft's petrels.

Species	Priority for transfer	Wing-length on transfer day	Minimum weight on transfer day
Chatham petrel	1 (optimum)	170–210 mm	300 g
	2 (acceptable)	211–215 mm	300 g [2]
	3 (least preferred)	216–225 mm [1]	290 g [2]
Cook's petrel [3]	1 (optimum)	160–210 mm	300 g
	2 (acceptable)	211–220 mm	330 g
	3 (least preferred)	221–235 mm [1]	[3] 320 g (or 300 g if fence intact)
Pycroft's petrel [3]	1 (optimum)	155–195 mm	[3] 220 g
	2 (acceptable)	196–205 mm	[3] 240–250 g
	3 (least preferred)	206–215 mm [1]	[3] 250–260 g

[1] A reasonable amount of down cover on the chick is preferred to indicate that the chick has not yet emerged at the source colony.

[2] Note that the minimum weight criterion of the more advanced Chatham petrel chicks used to be higher (330 g) to avoid taking chicks that might have emerged. However, it has been lowered to 300 g for Priority 2 chicks and 290 g for Priority 3 chicks (relatively lower than for the other two species). This is because Chatham petrel is a threatened species and burrows at the source colony are intensively managed; so it is much easier to tell if Chatham petrel chicks have emerged from burrows at the source colony (i.e. criteria does not need to try and eliminate chicks that might have emerged).

[3] Cook's and Pycroft's petrel transfer criteria have yet to be trialled and confirmed.

7.2.2. Chick emergence at the source colony

It is vital that transferred chicks have not emerged at the source colony. Inspecting stick fences on the transfer day that have been erected at burrow entrances on the day before transfer can help to determine if a chick, suspected as being close to emerging, has visited the surface:

- A stick fence that is intact on the transfer day will show that the chick did not emerge on the night before the transfer day. Thus, the chick can be taken.
- A stick fence that is down can mean that either a parent visited the burrow, and/or the chick emerged from the burrow on the night before the transfer day. Further assessment is required: burrow entrance and chick must be carefully inspected to decide if there is a chance it could have emerged. Note that a chick can still emerge from its burrow on a night when a parent visits to feed it.

Note: If time permits, it would be beneficial to observe the activity at the burrow entrance over several nights before the transfer day, to give a clearer picture of whether or not a chick might have emerged.

It can be easy to see if a chick has emerged if it is very downy and has to squeeze through a natural entrance, leaving lots of down at the entrance (and knocking the stick fence down). But it can be quite hard to determine if a chick has emerged in the following circumstances:

- At burrows with wide natural entrances or where artificial pipes are installed
- If the chick is not particularly downy by the time of its first emergence—this may be because:
  - The chick is particularly advanced with well-developed plumage
  - The chick's natal burrow chamber is small/tight inside so down is worn off rapidly
  - Down has been lost from the chick through a previous flooding event, or through previous handling in wet weather
- Where chicks have been previously pulled out from reach-in burrows (chamber access through burrow entrance) and have lost down during the first extraction—in this situation, down is deposited at the entrance and should be removed at the time, or it can be mistaken for down deposited by an emerging chick

7.3. Selecting chicks

Methods for selecting chicks of threatened species where all burrows at the source colony are managed are different to those used for more common species.

Detailed protocols for selecting chicks at source colony burrows should include details on:

- Preparation of equipment, notebooks and data forms
- Extracting and handling chicks—including methods for avoiding and dealing with incidences of regurgitation. For essential information on regurgitation, refer to Section 12.7.1. Regurgitation

- Banding, processing and assessing chicks—first measurements for chick selection.
- Marking burrows—depending on suitability for transfer
- Confirming chick suitability for transfer—second measurements
- Checking fences at burrow entrances leading up to the transfer day—if time permits
- Transcribing data daily—to determine how many new chicks (if any) need to be found
- Searching for additional chicks

7.4. Transfer boxes

7.4.1. Transfer box design

Whatever type (material) of box is used, consider the following:

- Box exteriors are ideally white or light-coloured to reflect more heat. (Neutral coloured boxes may be effective.)
- Box interiors are black or dark-coloured to reduce chick stress levels. (Neutral coloured boxes may be effective.)
- Boxes have adequate appropriately-sized and positioned ventilation holes to suit the species and journey involved.
- Boxes are ideally water resistant and at least splash-proof, otherwise plastic bags tend to be required to protect boxes in the rain or during boat trips.
- Re-usable boxes must be thoroughly disinfected and dried after use.
- Spiders and other insects have been known to crawl into the open ends of stored transfer boxes, so it is important to note that re-used boxes (or new boxes stored unsealed) might not pass quarantine regulations (e.g. for off-shore island sanctuaries). Boxes would need to be thoroughly disinfected and stored in insect-free containers to be guaranteed to meet quarantine requirements if planning to take them back to the source colony.
- Robust transfer boxes are a good option for back-up post-transfer accommodation in severe flooding conditions at the release site.

The transfer box design used for most seabird transfer in New Zealand is based on a standard pet-carry box. Two chicks of a smaller species (e.g. small gadfly petrel) can be comfortably held in one box (with a single diagonal divider) for <1 day, in transit; however, the optimum holding for larger chicks (large gadfly petrel) is one per box so there is enough space to avoid overheating issues, and to avoid wing or tail feathers becoming damaged.

Note: Any chicks that need to be held longer than 1 day due to exceptional or emergency circumstances, must be held individually, i.e. one chick per box (refer to Section 8.7.2 Time of day).

Two types of pet-carry boxes have been used to date in New Zealand: Corflute™ (fluteboard) pet-carry boxes (425 x 240 x 310 mm) and cardboard pet-carry boxes (380 x 200 x 265 mm).

7.4.2. Preparing transfer boxes

Preparation of transfer boxes on the day before the transfer involves the following:

- Lining transfer boxes with folded newspaper for improved grip and to absorb excrement. Avoid using shredded paper as chicks may overheat. A non-slip perforated rubber matting can also be used if taped down securely and it allows waste matter to fall through to the newspaper layer.
- Ensuring any diagonal dividers sit flush on the floor of boxes and there are no gaps for feet or legs to slip under. Note that the small gadfly petrel chicks do not tend to jump up in boxes, but long wing feathers could get caught up in gaps.
- Sticking two strips of packing tape above each compartment on top of the lids on which to write the source colony burrow numbers and fence status. It is easier to relocate a chick if needed by reading details on the lid rather than on the side of the box.

7.4.3. Transferring nest material

Some project managers recommend removing some of the nesting material from natal burrows for the purposes of providing additional scent in the artificial burrow at the release site to help the chicks 'settle in' and fix to its new burrow. Although not considered essential because chicks quickly scent up their new burrow at the release site during the acclimatisation period when they are blocked in, with down rapidly deposited in the burrow soon after transfer, it can be a useful tool to improve the chances of a more advanced chick returning to the same burrow after night-time excursions. If choosing to do it, note that:

- The biosecurity issue of transferring nesting material (which can potentially contain invertebrates, seeds and pathogens etc.) between locations has been questioned in translocations, especially if the release site has high ecological value.
- Sticks and twigs must not be placed in transfer boxes with the chicks because there is real potential to cause injury to chicks in transit.
- It is time-consuming for personnel to collect material on the transfer day, especially if it has to be placed in a clearly labelled zip-lock bag, and to then distribute it in the correct burrow (with the right chick) at the release site.
- There may be a negative impact on the breeding pair if too much scent is removed from the source burrow, especially if the parents perceive breeding failure. Ensure not too much material is removed from the nest.

7.5. Collecting chicks

Detailed protocols for collecting chicks on the transfer day can include:

- Weighing and measuring each chick on the transfer day to double-check suitability for transfer
- Inspecting the burrow entrance for signs of chick emergence
- Checking to ensure adults are not accidentally transferred
- Checking each chick for any abnormalities or obvious signs of poor health
- Recording fence status on the morning of transfer—**only if** fences were erected on day before the transfer day and information is useful for meal planning at the release site
- Leaving all burrow markers in place at the source colony—essential, in case a chick needs to be returned to its burrow for any reason

Important note: If a chick is to be moved but is known to have been fed in the previous 1–2 nights, then **extreme care** must be taken during the handling process. The chicks head must be kept clear at all times to allow projection of regurgitant (refer to Section 12.7.1. Regurgitation). Contingency plans should be in place if a chick badly soils itself with regurgitant (e.g. chick is not transferred, or chick is transferred and treated for lack of water-proofing).

Chicks soiled in regurgitant are unlikely to do so well at the release site because:

- They have a low chance of survival if water-proofing has been compromised
- They may have fallen below the minimum base weight criterion for transfer after regurgitating

7.6. Transport requirements

Seabird chicks are particularly vulnerable to over-heating when removed from burrows below ground. Some species have particularly thick subcutaneous fat layers that make them more vulnerable to over-heating than others, especially in: warm conditions; in confined spaces with limited ventilation; if exposed to the hot sun; and, if chicks have recently been fed a large meal by parents.

Therefore, transport needs to be as efficient and fast as possible, and boxes should be kept a cool as possible at all stages in the journey.

7.6.1. Mode of transport

In New Zealand, small gadfly petrel chicks have been transported by air, sea and road successfully as follows:

- Helicopter or plane is the preferred mode of transport for long distances during summer months, to minimise the risk of chicks over-heating and reduce movement of boxes. Boxes may be temporarily packed together in the craft, but box height should allow for enough ventilation during a relatively short helicopter flight.
- Boat is currently the only available transport for Chatham petrel chick transfers; chicks tolerate fairly choppy sea conditions for up to 2 hours on a fishing vessel. Boxes are usually placed loosely in individual plastic bin bags (leave tops untied for ventilation) to protect them from salt spray and are spaced out on the deck.

Pycroft's petrels have tolerated boat trips of up to 3 hours between islands (in summer) with difficult landings at either end (boulder beach to dinghy to launch; and launch to dinghy to wharf). Boat trips longer than 3 hours may be problematic because there may not be enough time to process chicks at the release site before dark, and chicks will be more vulnerable to over-heating if in a confined space for too long (e.g. below deck). Transfer boxes can only be placed outside on deck if conditions are not hot and sunny. Transfer boxes stored below deck must be spaced out in a ventilated area.

- Road travel has been used to move birds from air or sea drop-off points to new colony sites. Chatham petrel chicks have tolerated 2 or more hours in road vehicles (truck/trailer/ATV) but every effort is made to make sure boxes are well-secured (tied down), and well-spaced (planks of wood are laid down between rows of boxes to improve air-flow and help reduce over-heating risk).

7.6.2. Time of day

Comment [H10]: There are species that need feeding on the same day that should be mentioned here. So transfer must allow enough time in afternoon to feed all the chicks.

Ideally, chicks need to be collected and transported in a cooler part of the day. Boxes must never be left in exposed sunlight during the hottest part of the day.

It is important to note that chicks do not necessarily need to be installed in artificial burrows on immediate arrival to the colony, especially if this is during the hotter part of the day. In fact, these species are more tolerant to being in transfer boxes for prolonged periods than some other species, providing they have adequate space. It is good practice to inspect all chicks (visual in box) immediately after the transfer, to ensure none have been injured in transit. After this, it may be best to store the boxes somewhere dark and cool (e.g. a shed or under dense canopy) for several hours, and then process the chicks (band check, re-hydrate and put in artificial burrows) later on when it is cooler, allowing enough hours to complete this in daylight. It is not good practice to process chicks in the dark by torchlight at the end of a transfer day.

While it is not considered best practice to plan to hold chicks for longer than one day in transport boxes, if there is an unexpected delay in transit or other emergency, chicks can be held overnight in boxes PROVIDING they are separated into individual boxes. For this reason, it can be beneficial for some projects (location dependent) to carry additional cardboard boxes with the transferred birds to use as emergency temporary accommodation if required.

If chicks need to be held overnight, these are the requirements:

- Chicks MUST be held in separate individual boxes to allow extra space to keep cool and to minimise disturbance for each chick. Boxes need to be weather-proof if they are stored in the outdoors, or stored under a shelter e.g. tarpaulin.
- Consider hand-feeding some of the lighter chicks immediately on arrival at the release site rather than leaving them to the day after transfer (refer to Section 10.5.4 First [introductory] meals).

7.7. Installing chicks in artificial burrows at release site

Comment [H11]: There species that need feeding on the same day as transfer which should be described here

Before chicks are installed in burrows, they are checked over and rehydrated (when necessary). This involves:

- Checking each chick methodically for any physical injury afflicted during transport, for example:
  - Wings and legs held correctly and have normal strength and movement
  - Eyes are clear and bright (not closed or weepy).
- Delivering an appropriate volume of oral fluids (e.g. an electrolyte fluid) to each chick before it is placed in its allocated burrow. Some chicks will reject these fluids, and there is a high risk of triggering regurgitation by recently fed birds, but oral fluids are considered to be important to counteract dehydration in species transferred in hot weather, especially for those chicks not fed by parents for several nights before transfer. For essential information on regurgitation, refer to Section 12.7.1 Regurgitation.

  Note: Weights and wing-lengths can be recorded for all chicks on the day after transfer to reduce handling on the transfer day.
- Placing chicks directly in allocated burrow chamber; and, checking that internal blockade is safely in place and that the external blockade at entrance is present, safely positioned and secure. Refer to Section 9.4.3. Preparing artificial burrows, for more information on internal and external burrow entrance blockades.

8. Release site

8.1. Suitability of release site

A site must meet the following criteria for it to be considered suitable for a colony establishment project:

- Situated within appropriate geographical location/ecological zone. Note: The location of release sites may need to be considered in relation to a species' feeding grounds, particularly if they are not pelagic feeders that travel rapidly over very long distances to forage. But even for pelagic feeders, there may be a consequence to breeding fitness if birds have to travel an extra distance (e.g. 100+ km) to reach the colony; this may need to be investigated in future projects.
- Free of predators and competitors
- Featuring appropriate habitat, including:
  - Easy landing and take-off points—relates to distance above sea-level
  - Suitable ground for burrowing
  - Shade for artificial burrows in hot, sunny locations
- Preferably accessible to passing 'immigrants' as well as to returning transferred birds

Comment [H12]: Here we placed Release after Source to offer a chronological flow in relation to a transfer operation (collect birds and then take them to the release site). However, release site specs are very important and many need to be up front in the document as one of the first steps is to identify an appropriate site before any translocations occur.

Note: Until recently, close proximity to the sea has been considered to be paramount to optimise project success, especially if aiming to attract passing birds. However, inland sites far from current range for some species in New Zealand are being considered where there is evidence they occurred historically at such sites.

- Not too close to bright lights (e.g. towns and cities). Avoid sites close to bright lights because these species are strongly attracted to light and can become grounded near such light sources.

8.1.1. Predators

Predator-free off-shore islands are favoured as release sites; however, mainland island sites are now considered suitable providing fenced areas are proven to be 100% free of all introduced predators, farm stock, feral pigs, etc. There must also be a long-term commitment to maintaining the predator-proof fence.

Many petrels and shearwaters are not large enough to withstand any kind of mammalian predator attack, and colonies are thus extremely vulnerable to predator invasion. Some of the larger species may be robust enough to fend off some predators, but eggs and small chicks left alone in burrows when parents are at sea are extremely vulnerable to all predators.

8.1.2. Competition

Potential short-term and long-term impacts of competition with other seabird species need to be carefully considered for all release sites. Other seabird species may be:

- Already existing naturally at the release site, or introduced there through previous translocations
- Not currently resident but featuring on an acoustic attraction system, i.e. may arrive at any time
- Planned for future introduction to the site via translocation

Restoration projects must consider what mix of seabirds would have been at the site originally, and what mix is appropriate for the site now.

Specialist advice must be sought to determine:

- Normal interaction and compatibility of species, or predicted interaction if not known
- Recommendations for order of different species introductions and their priority
- Recommendations for relative proximity of burrow sites for different species

Negative short-term impacts of placing colonies of different species close to each other include:

- Transferred chicks housed at an artificial burrow site may wander into adjacent burrows of other species during the emergence period, which could have several implications:

  - An extremely labour-intensive search effort would be needed to find chicks that still required feeding.
  - If these other burrows are natural, chicks may never be found.
  - If chicks enter burrows containing larger species that are breeding, they may be subject to injury as resident adults defend their burrow.
- Monitoring efforts for adults in the years following translocation may be compromised. For example, monitoring methods for one species may disturb normal activity of another species present at the colony, e.g. a nocturnal monitoring regime for one species that might be well into the breeding season could disturb another species that might be still prospecting and are therefore more sensitive to disturbance.

Negative long-term impacts of placing colonies of different species close to each other include:

- Larger species digging their own burrows can undermine burrows of smaller species.
- Similar-sized species may compete for the same burrows. This can result in breeding failure for one or both species if their breeding seasons overlap.

8.1.3. Take-off points

Petrels and shearwaters require at least one or both of the following key features at a colony site in order to be able to take-off to sea, depending on their size and behaviour:

- Mature trees—required for all species that are tree-climbers. Note that chicks of some species are capable of wandering 50 m or more to a suitable tree (sloping, emerging from the canopy, rough bark).
  - Agile tree-climbers (e.g. small, forest-nesting species)—chicks of such species are most likely to be able to climb near-vertical trees during the emergence period and may need to fledge from the canopy. Burrow sites can be relatively close to sea level if there are plenty of mature trees that birds can climb to take-off into the wind. If the site is elevated and exposed, trees may not be used at all, with birds choosing ground take-off points.
  - Less-agile tree-climbers (e.g. larger species nesting in more open forest)—chicks of the less agile tree-climbers will climb large trees if required to depart the colony; they may not necessarily climb to the canopy, taking flight from part way up a mature tree, e.g. an exposed limb. If the site is elevated and exposed, trees may not be used at all, with birds choosing ground take-off points.
- Elevation—at most colony sites, birds will take off from high vantage points (clear areas on cliff-tops, above bluffs, ridges or rocky outcrops) whether they are tree-climbers or not.
  - Non-climbers—species that do not climb trees tend to be most reliant on elevation for take-off, especially the larger species. Ideally, they need an

Comment [H13]: NZ examples are Cook's and Chatham petrels, grey-faced petrels.

area clear of obstructing vegetation, i.e. exposed 'runway' area for lift-off. Some species can take-off from sea-level or low elevation if the site is very exposed (e.g. to wind).

- Tree-climbers—sites with mature trees and elevation are thought to be superior over those that are not elevated for species that climb trees.

Note: Immature forest can shelter sites from wind and make take-off difficult for all species because there are no mature trees to climb (tree-climbers), and no clear and exposed runway areas for lift-off (non-tree-climbers). This can result in chicks delaying their departure and fledging in less than optimum condition, especially if conditions are calm. Ramps can be installed at such sites to facilitate take-off. Vegetation may also need to be managed at the colony site to provide take-off opportunities (refer to Section 15. Post-release site management).

Note: Established vegetation canopy is considered to offer protection from aerial predators and the sun. The presence/absence of canopy cover tends to influence burrow design.

8.1.4. Landing points

Vegetation growth and density should be monitored annually at colony sites and controlled as required (refer to Section 15.1. Managing vegetation). Small, establishing colonies of seabirds would be unable to keep an area free of vegetation through their normal disturbance regimes on the surface.

Project managers should consider the following:

- Exposed area nesters—species nesting in exposed areas with minimal vegetation and/or low ground cover have a large choice of landing area and are less exposed to hazards compared to forest nesters. They are more likely to land relatively close to their burrow. Burrow sites may need to be kept actively free of re-growth.
- Forest-nesters—forest-nesting species tend to drop to the forest floor through a point in the canopy which tends to be fairly near their burrow. Birds are also known to land away from their burrows, e.g. in a clearing and walk to their burrow. Fore example, Rayner et al. (2007) report Cook's petrels walking up to 100 m to get to their burrow. For some species, burrows are often located in areas of less dense forest where the risk of collision (which can lead to mortality) with obstructing vegetation is reduced.
    - When existing forest habitat is being selected at a release location, it is safer for the birds (and easier for monitoring and management) if an artificial burrow site is located where the under-storey is sparse or only comprised of soft, broad-leafed vegetation as opposed to scrubby, dense vegetation. Re-growth can be thinned out so as not to be too dense and hedge-like, i.e. where birds can become entangled. Refer to Section 15.1. Managing vegetation.
    - In regenerating (immature) forest habitat in coastal cliff environments, the right type of vegetation for stabilisation needs to be planted, but should not conflict with the seabird habitat requirements. Again, trees which have a shrubby/dense growth form are not a good option as birds can become

entangled, and rushes and flaxes are also traps for birds that may get stuck in the central part of the plants.

- In either of the above forest habitats, as a minimum it would be beneficial to clear a pathway to an exposed bluff or cliff-top to allow birds to easily access an area suitable for take-off in all conditions.

8.1.5. Slope of ground/soil type

Aim to locate new colony sites in terrain that replicates that where most burrows are found at the source colonies. This may be a relatively flat area of coastal forest floor, or a gentle slope (soil is often more friable in such areas and there may be less erosion); or, a steep slope that still has relatively stable and thick soil.

Sites need to be checked prior to burrow installation during the wet season, and/or after heavy rain, to monitor how boggy the ground becomes. Soil needs to be friable and deep enough for birds to burrow into, and not too wet.

8.1.6. Shading/vegetation cover

Shading of burrows at the release site is an extremely important factor to consider for those species that nest during the warmer summer months, as there can be real over-heating issues for transferred chicks and potentially for breeding adults in later years. Refer to Section 9.2.5. Artificial burrow temperature.

Heat stress affects some species much more than others and has been observed in chicks of certain species that are translocated from deep burrows in a more shaded location, to artificial burrows in a less shaded situation.

8.2. Design of artificial colony sites

8.2.1. Function of artificial burrows

The following functions of artificial burrows all need to be considered before burrows are installed at a site:

- Optimise attractiveness of the colony site to prospecting adults—burrows tend to be installed in close proximity to the sound system speakers (normally in front of the two speakers that are separated by around 10–20 m). It is common for adults to prospect very close to speakers, sometimes within a 1 m radius, so some burrows need to be provided as close to speakers as possible (including in front of, and behind a speaker).
- Provide safe places for adults to nest that can be easily monitored—burrows need to be maintained to optimise rates of occupation (refer to Section 15.3. Preparing burrows for returning adults).
- Provide safe and secure housing for translocated chicks—burrow design does not need to compromise the attractiveness of burrows to adults if they are installed correctly and are made as light-proof as possible inside. However, tunnels in burrows installed for transferred chicks may be slightly shorter than is desirable for adults of the same species, because the chicks must be retrievable from all parts of the burrow (i.e. they can hide in the tunnel). Burrow design can take this

into account by allowing adults that eventually occupy the burrow an option to extend the burrow (refer below Section 9.2.2. Artificial burrow design).

- Facilitate safe, easy, regular access for chick management, which also enables safe and easy access for monitoring breeding adults in future seasons.

8.2.2. Artificial burrow design

There are two main artificial burrow types that are chosen for use in seabird colony establishment projects in New Zealand, and the choice of burrow type is primarily dependent on the terrain (degree of slope and soil type) at the release site:

Comment [H14]: Overseas projects will have their own designs for various species that may differ from these – so this is just an opportunity to suggest two options that we use here in NZ I guess…

- **Flat-ground burrow design**—developed for sites that are relatively flat or only slightly sloping, and where soil tends to be more friable (especially if under shaded forest). Burrows consist of the following:
  - Chamber is square four-sided nest box made of treated timber or moulded plastic dug into the ground with removable lid at ground level. Refer to Figures 2a & 2b.
  - Chamber may have a slightly sloping roof to stop rain water collecting on the roof and leaking into the inspection hatch.
  - Chamber roof can be a double-lid system in warmer climates or at exposed sites to improve insulation (Figure 2a), or there may be a 'chimney' above the inspection hole to ground level. In the absence of a double-lid system, sandbags may be used to insulate a burrow.
  - A PVC drainage-pipe tunnel is sunk as close to horizontally as possible into a channel leading from one side of the box, preferably along any gentle slope (rather than sloping steeply downhill or uphill from the box).
- **Sloping-ground/cliff burrow design**—primarily developed for sites that are steep-sloping; these sites tend to be more exposed to wind and have less vegetation cover, i.e. not as shaded, especially if they are within areas of regeneration. Soil in these locations tends to be much firmer. Refer to Figure 3. Burrows consist of the following:
  - Chamber has three sides made of treated timber with an earthen back wall, forming a rectangular box shape. The two long sides (made of treated timber) are set into the slope; the back end is deeper below the surface, with an earthen back wall to allow further digging by prospecting adults, and the front end (made of treated timber) emerges from the surface and is fitted with an access lid.
  - Chamber roof, made of thick treated timber, is divided into two parts: one part (chamber end) is fixed and permanently buried in the slope where it is cooler, and the other part is the hinged access lid.
  - A PVC drainage-pipe tunnel is sunk horizontally into a channel along the steep slope leading from the front-side of the box. Birds have to enter a trench below ground level to enter the pipe, which effectively extends the tunnel, sheltering the entrance from wind, and keeping the burrow darker.

Note: At most sites, one of these designs is chosen and installed because the burrow area is either predominantly flat or sloped. However, there may be some sites where

a combination of designs is used, e.g. a gently sloping site that may feature some areas of steeper slope with firmer soil.

It may be beneficial to make half the burrows with left-handed entry and half with right-handed entry for the following reasons:

- To avoid burrows installed on slopes all facing the same way (with entrances all potentially facing into the prevailing wind)
- To provide a range of options for prospecting adults

Figure 1: Photographs of flat-ground and sloping-ground/cliff burrows

Flat-ground, wooden burrow (double-lid version) used for Chatham petrels on Pitt Island (Rangiauria) (photo: H. Gummer)

Flat-ground, plastic burrow used—entire box is buried underground with neck and lid emerging above ground level (photo: Philproof™)

Flat-ground burrows (double-lid type) at Chatham petrel artificial colony site, Pitt Island (Rangiauria) (photo: H. Gummer)

Sloping-ground wooden burrows at fluttering shearwater artificial colony site on Mana Island (photo: D. Cornick)

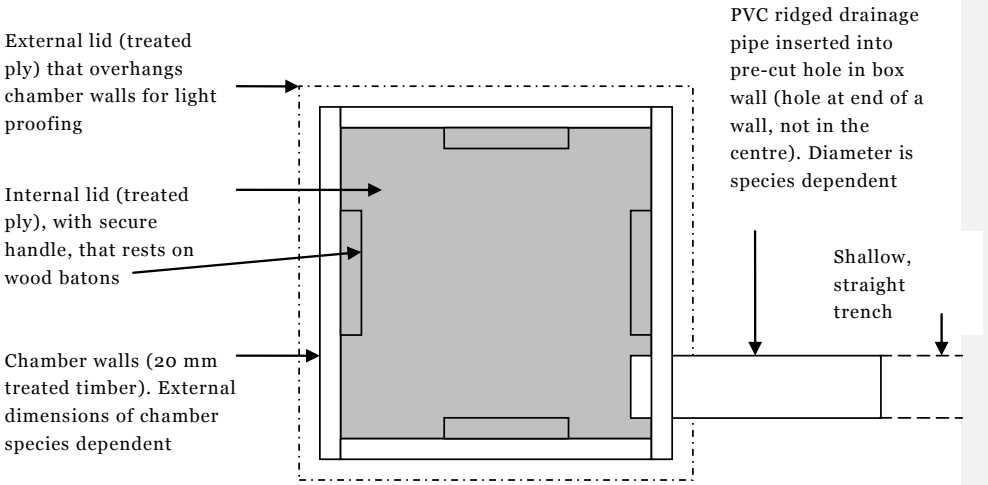
Sloping-ground burrows on Mana Island after installation (photo: D. Cornick)

Sloping-ground burrow used for Cook's petrels at Cape Sanctuary (photo: Cape Sanctuary)

Figure 2a: Diagram of double-lid artificial FLAT-GROUND burrow design

Comment [H15]: I'd like to replace this photo with one by Shane Cotter or an adult fluttering shearwater in a burrow as it shows the burrow type better.
Also, could add the taiko burrow design

Top view



Cross section

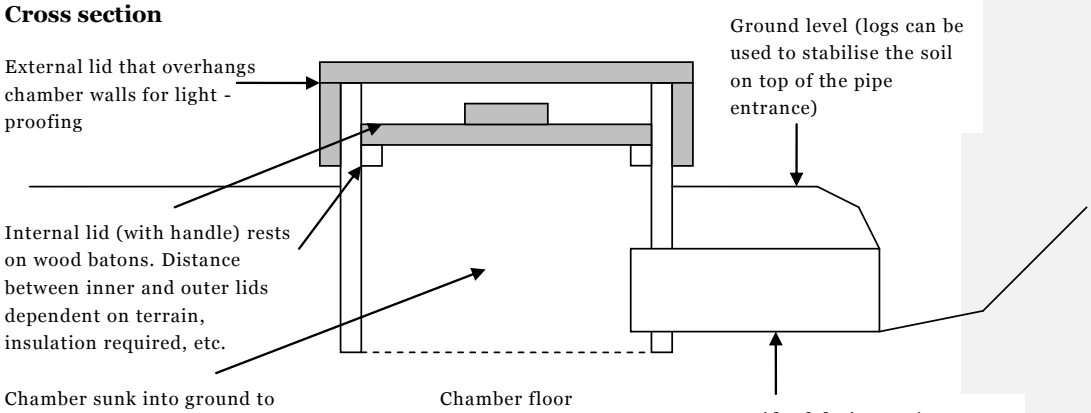


Figure 2b: Diagram of single-lid artificial FLAT-GROUND burrow design

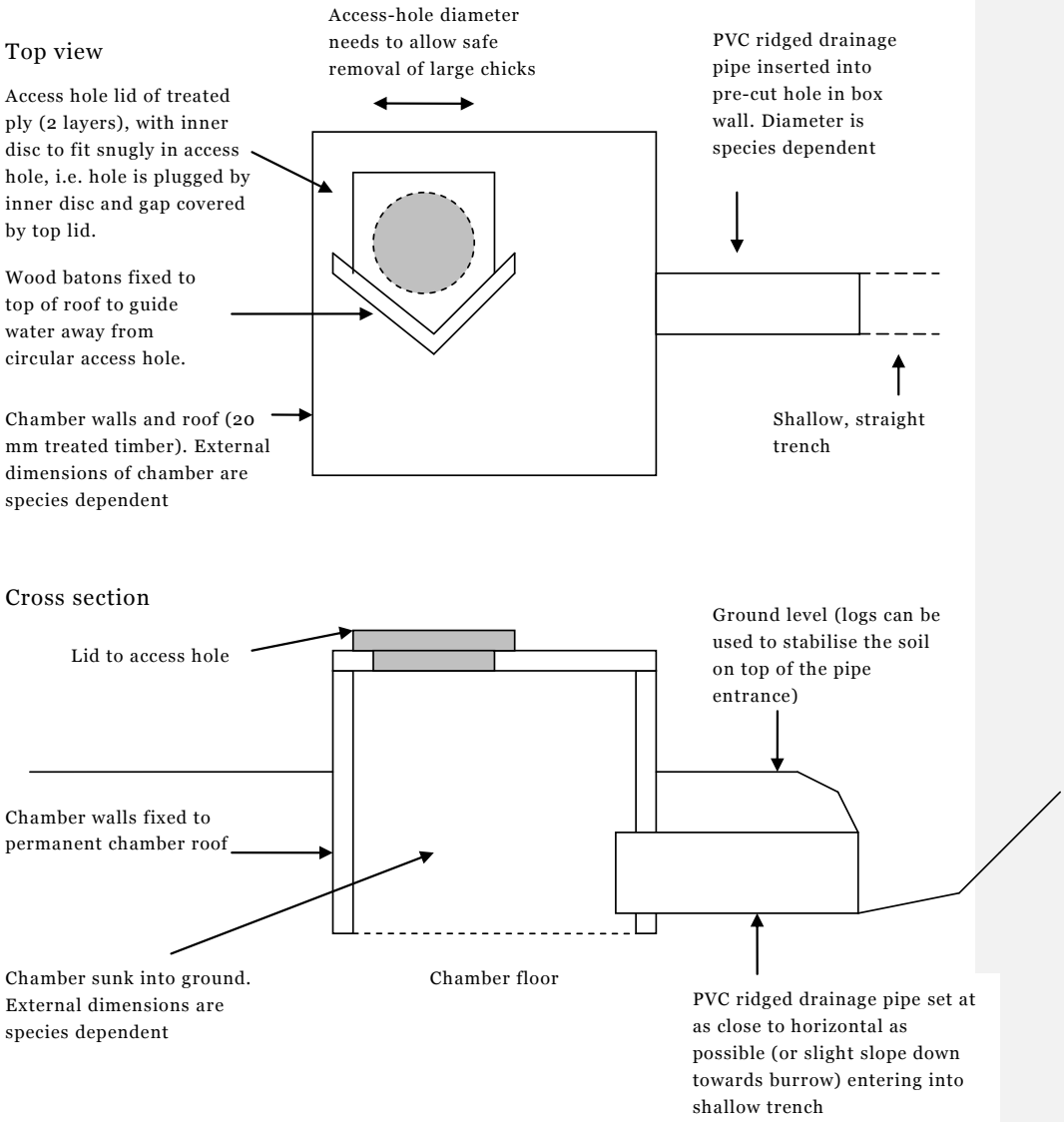


Figure 3: Diagram of artificial SLOPING-GROUND/CLIFF burrow design (adapted from: Gummer & Adams 2010)

Note: This burrow design was originally developed for fluttering shearwaters, but the size has been modified for smaller species (e.g. diving petrels), and for the more upright sitting gadfly petrels (Cook's petrels, and the larger grey-faced petrels). A deeper burrow is required for a species that has a more upright sitting position (i.e. requires more headroom), and for species that are more sensitive to over-heating (thick subcutaneous fat layers) where additional airspace within the burrow may improve ventilation.

Equipment used to make and install this design can be found in Section 2.2 of the Companion Guide (Gummer et al. 2012a).

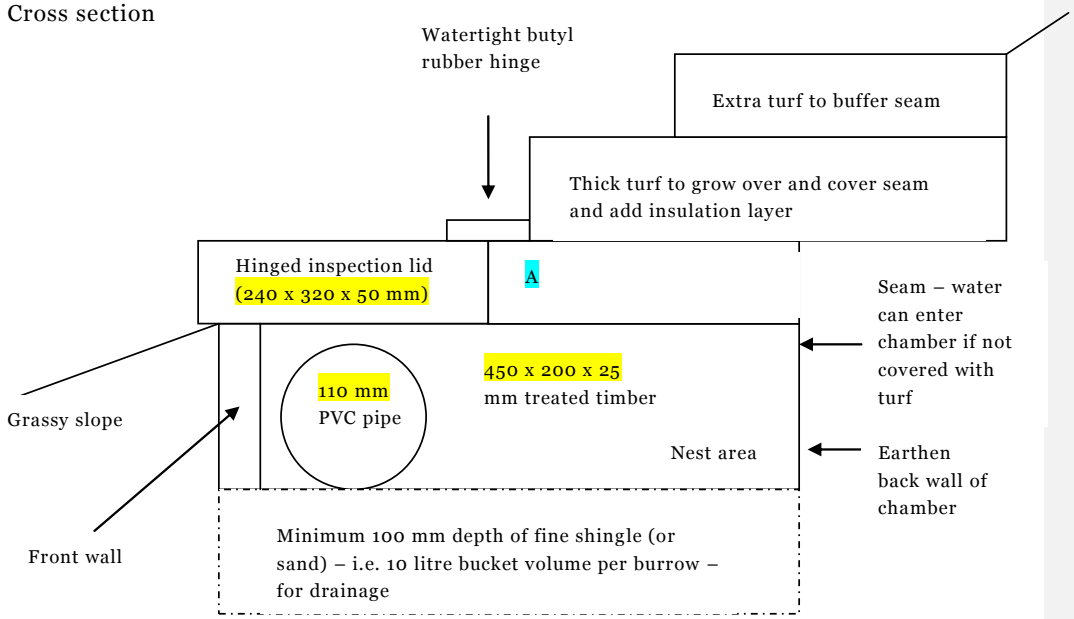
A = Fixed timber chamber roof: Cook's petrels 245 x 320 x 50 mm; grey-faced petrels 285 x 470 x 50 mm; etc.(in table form with species body size)

Comment [H16]: A couple of options here: remove all reference to measurements and let folk overseas work out their own measurements for their species; OR, add a small table with details of size as used for different species so far in NZ. This design has been used for 4 main different sized species and if we give the body size of our birds next to burrow dimensions – this could be a starting point for managers overseas.

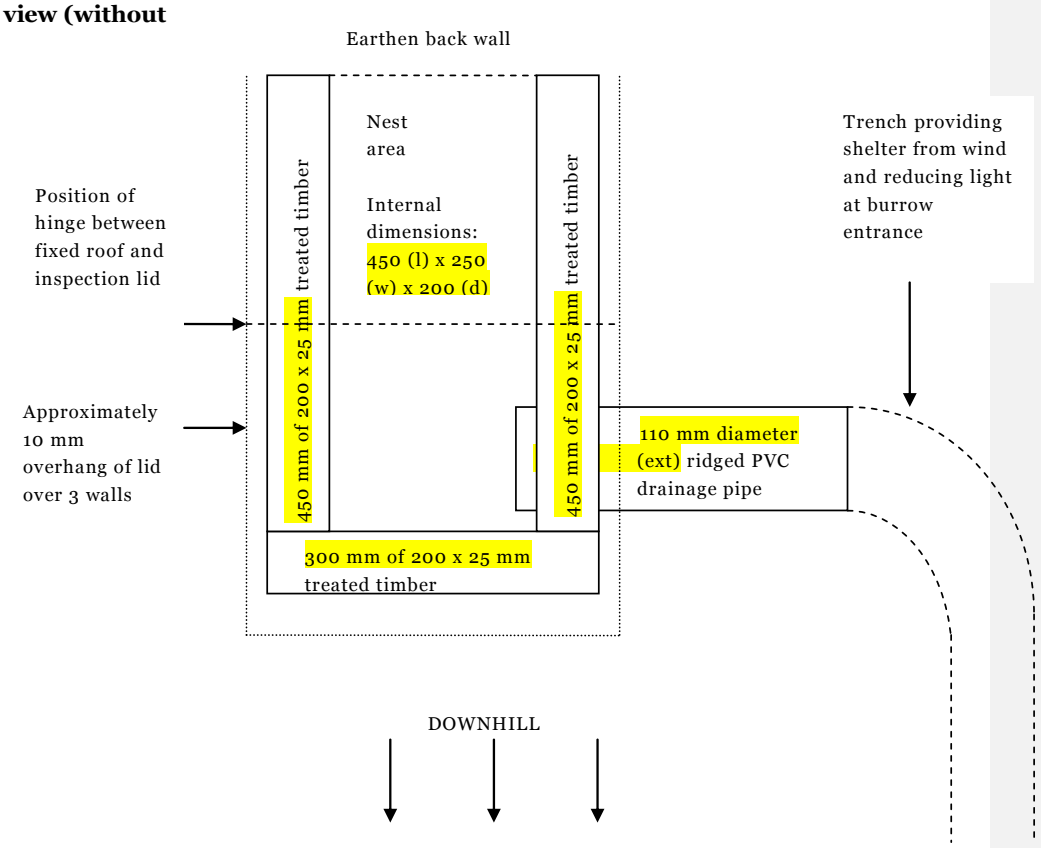
I've left the dimensions here in this diagram but they need to be deleted as they are species specific at the moment. Not sure how much detail is needed, but we could label each part of the box A, B, C etc. and then have a table with measurements for each component part as used for our 4 species to date. May be too much detail though.

My feeling is that overseas operators can work sizes out for themselves. However, in saying that I do get requests from overseas projects asking for a guide to burrow dimensions for species, e.g. those working with endangered species don't get much opportunity to try things out.

Cross section



Top view (without lid)



8.2.3. Artificial burrow materials

Whatever materials are chosen, roofs need to be well-fitting (light-proof), thick (insulation), and for inspection purposes the opening of lids (whole or part of chamber roof) needs to be smooth and easy (no noise or sudden movements), especially relevant when birds are breeding in later years.

Wooden burrows tend to be preferred for chick translocation projects in New Zealand primarily because:

- Plumage condition of fledglings is usually excellent as burrows are generally drier inside
- Risk of burrow-flooding is lower (burrows are not dug so deep into the ground as the current thinner-walled plastic-burrows need to be)
- Burrows are less vulnerable to over-heating, particularly at exposed sites
- In addition chamber access if often easier

Note: Wooden burrows are, however, usually more costly to make and transport to remote locations. They are less durable than plastic burrows and even treated timber burrows require replacement after 10 years (shady forested habitat).

Projects choosing plastic burrows should be aware of the following issues:

- The colour and thickness of the plastic will influence the burrow temperature and light levels within. Ideally, burrows that are exposed on the surface need to be a light colour on the outside to reflect heat, and a dark colour inside to keep light levels as low as possible for the birds
- Plastic burrows may be better insulated from heat, more stable in temperature and more light-proof if they are dug deeper into the ground, but this also increases their vulnerability to flooding
- Moisture tends to collect on the chamber walls and this can cause a chick's plumage to be continually damp (e.g. wing and tail feathers). Adequate ventilation must be considered

Tunnels should not be slippery for birds to walk within. Ridged PVC piping with drainage holes is preferred to provide grip and help reduce any build up of water or excreta in the pipes. Tunnels should ideally be dark in colour to keep the light levels low inside the burrow; they should be completely buried under ground and, therefore should not absorb much heat.

Floor-less tunnels can also be a good idea (wooden tunnel roof and walls only) in some situations. The advantage of these is that there is less likelihood of tunnels acting as a trap in later years if they become obstructed in any way as a bird still has a chance or digging under or around an object.

It can be beneficial to position the hole for the tunnel to the side of one of the chamber walls; this allows more space for adults to enter and exit burrows when they are feeding their chick.

8.2.4. Wooden artificial burrow dimensions

Comment [H17]: Need to decide if we put some measurement examples for a range of our NZ species (with body sizes). Could present 3 sizes (diving petrels, fluttering shearwaters, grey-faced petrels)

Chicks need to be able to sit comfortably within the chamber without wing and tail feathers bending up against the chamber wall. Burrows also need to accommodate a pair in future seasons, and up to three birds at the same time (pair plus growing chick).

Tunnels need to be long enough to maintain low light levels within the burrow, but kept to a length whereby chicks can be easily retrieved from the middle of the tunnel.

Comment [H18]: This is currently for certain species (small Pterodromas), but we could put in a table with species, body size, internal chamber dimensions , tunnel diameter etc.

The following **minimum** dimensions are preferred:

- Square flat-ground burrow design—**external** dimensions 350 mm (l) x 350 mm (w) x 250 mm (d) constructed of treated timber of 20 mm thickness. Internal height of chamber needs to be a minimum of 200 mm (refer to Figures 2a and 2b).
- Rectangular sloping-ground/cliff burrow design—**internal** dimensions 450 mm (l) x 250 mm (w) x 200 mm (d) constructed from 200 x 25 mm rough-sawn planks of treated timber. This rectangular design is longer than the square design but narrower. (Note that boxes wider than 250 mm may be trialled for Cook's petrels to improve burrow ventilation (refer to Figure 3).

Roof specifications:

- Square flat-ground burrow design—options used to date include:
  - Lids that form the entire chamber roof, i.e. square lids that extend over the box walls. Lids can be made of timber or thick plywood (>20 mm); they may warp slightly over time, but burrows can still be kept light-proof if there is an internal lid (usually thinner plywood set up to 50 mm below the top lid), or if the top lid features an overhang. Care must be taken to ensure inner lids do not swing into the chamber. (Refer to Figures 1 and 2a).
  - Solid lids have been incorporated into the boxes at construction, then a large round hole made in the roof. The circle of wood removed is then used to create an inspection lid or plug: another larger piece of wood is layered (fixed) on top of the round plug to prevent it from falling into the chamber, and to cover all gaps. These are suited to cooler climates where a double lid is not considered necessary. The timber would need to be quite thick if using this single-lid design in warm climates, to insulate birds from the heat. (Refer to Figure 2b).
- Rectangular sloping-ground/cliff burrow design—the lid is thick (50 mm) timber, with the back half fixed and buried into the slope. The front half is the inspection lid which can be raised, and has a watertight butyl rubber hinge. (Refer to Figures 1 and 3.)

Tunnels are made of 300–400 mm or 110 mm diameter ridged (for grip) PVC drainage pipe.

8.2.5. Artificial burrow temperature

Burrow temperatures tend to follow ambient temperatures fairly closely in non-insulated burrows, often only 1 or 2 degrees lower than ambient temperature, so every effort must be made to ensure chambers are insulated from the heat and are cool and humid when ambient temperatures are high.

A stable temperature within burrows is essential to prevent:

- Death of chicks through over-heating or chilling
- Effects on chick metabolism rates, i.e. chicks are spending more energy than usual trying to keep cool or warm
- Premature disappearance of chicks, i.e. chicks finding more comfortable places to 'hole-up' during the emergence period
- Chicks sitting in tunnels

When installing artificial burrows, it pays to consider the long-term management commitment to those burrows in terms of insulation.

For example, sand-bags are useful to place on top of artificial burrows to provide extra insulation for transferred chicks (particularly in warmer climates) and reduce temperature fluctuations between night and day; but they may then also have to be provided for burrows containing adults in subsequent years, leading to a long-term management commitment.

Note: Sand-bags (hessian or plastic sacks filled with beach sand) are only effective if large and well-filled, or if there are multiple bags. This can make them very heavy and unsafe (especially if sand gets very wet), and time-consuming to lift on and off burrows on a regular basis. In addition, they eventually perish and need to be replaced.

Points to consider regarding burrow temperature in the two different burrow designs presented above:

- Burrows in the forest tend to have more stable temperatures because they are shaded by the canopy. The flat-ground burrow design ideally needs to maintain stable, appropriate temperatures without using sand-bags if they are to accommodate breeding adults in future, because adults are unable to modify the 4-sided wooden nest box chambers (i.e. extend the burrow underground).
- Burrows on cliff slopes in areas of regenerating vegetation will be more vulnerable to over-heating. The sloping-ground/cliff burrow design has the advantage that adults can dig further underground in future years if a cooler chamber is required, negating a need for sand-bags after the chick translocation years.

8.2.6. Artificial burrow drainage

Good burrow drainage is essential to avoid:

- Death of chicks through chilling or even drowning. Chicks that have never emerged from the burrow before will not leave the burrow when it fills with water; they stay in the chamber and become wet-through. This has proven to be fatal if this happens during the night as chicks can chill and die before the next morning inspection.
- Poor plumage condition in developing chicks.
- Loss of eggs/chicks in flooded burrows during future breeding attempts by returning adults.

Artificial burrow drainage can be addressed by:

- Adding a thick layer (minimum 10–20 mm deep) of fine beach gravel or sand under the chamber floor and pipe during construction. When there is torrential rain, burrows will inevitably fill up with water, but a layer of free-draining material will 'buy time' for the occupant chick, i.e. the water should start to drain away before the rising level reaches the nest bowl.
- Carefully installing sloping-ground/cliff burrows using spirit-levels, to ensure that they tilt fractionally forwards so that water runs off lids and down the slope rather than back towards the chamber rear wall seam.
- Installing entrance pipes horizontally or sloping only fractionally, so that rain is not captured by the pipe and channelled down into the chamber. Note that:
  - Flat-ground burrows under forest canopy can have tunnels that slope down slightly into the burrow, as the canopy shields the direct impact of heavy rain and the soil tends to be more free-draining (be wary of this in clay soil situations).
  - Sloping ground/cliff burrows need to have tunnels that slope very slightly down away from the chamber, as these pipes can be more exposed to the direct entry of rain.
- Using a floor-less tunnel design in areas where there is much rain, as opposed to a pipe.

Note: Some soil types are exceptionally free-draining and so measures may not need to be as thorough.

8.3. Installing artificial burrows at the release site

Consider installing a few more burrows than are required for the number of chicks being transferred, for the following reasons:

- Any adults returning to the site during chick transfer years can be accommodated.
- Spare burrows can provide alternative housing for some chicks if their first designated burrow has issues (e.g. poor drainage, invertebrate infestation, etc.).

8.3.1. When should burrows be installed?

The recommended time to install burrows tends to be when soil is easier to dig in the wetter seasons. Allow a period of at least several months for the burrow site to settle, before housing any transferred chicks, so that:

- Soil and roots can mesh over the burrows to improve water-proofing.
- Burrows can be tested for flooding issues and temperature stability (using thermometers if necessary).

8.3.2. How are burrows positioned?

The position of burrows in relation to a predator-proof fence and prevailing winds must be carefully considered. Burrows should be at least 50 m from a fence as should the expected main take-off point (e.g. a ridge or hill or suitable take-off tree). If much closer than this, chicks could flip over the fence during practice take-off, landing outside the fence before they are ready to fledge and ending up stranded on the wrong side of the fence (refer to Section 11.5. Missing chicks).

Burrows need to be spaced with entrances preferably ≥1 m apart (no closer than 0.5 m apart for the small species), for the following reasons:

- It must be easy to see which entrance relates to which chamber (for burrow entrance fence records).
- Access to each chamber by people needs to be easy without causing noise or physical disturbance to an adjacent burrow.
- If burrow entrances are really close together, emerging chicks returning to the burrow at night may enter the wrong pipe. In addition, burrows with entrances that are very close to others are more commonly subject to interference (by neighbours) as they become occupied by adults in later years.

In general, burrows are positioned with the following in mind:

- In order to maximise the occupation of artificial burrows by adults, it is considered beneficial to position burrows with a variety of aspects so that not all burrows are facing the same direction.
- Avoid installing burrow in slopes that face most of the day's sun in areas of dark sandy soil which are particularly prone to absorbing the sun's heat.
- Avoid having entrances facing uphill—more prone to being blocked with debris and to water running into the chamber.
- Avoid having tunnels facing directly out into the full late morning/midday/ afternoon sun—more prone to over-heating.
- Avoid having entrances facing directly into open areas with exposure to strong prevailing winds/rain—more prone to chilling and/or flooding.
- Avoid installing burrows in places where they could be damaged or uprooted by unstable trees.

Fallen logs and branches can be added around entrances (particularly in forest habitat) as long as they are stable, to stimulate the natural tendency to dig under these more stable sites if birds show a tendency to find a natural site when they return as adults.

8.3.3. How should burrows be installed?

Detailed lists of equipment required for installing burrows at the release site can be found in Section 2.2 of the Companion Guide (Gummer et al. 2012a).

Detailed instructions on how to install artificial burrows at the release site can be found in Sections 4.2, 4.3 and 4.4 of the Companion Guide (Gummer et al. 2012a).

8.4. Pre-transfer preparations at the release site

8.4.1. Food preparation area

For smooth and hygienic operation of the food preparation area, the following pre-transfer preparations should be made:

- Checking that all required feeding equipment is present and that blenders are working
- Thoroughly disinfecting food preparation and washing-up area
- Washing, sterilising and rinsing all feeding equipment

8.4.2. Feeding station

A sheltered area must be provided as close to the burrow site as possible, where feeding equipment can be set up for each feeding day, and where chicks can be fed out of direct sunlight and protected from wind and rain. Ideally, this would be a 3-sided shelter or a shed; but fly-sheets can also be used.

In addition, facilities for effective, regular hand-washing will need to be set up, and storage for all relevant feeding and cleaning equipment that may need to stay at the burrow site, because it is difficult to transport there on a daily basis.

8.4.3. Preparing artificial burrows

Prepare burrows at the release site in the days leading up to a transfer as follows:

- Clean out tunnels and chambers of all burrows (pipes tend to fill with debris during the year), even if they are not going to be occupied by chicks. Look out for any sign that a burrow has been occupied by a prospecting seabird, e.g. digging at entrance or in chamber, new leaf litter in chamber. Leave known or suspected 'active' burrows as found and mark them so they are not used to accommodate transferred chicks.
- Line all artificial burrows with a thick layer of dry appropriate nest material (e.g. leaf litter, grass). Avoid collecting litter that looks mouldy as this may contain concentrations of naturally occurring fungal spores that can cause chick health issues (e.g. aspergillosis).

- Place **external blockades** (e.g. rocks, small logs or pieces of wood) at the entrances of all burrows planned to accommodate chicks. Blockades must not prevent ventilation—there should be a small gap for air flow without any risk of a bird's head getting stuck (refer below to Section 9.4.4. Internal and external blockades).
- Place **internal blockades** (as above, safe and not restricting ventilation) at the chamber end of ALL pipes that have entrances blockaded, ensuring that these do not take up space in the chamber itself, i.e. restrict chick movement in the box (refer below to Section 9.4.4. Internal and external blockades).
- Remove any plant threats such as thistles, brambles, vines or thorny vegetation that have invaded the burrow site (that chicks could get caught up in or injured on).
- Clear the burrow route and area around each burrow so that chicks can be retrieved from and returned to burrows safely and easily.

8.4.4. Internal and external blockades

Burrow entrance blockades are required for the purposes of allowing an acclimatisation period for each chick following transfer (refer to Section 11.2. Burrow acclimatisation period).

They are also required to prevent chicks from leaving burrows that are not ready to do so, i.e. that might perish in the event that they emerge and disappear (refer Section 10.4.2 Delayed blockade removal – lightweight/problem chicks)

Internal blockades are designed to prevent chicks wandering down their tunnels after transfer, allowing them to settle and build up scent in the chamber itself. **External blockades** need to be put in place at all burrows with internal blockades to prevent chicks that are emerging from other burrows entering dead-end pipes. External blockades also clearly indicate which burrows are blockaded.

Using both internal and external blockading is recommended **for all species where the chicks cannot turn inside the pipe** (tunnel) and may have difficulty reversing back up a dead-end pipe. This scenario has been known to lead to death through stress or physical trauma.

If chicks are allowed to enter dead-end pipes, the negative impacts are:

- Chicks that are unable to reverse back up the pipe into the chamber end up spending the night in blocked pipes and can be vulnerable to stress and potential chilling or overheating. Chicks can also suffer physical trauma if they are struggling inside pipes (e.g. raw wing injuries found on fluttering shearwaters).
- Chicks that can reverse back up a pipe may damage wing feathers in the process or even dislocate or break a wing.
- Heavy-weight chicks can be pressed against the blockade in downward sloping pipes and suffer injury or death (e.g. likely asphyxiation of fluttering shearwater chicks found this way).

8.4.5. Blockade materials

Two types of blockades can be used for both internal and external blockades:

- Mesh gates—although burrows are better ventilated, mesh gates do carry some risk if the design is wrong. The correct mesh size must be used to avoid bills or heads getting stuck, and chicks should not be able to push over a mesh gate and get stuck between the gate and pipe. Mesh should either be so fine that a chick's bill cannot be pushed through it at all, or, too small for a head to be pushed through and too large for a bill to get jammed).
- Solid gates (e.g. rocks or sections of heavy wood)—birds are less likely to push these, but care must be taken to ensure there are gaps for ventilation, but that these gaps do not present a hazard.

Choice of blockade materials is strongly influenced by pre-fledging behaviour of the translocated species:

- **Chicks with an emergence period**—these chicks have the opportunity to engage site-fixing mechanisms during nightly excursions from the burrow after blockades are removed. Observations on a range of New Zealand species show that emerging chicks tend to exit the burrow most commonly on their first excursion up the tunnel, i.e. they are more likely to come out of the burrow when they walk up the tunnel for the first time. However, some chicks will emerge on their second excursion up the tunnel, sitting at the entrance only on the first night up the tunnel. In this scenario, there is no requirement to allow chicks the opportunity to look out from the entrance whilst staying blocked into the burrow. Therefore, an **internal and external blockade of either material** can be used, and then removed before the anticipated first emergence date for that individual (refer Section 10.4 Blockade removal). A successful design in New Zealand is to incorporate a removable mesh gate at the chamber end of the pipe, and a solid gate for the external blockade.
- **Chicks that fledge on their first night outside the burrow**— looking out at the surroundings from the burrow entrance may be critical for these chicks as there is limited time once they depart the burrow for site-fixing processes. Chicks that show little or no emergence period in New Zealand tend to be the very small species (such as diving petrels, *Pelecanoides spp*.) which are likely to be able to exercise within the burrow itself, and are able to turn around within the pipe. In this scenario, a chick must be allowed to move up the tunnel and sit at the entrance to gain visual cues to the colony site, but must not be allowed to depart prematurely. Therefore, it is recommended to use an **internal blockade of either material** with an **external mesh gate**. Thus, when the internal blockade is removed a few days after transfer, the chicks can visit the entrance but cannot exit the burrow until the mesh gate is finally removed on a day as close to the expected fledging date as possible (refer Section 10.4 Blockade removal).

9. Hand-feeding chicks

9.1. Objectives of hand-feeding chicks

Chicks must be hand-fed at the release site so they can:

- Complete growth and plumage development
- Be sustained through an appropriate emergence period at the release site (if an emerging species)
- Fledge with appropriate reserves to see them through their first days at sea while they learn to forage for themselves

The key to achieving good chick fledging rates and post-fledging survival is to understand the optimum fledging condition for the species, aiming for the majority of birds to fledge:

- Within the known fledging weight range for the species. Seabird research shows that in general it is the heaviest chicks that fledge from a colony that will survive to return as adults, although this may be less critical for non-migratory species.
- With wings that are very close to completing growth, or have already stopped growing. This is a good indication that the rest of the body plumage is also fully developed with optimum physical protective qualities (water-proofing and insulation).

Hand-feeding of seabird chicks is a specialist area because:

- Food amounts and feeding frequency are adjusted for each individual chick to meet its needs—some species are not fed on a daily basis.
- An understanding of the growth patterns and weight gain and loss trends through the rearing period is essential, to be able to adapt a feeding regime to suit a species and individual.
- Different species require different types of fat reserves to get them through the post-fledging period when they disperse or migrate, and while they learn to forage. Hand feeding methods must ensure these fat reserves are appropriate to the species, or survival will be compromised.
- Feeding regimes cannot replicate natural conditions for several reasons:
    - Artificial diet composition is different to the natural diet. It lacks the petrel-produced stomach oil that is fed to chicks of some species, which is energy dense and a source of hydration.
    - Each meal is artificially delivered (force-fed) much faster than would be naturally delivered by parents.
    - Potential peak weights that chicks normally reach in the wild may not actually be reached if chicks are transferred before this time. (Rates of weight loss of lighter chicks then need to be slowed so that they still fledge in optimum condition.)
- A meticulous hygiene regime is paramount, especially when feeding large numbers of chicks on any one day.

9.2. Target fledging condition

The target fledging condition of hand-fed chicks at the release site can be based on one or more of the following:

- Fledging condition of naturally-reared chicks of the species, especially at the relevant source colony; this condition can change for a species with changing latitude. Note that chicks fed on the diet presented in this document have the capacity to fledge at heavier weights and with longer wings than naturally reared chicks as there is no desertion period and chicks are fed up until departure.
- Fledging condition of hand-fed chicks of the species in previous translocation projects, especially if they have returned as adults.
- Adult weight and wing-length—see below Section 10.2.1. Minimum and maximum weights; and Section 10.2.2. Minimum wing-lengths.

9.2.1. Minimum and maximum weights

Fledging weight should match or slightly exceed the most common adult weights, noting that:

- Migratory seabird chicks need to store dense layers of cavity fat prior to departure and tend to fledge at slightly heavier than average adult weights. (They may also show a high peak in weight prior to fledging.)
- It may be less critical for non-migratory seabird chicks to fledge at weights heavier than average adult weight because they can forage fairly locally after fledging. (They may not necessarily peak at such high weights prior to fledging.) It may be more beneficial for chicks to fledge in a lean and trim condition, especially if they are fledging in a season where conditions are frequently calm.

Although reserves are considered an advantage in fledglings, if chicks are too heavy then their flight ability is compromised, especially since they have not got the well-developed flight-muscle mass that adults have. Fledglings that feed in pelagic waters need to be able to move off-shore as quickly as possible, where they can feed and are less vulnerable to attacks by coastal predators, e.g. large gulls. Ensuring such chicks are not too heavy when they depart the colony means that they are less likely to become grounded on the shore or stranded on near-shore waters immediately after departing the colony site.

Projects that avoid matching some of the lower known adult weights can maximise the chances of post-fledging survival of ALL chicks.

9.2.2. Minimum wing-lengths

Wing-lengths should reach the known adult wing-length range; chicks that leave a site with wings shorter than the shortest adult wing may be compromised at or after fledging.

Wing growth tends to slow once chicks have completed the bulk of wing growth, and for chicks of some naturally reared petrels this is highly synchronised with the weight loss, i.e. the wing growth reduces in line with weight loss so that chicks meet optimum fledging weight and wing-length simultaneously. This is the optimum scenario for translocated chicks, i.e. chick departing after wing growth has slowed or

stopped, coinciding with reaching (dropping to) the most suitable fledging weight for the individual.

9.2.3. Emergence period

To improve the chance of chicks returning to the release site, the target mean emergence period should closely resemble the mean emergence period for non-translocated chicks. This period will reflect the amount of time chicks of different species require to exercise and prepare body condition for flight.

Previous transfers of a species may also reveal that there is an improved rate of chicks returning as adults if they stay a minimum time at the release site.

Table 6: Example target fledging size, pre-fledging emergence period (number of nights on the surface) and hand-rearing period (total time at release site) for a selection of New Zealand *Pterodroma* species

Species	Targets for translocated chicks			
	Mean fledging weight (and range) on day before night of fledge	**Mean fledging wing-length (and range) on day before night of fledge**	**Mean emergence period (and range)—including fledging night**	**Range of days spent at release site—including transfer day**
Chatham petrel	≥225 g (190–260 g)*	c.225 mm (215–238 mm)	9 to 12 nights (site dependent) (3–23 nights)	10–30 days (most gone before 26 days)
Cook's petrel	≥225 g (190–260 g)	c.235 mm (225–255 mm)	4 nights (2–11+ nights)	10–30 days [4]
Pycroft's petrel	≥175 g (150–200 g)	c.217 mm (206–232 mm)	7 or 8 nights (3–13+ nights)	10–30 days

9.3. Artificial diet

The artificial diet currently used in New Zealand to feed translocated petrels and shearwaters has been established following many years of trials initiated by Graeme Taylor in 1995. Trials have involved wild-origin grey-faced petrel chicks hand-reared in captivity and translocated back to the wild, as well as chicks of a range of species in wild-to-wild translocations.

The artificial diet is designed to feed chicks for the last third of the rearing phase prior to fledging. This is when a chick has completed skeletal growth and is in the phase of plumage development and building up fledging reserves. Chicks of some species have also successfully fledged when fed for almost 50% of the rearing period; however there may be unknown resulting impacts on long-term survival.

The following ingredients are blended together to a smooth puree:

Comment [H19]: Further background material can be provided if international readers need to know how we got to this diet?

Comment [H20]: A veterinary Masters student is also mid way through a study on our current diet and comparisons with wild diet. She is also looking at using a fish oil instead of soy oil , and trials so far indicated is it working, but there are issues with storage. Basically, still not ready to publish these studies and results, but trials are continuing. It would be good to at least write about the trials briefly, so that others know we are still trying to improve the diet.

- 1 (106 g) tin Brunswick™ sardines in soya oil (include oil contents)—tin contents (in 2013) are: sardines (89%), soya oil (10%), salt (<1%)
- Mazuri® Vita-zu seabird vitamin/mineral supplement (dose as advised)
- 50 ml cold water (previously boiled > 3 mins—this is because many water sources used are not sterile, e.g. collected rain water in remote locations)

Note: A quantity of 150 tins should be more than sufficient to feed 100 small gadfly petrel chicks for up to 1 month at the release site, as chicks of these species are not fed on a daily basis. Contrastingly, approximately 1000 tins would be required to feed 100 chicks of a small daily-fed shearwater species for up to 1 month.

9.4. Hand-feeding equipment

Food is delivered directly to the crop using a crop-tube attached to a syringe. Two main systems have been used in New Zealand:

- Bovivet™ Plexiglass syringes (up to 50 ml) with custom-made clear Teflon crop-tubes (c.6 mm outside diameter/3 mm inside diameter) cut to length to suit each species. The Luer-lock system can be removed from the syringe and a custom-made, low-friction tube (with blunted end) screwed directly into the syringe barrel. The wider diameter exit hole helps to reduce blockages and negates the need to sieve food. This set-up allows for an effective hygiene regime to be used in between birds (refer to Section 8 of the Companion Guide [Gummer et al. 2012a] for New Zealand chick feeding protocols).
- Disposable catheter-tipped syringes (up to 50 ml) with catheter tubing. The tubing is pushed over the end of the syringe, so there is a higher chance of blockages if the syringe exit is narrow. Food needs to be blended extremely well. Sieving of food is not ideal as this may remove some components that complete the diet. Soft round-ended catheter tubing is a little harder to effectively clean in between birds so separate tubes may be needed for each bird. Plastic tubing from hardware stores is not friction-free and needs lubricating (e.g. with sterile water) before introducing to the chick's oesophagus.

9.5. Planning meal size and feeding frequency

9.5.1. Importance of planning meal size

As a starting point, it is useful to know the range of meal sizes received by parent-fed chicks in the wild. However, hand-feeding should not aim to replicate natural conditions because the diet and feeding method is very different.

Identifying the **minimum** meal size for each chick ensures appropriate weight gain, maintenance or loss (depending on stage of chick development) so that chicks can fledge in optimum condition. Some examples of the minimum volume of artificial food fed to different species: 5 ml to ?????; etc..

Comment [H21]: Not sure whether we need to give an idea/examples of minimum meal volumes for a range of different sized species.
Once again, it could be a really good starting point for those completely unfamiliar with the NZ diet, if they don't have access to data from the wild.

Identifying **maximum** meal size for each chick before feeding reduces:

- Risk of triggering the regurgitation response by over-feeding, which can have fatal consequences (refer to Section 12.7.1. Regurgitation, for essential information)

- Risks associated with slow digestion of meals and gut blockage, which can have fatal consequences (refer to Section 10.5.3. Over-feeding, for essential information)

Maximum artificial meal sizes in general will be less than those recorded for parent-fed chicks because of the difference in diet and feeding method. Some examples of the maximum volume of artificial food fed to different species in one hand-feeding event: 35 ml to ????; etc.

9.5.2. Importance of planning feeding frequency

Comment [H22]: This section is currently geared to small gadfly petrels but needs condensing and restructure. It is not relevant to daily feeders.

Gadfly petrel chicks are not fed nightly by parents, but at irregular intervals. For example, Cook's petrel chicks are fed on average once every 3 nights by a parent, with an average feed weighing just over 37 g (Imber et al. 2003). Pycroft's petrels have been recorded as receiving average parent meal sizes of 34 g (Gangloff & Wilson 2004). Moreover, feeding frequency is known to decline as fledging approaches, and in the wild parental abandonment of 3–10 days (where parents make no further visits to the burrow and depart on migration) prior to fledging occurs in Chatham, Cook's and Pycroft's petrel.

Gadfly petrel chicks fed an **artificial diet** generally require more regular and slightly smaller meals than parent-fed chicks on a natural diet for the following reasons:

- Chicks are not able to take large volumes of food (>35 g) in a short delivery time (few minutes) without the risk of regurgitation. Natural parental meal delivery time would be over a minimum period of half-an-hour, but more commonly over 1 or more hours during the night.
- Artificial diet is not as rich as the natural, oily diet delivered by parents.
- Artificial diet (particularly blended form) is likely to be processed by chicks at a faster rate.
- Translocated chicks metabolism of valuable reserves may have increased during the stress of transfer.
- Hand-fed chicks are presumed to experience an increased metabolism rate caused by the stress of regular handling and potentially from loss of stable-temperature air from burrow during inspection. (Naturally reared chicks normally tend to go into a state of slowed-down metabolism during the daytime, and can enter an almost torpor-like state during long intervals in between parental meals.)
- Survival chances following departure are maximised by giving energy boosts prior to fledging even though this may not replicate the normal abandonment period by parents.
- Site fidelity to the new colony site may be maximised by allowing chicks to experience an average or longer emergence period prior to fledging, i.e. heavier chicks take longer to reach an appropriate fledge weight. This also affords chicks plenty of time to find suitable take-off points.

Identifying a suitable feeding frequency for each chick ensures appropriate weight gain, maintenance or loss (depending on stage of chick development), and aims for

every chick to fledge in the best possible condition. Feeding all chicks the same amount/frequency might result in most chicks surviving to fledge, but not necessarily at optimum weights, and may mean that some chicks are under or over-fed (refer to Section 10.5.3. Over-feeding).

For the small gadfly petrels, chicks will be fed 1–15 meals during their stay at the release site, depending on their age and weight on arrival. Chicks rarely get fed on two days in succession unless some in very poor condition have been accidentally transferred. Feeding frequencies vary as follows:

- Every second day—youngest chicks that are light in weight.
- Every third day—the most common feeding pattern.
- Once every 4–6 days—this regime suits a few heavy chicks.
- Once every 7–10 days—there are usually only a few very heavy-weight chicks that do not require feeding at all because they were getting on for double the fledging weight at transfer. However, it is recommended to try and give the occasional very small meal to provide immediately available energy/fluids if required. Many chicks will even reject this in which case no hand-feeding is required at all. One meal is the minimum number any chick would receive at the release site (i.e. a chick tried on this regime but rejecting food).

9.5.3. Over-feeding

Feeding a chick a volume of food that is more than its digestion/metabolism can process at a normal rate can have the following serious consequences:

- Food accumulates in the gut (gut stasis) and if it sits in the proventriculus/ventriculus for too long it can allow the growth of bacteria/fungi causing an infection (usually fatal)—refer to Section 12.7.2. Ventriculitis/proventriculitis.
- The digestive system slows down further and is unable to process any further meals.
- Birds may regurgitate and choke on the excess food—refer to Section 12.7.3. Aspiration of food.

Often, chicks that are over-fed show no symptoms of ill-health until it is too late, e.g. 1 or 2 days before death. Symptoms include:

- Immediate regurgitation of all or part of the meal following feeding or in the burrow.
- Chicks tend to be fairly light in weight.
- Dead chicks can be found inside or outside burrows, often with heads lying in a pool of regurgitation.

Note: Some chicks that display the above symptoms are later found to have regurgitated squid beaks in the burrow. These appear to prevent or slow down digestion (possibly blocking part of the digestive tract) and once regurgitated, chicks often feed normally.

Comment [H23]: These next sections in blue are very detailed info for small gadflys only. Will require further work to strip it right back and incorporate general feeding regimes for all the other groups we have established too.

9.5.4. First (introductory) meals

Chatham, Cook's and Pycroft's petrel chicks should be fed a relatively small introductory meal of 15 ml for the following reasons:

- Chicks fed large volumes in their first hand-feeding event may regurgitate, including the very valuable previous parental meal.
- Chicks need to adapt to the new diet and feeding technique; the digestive system will be able to more effectively process the new food if there is less of it to begin with.

For this volume, the mixture does not need to be more dilute than the normal recipe (1 x 106 g tin sardines: 50 ml water) for these species because dehydration seems to be less of an issue: chicks have slow metabolism and larger fat reserves, and an ability to convert fat to water if required. Note that some very heavy chicks, and/or some more advanced chicks in the longer transfer wing categories, may take less than 15 ml of the introductory meal because they need to lose weight.

Ideally, you will know which chicks are likely to have received a parental meal the night before transfer, if there was time at the source colony to erect the stick fences at burrows (refer to Section 8.4. Preparations on day before transfer). The chicks can be divided into two main groups:

- Chicks that **DID NOT** receive a parental meal on the night preceding transfer. Some of these chicks may not have received parental food for many nights. They will be fed sooner so they do not fall too far behind in weight.
- Chicks that **DID** receive a parental meal on the night preceding transfer. These chicks must be allowed to process at least some of their rich, oily parental meals before the introduction of more food. These chicks will be fed a little later when there is a lower risk of regurgitation.

In practice:

- Compile a list of all chicks that may require feeding on Feed Day 1 (from the natal burrow fence status data recorded on transfer boxes).

  Note: Any heavy chicks in this list will be eliminated from this list the following day (see next point) and rescheduled for feeding for an appropriate later date.
- Weigh and measure all chicks at their burrows on the morning after transfer (before feeds commence), and subdivide the two groups described above into 'light, medium and heavy' chicks.
- Refer to Table 7 below to determine which chicks need to be fed on which days.

Table 7: Guide to feeding frequency and meal size for the first 9 days of hand-feeding of Chatham and Cook's petrel chicks.

Notes: 1 ml of food weighs approximately 1 g.

A Pycroft's petrel guide is yet to be trialled/confirmed.

	Chicks NOT FED by parents during night before transfer			**Chicks FED by parents during night before transfer**		
	LIGHT	**MEDIUM**	**HEAVY**	**LIGHT**	**MEDIUM**	**HEAVY**

CHATHAM PETREL	<320 g Any wing length	320–340 g Any wing length	>340 g Any wing length	<320 g Wing <215 mm	320–340 g Any wing length <320 g Wing >215 mm	>340 g Any wing length
COOK'S PETREL	<320 g Any wing length	320–340 g Any wing length	>340 g Any wing length	<320 g Wing <225 mm	320–340 g Any wing length <320 g Wing >225 mm	>340 g Any wing length
Day 1	Feed 15 ml	No feed	No feed	No feed	No feed	No feed
Day 2	No feed	Feed 15 ml	No feed	Feed 15 ml	No feed	No feed
Day 3	Feed 20 ml	No feed	Feed 15 ml	No feed	Feed 15 ml	No feed
Day 4	No feed	Feed 20 ml	No feed	Feed 20 ml	No feed	Feed ≤15 ml with caution
Day 5	*Feed ≤30 ml	No feed	No feed	No feed	Feed 20 ml	No feed
Day 6	No feed	No feed	Feed 20 ml	*Feed ≤30 ml	No feed	No feed
Day 7	*Feed ≤30 ml	*Feed ≤30 ml	No feed	No feed	No feed	No feed
Day 8	No feed	No feed	No feed	*Feed ≤30 ml	*Feed ≤30 ml	*Feed ≤20 ml with caution
Day 9	*Feed ≤30 ml	No feed	*Feed ≤30 ml	No feed	No feed	No feed
	Etc.	Etc.	Etc.	Etc.	Etc.	Etc.

* At any stage, volumes may need to start decreasing as the chick gets closer to fledging. This will be gauged primarily by response by chick to feeding.

9.5.5. Second meals

A volume of 20 ml is appropriate to deliver to each chick at its second meal to prevent chicks being loaded up too much with the new diet so early on.

Avoid using chick response to feeding at this stage to influence future meal sizes as any food rejection can be attributed to feeding technique during the first couple of feeding events (unless chicks are very heavy in which case they may just be too full). Most chicks readily take the 15 ml introductory feed and the 20 ml second meal (unless they are heavy).

9.5.6. Planning all subsequent meals

For all subsequent meals, meal sizes can be divided into four categories to aid with planning the appropriate quantity of food to each chick at each feed:

- Big meal = 20–30 ml of food
- Medium meal = 10–20 ml of food
- Small meal = up to 10 ml of food
- Energy meal = small meal (5 ml) given to chick requiring energy boost rather than food for growth and development

Meal size and feeding frequency in relation to all subsequent meals for each chick can be planned using the following:

- For Chatham and Cook's petrels—the Table 7 Guide to feeding frequency and meal size (above). Regimes range from small meals fed infrequently (for heavy chicks), through to large meals fed regularly (young, lightweight chicks). The pattern (feeding frequency) should stay the same as the chick advances in development; although meal sizes are slowly reduced (refer to Section 10.5.7. Reducing meal sizes).
  - For Chatham petrel chicks: Table 7 should be used in conjunction with the detailed feeding guide within the Chatham petrel chick translocation guidelines (Gummer 2011a). The detailed feeding guide was specifically developed so that feeders can cross-reference current pre-feed (base) chick weight with wing-length shortly after transfer, to identify an approximate feeding regime that is likely to suit the individual. The guide needs to be referred to several times over the subsequent weeks in order to identify when to change the plan, e.g. reduce food volumes.
- For Pycroft's petrels—both Table 7 and the Chatham petrel feeding guide will be adapted to suit Pycroft's petrels, and will be trialled in 2013 to determine which is the simplest to follow.
- Feeders must also make decisions on subsequent meal sizes and feeding frequency based on:
  - Volume of last meal successfully delivered (recorded on field data sheets)
  - Ease of delivery of last meal (notes written on field data sheets regarding chick behaviour during feeding and incidences of regurgitation, overflow, etc.)
- A feeding calendar can be filled in with estimated meal volumes on appropriate days for each chick (refer to example in Section 10.4 of the Companion Guide [Gummer et al. 2012a]). The calendar helps to:
  - Identify the work load for the next feeding day.
  - Establish the total volume of food that needs to be made (number of tins of sardines).
  - Identify (towards the end of the project) any potential 'non-feed' days where chicks are monitored only, but none are fed, easing the work load (refer to

Section 10.5.9. 'Non-feed days'). These may be days when only a few chicks are scheduled to be fed, and the feeding of such chicks can be brought forward a day, or delayed a day, without compromising individual chick welfare, so that a 'non-feed' day can be planned.

Note: Once a chick is put on a feeding regime, it is rare to change the frequency of feeding for that individual, i.e. a chick fed on every second day tends to stay on that regime until fledging (or very close to fledging), likewise for a chick fed on every third day etc.

9.5.7. Monitoring chick condition in relation to feeding regime

It is critical that every burrow is carefully and consistently inspected for signs of regurgitation on a daily basis, especially in the first week after transfer, while chicks adjust to a new diet and feeding regime, and to ensure chicks are passing waste matter (faeces/urates). During the first few days, it is useful to have a 'trained eye' to be involved in extracting chicks from chambers in order to check for the above and pick up on anything abnormal. Refer to Section 12.7.1. Regurgitation.

It is also good practice to check all chicks first thing each morning for well-being, before commencing any hand-feeding.

9.5.8. Reducing meal sizes

Observing a chick's response to feeding will help identify the exact point at which meal size should decrease. Responses can include the following:

- Food overflows out of the mouth—this is not meal rejection, but a sign that there is no more room in the crop for food. Note that sometimes this can be a reaction to technique, but it is probably a sign of fullness if it still occurs on a second feeding attempt.
- Chick regurgitates—in the event that chicks do regurgitate the artificial meal, they tend to reject just the portion of the meal they no longer require and rarely the whole amount delivered.
- Chick gapes and gags—it is hard to describe this response, but a chick no longer interested in food can sometimes be very difficult with agitated movement, and a reluctance to have the crop tube introduced into the throat. The response is also sometimes known as 'flaring' (the bill is open and the corners of the mouth and throat are stretched wide).
- Tight food pipe—as chicks reduce their intake, it is sometimes possible to feel a certain resistance in the throat, and a tightness around the crop tube as it is introduced.

Once meal size is reduced for a chick, it rarely increases again. Every subsequent meal will most likely be slightly less, or sometimes the same. As a rough guide, it works well to decrease a chick's meal size by the same small volume each day, although that is not standard for every chick.

Chicks need to be fed accordingly to maintain a gradual weight loss (around 5–10 g per 24 hr period for a small gadfly petrel chick) as they approach fledging. The

Comment [H24]: Can add other examples if needed – again these could be helpful as a starting point for others

amount of weight loss per day tends to decrease as chicks get closer to fledging, so allow a chick a gradual decline in weight in the final week leading up to fledging so the chick can depart under its own steam in optimum condition for its size.

Note: If continued hand-feeding slightly delays a chick's departure, then that is not considered a problem because the chick will be continuing to site-fix during the slightly extended emergence period. If hand-feeding is stopped prematurely and a chick loses weight at a faster rate close to fledging, then it may fledge prematurely and/or fledge at a lighter than desirable weight, i.e. it may not be quite ready to depart for other reasons (e.g. not emerged for long enough, or plumage not quite fully developed).

9.5.9. 'Non-feed' days

Comment [H25]: This is relevant to chicks that are not fed daily.

All chicks must still be checked for well-being on days when they are not fed, but not handled unless necessary.

'Non-feed' days (days where no chicks are fed) can usually be scheduled at some stage in the third or fourth feeding week. The timing is totally dependent on the age and condition of chicks at transfer: if the average chick weight at transfer is high, then 'non-feed' days may occur as soon as the end of the second week of feeding, but if the average transfer weight is low and chicks are younger, then such days may not occur until the fourth week of feeding.

9.6. Chick food preparation

Detailed equipment and protocols for daily chick food preparation should include methods for:

- Preparing syringes/crop-tubes
- Making food
- Preparing sterilising solution for crop-tubes
- Cleaning and sterilising food preparation equipment
- Preparing the items to take each day to the colony site

Note: Food pottles should contain meals for no more than 10 chicks, i.e. for as many chicks as can be fed in 1 hour. For example, for the small gadfly petrels receiving meals of up to 30 ml, pottles should hold around 1.5 tins worth of mixture (e.g. 250 ml pottles). This is because the food is warmed up in batches at the burrow site and should be used within the hour to avoid contamination issues—warm fish mix is particularly prone to contamination. Small food pottles can be effectively warmed up in a food thermos flask containing hot water, and large pottles in a flask used to make yoghurt.

9.7. Chick feeding, measuring and monitoring

9.7.1. Team size and structure

Comment [H26]: These sections would need re-working to suit teams feeding daily feeders.

Refer to Section 13.2 for Labour requirements at source and release sites.

For a 3–4 person team, the more efficient method of operation is to have one feeder stationed under shelter (concentrating on feeding, food temperature, and hygiene), and two or three handlers each collecting their designated chick, holding it for feeding, and returning the same chick to the burrow before collecting their next designated chick.

9.7.2. Preparing notebooks/data-sheets

The main drawback of a regime involving feeding different chicks on different days is that there is room for errors such as chicks being missed off a daily feeding list. Therefore it is critical with this regime to plan ahead and communicate clearly. On the day before each feeding day:

- Clearly indicate on the chick data sheets the processing that is to occur for each chick, on their respective page of records. Feeders should be able to turn to the records of a chick (in the folder at the feeding station), and see if a chick requires a meal and what the meal size is.
- Write out a separate list (in a water-proof notebook) of all chicks that are to be fed on the following day as a quick reference to which chicks need to be collected and brought to the feeding shed. Double check this list against the chick data sheets and the Feeding Calendar (if used). This list can be used by the handlers to check against when collecting the birds for feeding.

9.7.3. Processing chicks on a chick-feeding day

Detailed protocols for chick feeding, measuring and monitoring should include methods for:

- Setting up feeding equipment at the feeding station
- Checking all chicks before feeding commences (chick roll-call)
- Collecting chicks from burrows
- Weighing and measuring chicks

  Note: Chicks are weighed on every feeding day, and daily when the chick is expected to depart (to obtain fledging data) until the chick has fledged.

Comment [H27]: Needs revising to suit daily feeders

- Hand-feeding chicks
- Returning chicks to burrows
- Food hygiene and temperature control
- Clean-up after feeding

Note: It is critical that birds are handled at all times in such a way that minimises damage to flight feathers. A chick that has damaged or lost wing or tail feathers will be compromised at fledging time (refer to Section 11.6. Assisting chicks to fledge).

The following tasks are best undertaken at the end of each chick-feeding day, once chicks are well-settled back in their burrows, before personnel depart the colony site:

- Removing blockades (internal and external) from relevant burrows to allow chick emergence

  Note: A large proportion of blockades will have been removed on day 3, but entrances of particularly young and/or lightweight birds may need to remain blockaded for some time to prevent premature disappearance, and be removed on a case-by-case basis (Refer to Section 11.3. Blockade removal).

- Restoring stick fences at burrow entrances and final burrow security checks

Comment [H28]: Needs revising to suit also non-emerging species

On return from the colony site at the end of a feeding day, data is transcribed onto computer spreadsheets in case field records are damaged. Notebooks and/or data sheets are prepared for the following feeding day (refer to Section 14.3. Chick feeding and measurement records).

9.8. Cleaning equipment after feeding chicks

Detailed protocols for cleaning up at the end of chick-feeding days should include methods for:

- Washing-up and sterilising feeding equipment
- Washing weigh bags and towels
- Boiling water (>3 minutes) for chick food and for use during feeding (for rinsing disinfected crop tubes)

10. Managing emerging and non-emerging chicks

10.1. Emergence behaviour

Many burrow-nesting seabird species have an emergence period prior to fledging; this is when they leave their burrows each night to explore on the surface. In general, chicks tend to stay in the near vicinity of their burrow entrance on their first excursion, stretching wings and walking for the first time. In the following nights they will venture further afield; emerging chicks have been found over 50 m from their burrow during the night. Close to fledging time, chicks can be away from their burrow for much of the night, or may not return to their burrow and spend the day in another location.

Emergence behaviour is considered to have the following benefits for these species:

- Chicks can stretch and exercise outside the burrow. This is thought to be particularly important for chicks of the migratory species that have a long distance flight ahead of them once they have departed the colony. Chicks of these species are rarely observed in inshore waters after fledging, indicating that they head immediately out to the open sea. (Note, however, that fledglings are sometimes found on land through light attraction, e.g. street lights, etc.)
- Chicks can familiarise themselves with the environment and surroundings, an important process for site-fixing (locality imprinting).
- Chicks can explore options for take-off and landing. Tree-climbing species tend to practice climbing trees during the emergence period. In New Zealand,

Chatham petrel fledglings have been observed climbing up near-vertical trees to a tall canopy, then flapping in the breeze, and then dropping down again to the forest floor before returning to their burrows again.

- Emerging on the surface in wet weather may play an important part in stimulating chicks to preen and in optimise plumage conditioning (water-proofing) before embarking on their maiden flight. The down may also be easier to preen off when it is wet. Chicks of many species are commonly observed emerging early on rainy nights, and in large numbers; rain appears to stimulate many chicks to emerge from burrows for the first time (refer to Section 11.5. Missing chicks). The fact that chicks tend to exit burrows during rainfall may also be attributed to predator avoidance—rainy nights tend to be dark and this would reduce the risk of chicks being seen on the surface by aerial predators, particularly when they are preening and wing-flapping. In addition, chicks may be thirsty and this may even be a driver for parent-reared then abandoned chicks to eventually depart to sea.

The total number of nights that chicks emerge before fledging varies between species and individuals and sites. There appears to be strong correlation between the average length of the emergence period at a particular colony site and the ease at which birds of the same species can take off from the site.

Two examples that show this correlation for New Zealand gadfly petrels are:

- Translocated Chatham petrels spent on average 3 nights longer exploring on the surface at the Pitt Island (Rangiauria) colony site than the same number of transferred chicks spent at the Chatham Island (Rekohu) site. This reflects the fact that the Pitt Island (Rangiauria) site was closer to sea level and all birds had to take off by climbing tall trees, whereas chicks at the Chatham Island (Rekohu) site could lift off more easily from lower vegetation at a more exposed and elevated site.
- Translocated grey-faced petrels spent on average 3 nights longer exploring on the surface at the Matakohe-Limestone Island colony site than those transferred to the exposed and elevated Cape Sanctuary mainland site in later years. The Matakohe-Limestone Island burrow site was much closer to sea level and in areas of regenerating forest and it is thought that birds would have taken longer to find exposed areas for take-off, and/or had to lose more weight for effective take-off from the site, especially during periods of exceptionally calm weather.

10.2. Chicks with no emergence period

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Comment [H29]: Need to add some info on the species that don't emerge and why we think they don't – usually small species, non-migratory etc. Examples are diving petrels and fairy prions – both have been translocated in NZ, but there are no best practice guidelines as yet.

10.3. Burrow acclimatisation period

Following transfer of any species, a strategy is employed at the release site to encourage burrow affinity to the new artificial burrow, and to prevent chicks wandering away from the site. Chicks are blocked into their artificial burrows for an acclimatisation period of **at least 2 nights** after the transfer, using an internal (chamber end of pipe) and external (burrow entrance) blockade (refer to Section

9.4.3. Preparing artificial burrows). During this time, chicks will settle, adjust to the new temperature and humidity, and build up their own scent (e.g. deposited down) in the chamber.

10.4. Blockade removal

As a general rule, burrow blockades are not removed, i.e. chicks are not allowed to exit burrows, before any chicks have reached the minimum known wing-length for the species at first emergence (emerging species), or at fledging (species that fledge on the first night outside the burrow).

There are two main strategies employed for removing blockades from burrows housing translocated chicks. Strategies are developed on the basis that there is no daily access to a trained species detection dog and handler that can find any chicks that potentially go missing (as described in Section 11.5.3. Searching for missing chicks).

- Species that **are hand-fed every 2–3 days or even less often**—interestingly, these tend to be the species that have the strongest affinity to their own burrow (in New Zealand), i.e. chicks are highly likely to return to their own burrow after a night exploring on the surface (e.g. the gadfly petrels). In general, blockades can be removed from all burrows on a fixed date after the acclimatisation period, **providing** chicks exceed a specified body weight (refer below to Section 11.4.1. Blockade removal—less frequent feeders). However, light-weight and problem chicks need to have blockades removed on a case-by-case basis using species-specific criteria (refer below to Section 11.4.2. Delayed blockade removal—light-weight/problem chicks).
- Species that are **hand-fed daily**—these can be divided into two groups, but the approach to both is the same. In order to prevent chicks permanently disappearing before they are ready to fledge and to enable chicks to be hand-fed for as long as possible up to the time of fledging so they can depart in optimum condition, blockades are removed on an individual basis using criteria designed specifically for the species (refer below to Section 11.4.3. Blockade removal—daily feeders).
    - Emerging species prone to wandering away from burrows, i.e. chicks have a relatively higher rate of not returning to their burrow after a night exploring on the surface than the gadfly petrels (e.g. fluttering shearwaters in New Zealand). This is the most complicated group to schedule blockade removal for, so that the emergence period is not compromised.
    - Non-emerging species that largely fledge on the first night outside the burrow—in New Zealand, the two transferred species known to fledge on the first night of emergence have both been daily feeders, so scheduling blockade removal is simpler.

For all emerging species, it is critical that all internal blockades are methodically removed at **exactly the same time** as the external blockades so they do not get forgotten (refer to Section 9.4.3. Preparing artificial burrows). It is good practice to

feel up the entire length of a pipe at this time, to ensure there are no obstructions preventing a chick from exiting its burrow.

At the time of blockade removal at each burrow, stick fences are erected at the burrow entrance to monitor emergence behaviour.

10.4.1. Blockade removal – less frequent feeders

A good proportion of translocated chicks may have reached the minimum known wing-length for the species at first emergence following the minimum acclimatisation period (e.g. 2–3 nights for gadfly petrel chicks), so most burrow entrance blockades (internal and external) can be removed 2–3 days after the transfer day depending on the species (i.e. no burrow blockades for the third or fourth night onwards).

Blockades can generally be removed from the rest of the burrows as chicks' wings reach the minimum known length for the species at first emergence.

Note: Transfer criteria should avoid moving very advanced chicks, but occasionally blockades may need to be removed after 1 night (to avoid stress). Signs to look for are digging inside the burrow, or abnormally high weight loss compared to other chicks, that could indicate high levels of activity inside the burrow. Such chicks ay have little or no down cover left and their wing-lengths are likely to exceed the minimum known fledging wing-length for the species.

10.4.2. Delayed blockade removal – lightweight/problem chicks

There is an obligation to delay blockade removal at any burrows containing chicks that would be severely or fatally compromised if they permanently disappeared well before predicted fledging time (refer to Section 11.5. Missing chicks).

For any **lightweight and/or young** chicks, or **chicks requiring medical treatment**, blockade removal can be delayed until a later date, to avoid premature disappearance of these chicks that are completely reliant on regular hand-feeding for successful fledging.

A set of species-specific weight and down-cover criteria is developed to determine when a chick must have its blockade removal delayed and when it can be eventually allowed out, without having its emergence period compromised too greatly. There may be a risk of stressing the chick if it wants to emerge earlier, but this has to be balanced against the risk of a light chick permanently disappearing and not being able to receive more meals before fledging.

Occasionally, the emergence period of a chick has to be compromised when a chick with health issues requires essential drug treatment (such that if the bird departed without receiving the full course of treatment it would be likely to perish), or where further advice from a vet is required. In some cases, a blockade gate may even need to be reinstalled after it has been removed, to allow a chick to receive treatment or a period of rest.

10.4.3. Blockade removal—daily feeders

YET TO DO....(HAVE ALL THE INFO FROM FLUTTERERING SHEARWATERS AND DIVING PETRELS).

Comment [H30]: We can add details on how to manage chicks of species like diving petrels and fairy prions. Removing internal gate first, then external mesh gate just before fledging

10.5. Monitoring chick emergence and fledging

Chick emergence behaviour and final departure from the burrow is monitored by recording the status of the stick fence at the burrow entrance on a daily basis.

10.5.1. Deviations from normal emergence patterns

Once a chick has begun to emerge from its burrow, it will normally emerge on every subsequent night until departure. However, there are occasions when one or more chicks at the release site do not emerge on a particular night which can be attributed to any of the following reasons:

- The chick has received a very large meal, and as a result may feel too full to move outside the burrow at night. For example, a chick of a species that is not fed daily may emerge for the first time on a night following a non-feed day, but then may not emerge on the next night if it receives a large meal on that day. This can be one of the indications that meal size needs to be reduced for that individual.
- There is a full or near-full moon with no cloud cover; chicks are more vulnerable to predation if the burrow site is lit up by bright moonlight and have an instinct to avoid those conditions.
- The night is wind-still; some chicks would waste energy exploring on the surface on such a night if there is no wind to give any lift when exercising or practicing take-off.

Note: Where a chick does not emerge for 1 or more nights between its first emergence and departure, the non-emergence nights should not be counted in the emergence period for that chick.

10.5.2. Assessing fledging success

Fledging date can only be recorded for a chick if it fits ALL the parameters required for a successful fledging. This will involve looking at the most recent weight, wing measurement and emergence data. Fledging parameters include:

- Wing-length falls within the known fledging wing-length range for the species
- Wing growth rate will have started to decrease from approximately, or will have ceased.
- Weight falls within the known fledging weight range for the species
- The chick has emerged from its burrow for a number of nights that falls within (or exceeds) the known range for the species
- The chick has little or no down cover—for most species, loss of down is likely to signal the completion of plumage development. Chicks with down estimated to cover >10% of the body area are often still developing e.g. wing primary feathers

still growing. The majority of chicks of the species transferred in New Zealand fledge with no down or with <5% down cover.

Do not presume that a **chick of an emerging species** has fledged if the following applies:

- The chick has not emerged on any previous nights—chicks of these species that have not previously exercised before would be unlikely to fly direct to sea on their first night out of the burrow unless they are particularly well-advanced and probably light in weight.
- The chick is heavier than the upper known fledging weights for the species—such chicks can be 'holed-up' elsewhere at the site (or outside a fenced area, or down a steep decline) because they have crash landed after a fledging attempt.
- The chick's wings are still growing at the normal wing growth rate for the species—for most species the primary feathers will slow in growth towards fledging, or may even have stopped by departure time (e.g. heavy chicks that still need to lose more weight before fledging).
- The chick has >10% down coverage—in general, most chicks should be fledging with zero down cover, or with wisps remaining only, and a proportion are likely to have up to 10% down cover on departure. It is possible that chicks fledging from release sites where there has been no rain are covered in slightly more down.

Comment [H31]: May need to reword this as there may be the odd overseas species that is known to fledge successfully with down cover.

If the chick does not fit fledging parameters, then it should be recorded as missing and although its fate will be unknown (refer to Section 11.5. Missing chicks), likelihood of survival to fledging can be predicted (refer to Section 14.4. Chick emergence behaviour and fledging records).

10.5.3. Use of radio-telemetry

In New Zealand, grey-faced petrels and Chatham Island taiko are the only species to date where radio-transmitters have been attached to translocated chicks prior to fledging.

The requirement to radio-track individuals has been for the following reasons only:

- To confirm fledging success from a fenced release site in the first transfer year, i.e. to ensure that chicks are not becoming grounded outside the predator-excluder fence where they would be vulnerable to predators.
- To manage young and/or lightweight emerging chicks reliant on hand-feeding for successful fledging, so that they can be found and fed if they wander away from their burrow. This can be a useful tool to ensure that all translocated chicks of a critically endangered species fledge in optimum condition.

There must be **strong justification** for the use of radio-telemetry to track birds from the release site out to sea, because there are risks associated with:

- The device or tag attachment procedure, e.g. feather damage or loss

- The extra energy cost to tag-bearing chicks with regard to tag weight and profile, and position in relation to the bird's centre of gravity:
  - During the emergence period and on their maiden flight to sea
  - At sea, learning to forage and commencing any long-distance flights

The use of transmitters over 5 years of Chatham Island taiko transfers provided an opportunity to refine device attachment protocols for large gadfly petrel chicks. If transmitters are attached to chick tail feathers before they have stopped growing, the distance between the transmitter and the preen gland increases as the tail continues to grow, moving the transmitter further from the birds centre of gravity (compromising flying birds), and increasing the likelihood of damage to, or loss of tail feathers. In addition, the transmitter attachment process can weaken the base of the growing feathers and can cause the feathers to fall out before they are fully grown and/or irritate the chick, causing it to pull its tail feathers out.

Comment [H32]: I think this could be relevant to overseas projects as they are likely to be tackling endangered species too.

Chicks requiring transmitters should have them attached as close as possible to the time of first emergence. Transmitters should be fitted close to the preen gland to take account of further anticipated growth. If a chick's tail has not yet reached a specified length when it is ready to emerge, the transmitter is fitted first to the chick's back and then moved to the tail when the tail feathers have stopped growing.

Important note: Any projects considering use of radio-telemetry in a translocation project will require specialist advice and may require additional approvals.

10.6. Missing chicks

10.6.1. How often do chicks go missing?

In most burrow-nesting seabird translocations, some chicks permanently disappear from their burrows before their predicted departure date. However, some species are more prone than others to wandering away from the burrow site (e.g. fluttering shearwaters in New Zealand; Gummer & Adams, 2010) and, as a result, have a more complicated burrow blockade removal system to ensure that all chicks have a good chance of survival, even if they disappear (refer Section 10.4.3. Blockade removal—daily feeders). (Note: Chicks that go permanently missing commonly disappear on their first night outside the burrow.)

For most species, there is a pattern for more chicks to be missing from burrows on a morning following a night of rain (especially heavy rain). This is probably due to the fact that chicks find it harder to follow their scent trails back to their burrows and effectively get lost, so they 'hole-up' in another burrow or more commonly under vegetation.

Chicks can disappear either temporarily or permanently:

- Some chicks disappear temporarily, returning to either their own or a different artificial burrow after a period of one or more days. In these circumstances, it is important to record the weight of returning chicks with the aim of calculating the rate of daily weight loss over the time it was missing. This will help to

determine if other chicks that go missing have a chance of surviving or not if they are unable to receive further meals.

- Some chicks are not present in burrows by day, but suspected to return to their burrow at night (fence status pattern) for a few nights before finally disappearing, i.e. they are not seen by day. During the day they are probably 'holed-up' under vegetation.
- Other chicks are never found again and are assumed to be in one of the situations described below in Section 11.5.2 What happens to missing chicks?

Regular measurements and good record-keeping are important when assessing whether a chick that is absent from its burrow has fledged or is missing (refer to Section 14.4. Chick emergence behaviour and fledging records).

10.6.2. What happens to missing chicks?

Chicks that have disappeared before they meet target fledging condition (refer to Section 10.2. Target fledging condition) are likely to be in one of the following situations:

- Sheltering under vegetation away from the burrow site.
- Landed outside a predator-proof fence (if present) and unable to get back through the fence to the burrow site. Although this has never been proven to date, it remains feasible, particularly at sites where burrows or take-off points have been sited too close to a fence.
- Fallen down a steep decline during practise take-off and unable to negotiate the terrain in order to return to the burrow before daylight.
- Plummeted down to the sea, but too heavy or weak to take off again.
- Attacked by aerial predators; it is possible that corpses can be carried away from a burrow site.

The **consequences** of chicks disappearing from burrows before they are ready to fledge are:

- Missing chicks can no longer be hand-fed—there are different implications for heavy and light birds:
  - Heavy, well-developed chicks can survive not being hand-fed for the time they are missing and still fledge in good condition, i.e. at average or above average fledging weights. This is why their blockades can be removed sooner: if they disappear, there is still a good chance they can fledge successfully and survive their first days at sea without further hand-feeding providing they can find shelter from the elements and avoid predation for the time between disappearing and fledging.
  - Light-weight chicks reliant on hand-feeding will be compromised at fledging to varying degrees depending on their stage of development. Chicks that are far from fledging will be severely compromised, losing weight daily. While there is still a chance they could fledge at the lighter end of the fledging weight range (providing they find shelter from the elements and potential

predation), they will have few reserves to get them through the post-fledging period and are the most likely chicks to perish because they will be weak at the time of fledging.

Note: Blockades are left in place for longer at burrows containing light-weight chicks for two reasons: 1) There is an obligation to ensure these chicks do not suffer a long and drawn-out death through starvation; and, 2) If they disappear prematurely, they are as good as written off in terms of birds likely to return as adults, which defeats the whole purpose of translocating them in the first place.

- Missing chicks that cannot find suitable shelter in time (before dawn) and can end up sitting on the surface, or under minimal cover, where they are exposed to the elements (sun's heat or rain) and/or to potential predators.
- Missing chicks that have plummeted down to the sea prematurely would be in an extremely vulnerable and exposed situation in near-shore waters where they may get taken by aerial or underwater predators.
- Missing chicks that have suffered injury through misadventure may never be recovered for treatment and rehabilitation.
- The overall average fledging weight of a translocated cohort is reduced if some chicks cannot be fed for an optimum period (Note: Managing blockade removal on a case-by-case basis improves average fledging weight).

10.6.3. Searching for missing chicks

There is usually limited time to search for missing chicks on any day, and manual searching can be a daunting task, often fruitless. As a minimum, all vacant artificial burrows at the colony site should be checked for chicks that might have wandered into them.

Setting blockade removal criteria removes the need to search for chicks because missing chicks still have a chance of fledging from the colony site, and are less likely to perish before their fledging attempt.

An alternative method for recovering missing chicks is to use a trained protected species detection dog and handler (refer to Section 16.4.6. Using protected species detector dogs to find natural burrows)—this can be useful if transferred chicks at a release site are regularly going missing and their disappearance is of concern.

10.7. Assisting chicks to fledge

An assisted fledge is one where the chick is taken directly to the cliff edge/sea for release because its mobility (e.g. tree-climbing ability) is compromised in some way, and there are no options with regard to veterinary facilities to improve condition of the chick before it fledges. Assisted fledges are only attempted when a chick has been assessed to be in otherwise good condition and capable of recovery of any symptoms at sea. Assisted fledges have been attempted to date at remote release sites where some effort is required by chicks to get out to sea i.e. where chicks must climb take-off trees, and/or walk some distance to a take-off point.

Assisted fledges should be considered in the following circumstances:

- When a chick's mobility is slightly compromised and veterinary attention or treatment is not feasible, or unlikely to improve the condition, or it is considered that holding the chick back for rehabilitation may result in other more serious complications (feeding problems etc.).
- When a chick has returned from veterinary treatment and it is urgent for it to get to sea to feed for itself and no further recuperation is required at the release site burrow (as per veterinary advice).
- If a chick has a slight weakness in one limb—the chick may not be able to climb a tree, but once at sea it can rest the limb in flight and exercise it on the water.
- If a chick has lost two or more tail feathers—there is not enough time for these to be replaced before fledging. Experience has shown that the loss of central tail feathers can be a real disability when chicks are climbing trees as they need the tail as a prop during the ascent. If they cannot climb a tree, they will never be able to depart some sites.
- If a chick has lost one or two significant wing flight feathers, it may be a good idea to assist it to fledge in case the chick needs some flying time to adjust to balance issues. This may be particularly important if the chick has to negotiate an area of mainland (with predators) before reaching the sea—an assisted fledge will avoid the risk of the chick becoming grounded outside a fenced area if it is not flying well. It would be safer for the chick to land on the sea surface and practice further flights from there. However, if quite a few flight feathers are missing and survival is predicted to be compromised, veterinary rehabilitation should be considered if it is practical.

Note: Chicks with more severe issues must be referred for veterinary advice/treatment, or in remote location euthanasia may need to be considered (refer to Section 12. Managing chick health issues).

Chicks can be released just after dusk by placing them on an elevated and exposed place as close as possible to the sea. Always check the weather conditions beforehand, and avoid releasing a bird in extreme weather conditions.

10.8. Managing vacant burrows

Blockades should be left off all vacant (unoccupied) burrows for the following reasons:

- To ensure any chicks accidentally put in wrong burrows (e.g. a vacant burrow) after being fed can emerge/depart.
- Spare vacant burrows provide additional places for wandering birds to occupy, reducing incidences of birds disappearing and missing feeds.
- Non-breeding adults prospecting at the colony site late in the season (when transferred chicks are in residence) can still find burrows to enter.

11. Managing chick health issues

11.1. Wildlife Health Management requirements

Translocations involving wild animals should minimise disease risk related to conservation management practices, by implementing practical and achievable disease management actions. Important aspects include; hygiene; observations of illness; mass mortality events, necropsy; surveillance for disease; translocation health management; captive wildlife health management; wildlife rehabilitation. Official guidelines or approvals may be relevant.

11.2. Disease screening

Disease testing/screening may be required as part of a Wildlife Health Management programme associated with a translocation.

Screening may involve one of the following options:

- Sampling all translocated chicks; or
- Sampling a proportion of translocated chicks (that would reflect the health state of the whole translocated cohort); or
- Sampling birds at the source colony not actually being translocated (to give an indication of presence of certain parasites or pathogens at the source colony).

Screening can involve collection of faecal samples, and/or cloacal swabs, and/or blood samples. (Note that blood-sampling should be undertaken by vets or highly experienced operators only).

If screening is to occur after transfer at the release site, the following must be considered:

- A settling-in period of a few days should be allowed before invasive procedures (e.g. blood-sampling), but screens ideally should be made as soon after transfer as practical. Coinciding screening with the period when burrows are still blockaded is ideal (e.g. around day 3 or 4 at the release site) and will avoid chicks disappearing from burrows as a direct result of the invasive procedure. Choose a sample of chicks that are younger and in burrows where blockade removal is not scheduled until at least a day or two after the screening date.
- Screening procedures should be scheduled to occur BEFORE feeding, i.e. not after a chick is fed, and preferably not on the day after it has been fed. This will help reduce incidences of regurgitation though handling birds with full stomachs.
- Invasive procedures should be avoided on emerging chicks (to reduce the chance of them disappearing). If an already emerging chick must be blood-sampled for any reason; block the chick in the chamber (with ventilation) for the remainder of the day to ensure it settles there, before removing the blockade at the end of the day.

In addition to screening for translocation purposes, some projects also provide researchers the opportunity to sample for baseline health screening of a species, or for a particular health study.

11.3. Physical examination

As well as the physical health check made prior to transfer, a full physical examination should be given in the event of unexpected and/or unusual chick behaviour. Examples would be: aggressive/biting chick especially if it has been previously quiet (this could indicate a painful fracture or joint problem); failure to emerge despite being mature enough to do so; wandering chicks; chicks showing the more obvious symptoms such as sudden weight loss, excessive weight gain, vomiting, poor plumage condition, etc.

11.4. Veterinary advice

Before any project commences, contact should be made with appropriate veterinarians so they know to expect potential correspondence regarding sick or injured birds, and can advise on protocols for dealing with such birds—in situ treatment or transfer to appropriate vet facilities.

11.5. Managing sick/injured chicks

11.5.1. Utilising veterinary facilities

Where a chick is sick or injured, and diagnosis (and potential treatment) is not possible without veterinary assessment and advice, then it may be feasible to get a vet to visit the release site, or for the chick to be sent to an appropriate veterinary facility.

Methods for treating and rehabilitating seabirds are improving all the time. In fact, some individual birds are now even being sent for rehabilitation if they have plumage issues, i.e. are lacking in water-proofing (refer Section 11.6.2 Water-proofing issues).

11.5.2. Remote locations

Sending birds to a veterinary facility is not always a practical option in some isolated island locations, as weather conditions and cost restrictions may prevent a sick/injured bird being transferred. In these cases, euthanasia should be considered.

11.6. Managing specific health issues

11.6.1. Regurgitation

The chicks of some species of seabirds are more prone to regurgitating than others. These tend to be the species that are fed less frequently (e.g. the gadfly petrel chicks) and are digesting/processing parental meals at a slower rate than some of the daily-feeders. Such meals also tend to have high oil content.

Regurgitation has several potentially fatal impacts on chick welfare:

- Soiling of plumage, spoiling water-proofing and insulation (can be fatal; more often than not results in a chick with compromised water-proofing and such chicks are unlikely to survive the elements at sea)

- Possible asphyxiation (fatal)
- Any inhalation of food particles can lead to aspiration pneumonia (fatal)
- Loss of valuable parent meals rich in oil (natural food and oils can still be seen in regurgitate up to a week after transfer in small gadfly petrels)

Important note: Avoiding incidences of regurgitation, and handling chicks appropriately at all times cannot be over-emphasized, because if the chick is unable to project the vomit away from its head, then there is highly likely to be a serious consequence, i.e. one of the above scenarios.

All handlers should be aware that regurgitation can occur at any stage of a transfer operation, with increased risk of it occurring:

- During first handling at the source colony, i.e. during chick extraction from a natural burrow, especially if the chick has been recently fed by parents
- During hand-feeding, especially if meal sizes are too large, or if a chick has a gut blockage (e.g. squid beak), and towards fledging time when a chick may not require as much food
- As a response to another ailment, i.e. chicks in poor health can regurgitate in their burrow in between handling events, and so burrows must be checked on a daily basis for this

11.6.2. Water-proofing issues

Lack of water-proofing becomes obvious when a chick is continually found in a wet state in its burrow (when other emerging chicks are dry).

Two common reasons for chicks not being as water-proof as they need to be before fledging are:

- Chicks are not preening effectively, or not preening at all—a common symptom in chicks that are not well or have high parasite loadings.
- Feathers have been soiled with oil or some other substance (e.g. regurgitation, human sun-screens, hand-cleaners or moisturisers). Handlers should always be encouraged to thoroughly wash hands, or use clean gloves or a towel to handle birds.

Chicks that exhibit a lack of water-proofing **are highly likely to perish at sea**, so treatment and rehabilitation is considered to be important, particularly for endangered species. This can be at a veterinary facility, or as a minimum, water-proofing therapy (to encourage preening) can be undertaken in situ by spraying chicks with water, or even introducing them to a water-bath (before hand-feeding).

11.6.3. Ventriculitis/proventriculitis

Ventriculitis/proventriculitis is the inflammation of the gizzard and forestomach, associated with bacterial or fungal infections. Factors which can lead to the condition (alone or in combination) are:

- Gut stasis—if the food sits in the proventriculus/ventriculus for too long it can allow the growth of bacteria/fungi for long enough to cause an infection. Gut

stasis is affected by the temperature and humidity of surroundings, the temperature of the food at feeding, the water content of the food, and any systemic illness which might be affecting the bird.

- Food quality—contaminated food, feeding tubes or other equipment can pass pathogenic bacteria or fungi into the gastrointestinal tract of the bird and cause a rapid infection. The quality of food is affected by: the hygiene level at preparation; the raw ingredients used; storage conditions (temp./hygiene/time); and hygiene during feeding.

If caught in time, e.g. if multiple regurgitations occur in a reasonably bright chick, or when regurgitation is first seen in the burrow of a sick lethargic chick, treatment (such as the administration of fluids and antibiotics) can be successful. However, chicks tend to lose more weight because they are not feeding well and food volumes must be reduced to allow digestion.

11.6.4. Aspiration of food

Aspiration of food particles can occur through over-feeding, or through poor hand-feeding technique, or when a chick regurgitates (in particular if it is weak or in poor health at the time).

Death through asphyxiation can be either a primary or secondary cause of mortality. Aspiration of small food particles is also known to have caused aspiration pneumonia which has been fatal. Symptoms may not show until it is too late to treat the chick.

Symptoms of aspiration include choking sounds or coughing during or after feeding, followed by (immediately or within 2 days) increased respiratory effort and audible breath sounds.

11.6.5. Neurological symptoms

Neurological symptoms have only been observed in a few translocated large gadfly petrel chicks in New Zealand. Symptoms included: arching back of head (opisthotonus); ventroflexion of the head (bending towards the belly); lack of co-ordination; trembling; and distress when handled. Symptoms became more obvious on handling, possibly due to the lack of coordination. In all cases, the chicks were of fledging weight and wing length when symptoms developed, and the symptoms coincided with a period of hot calm weather.

All affected chicks recovered from their neurological symptoms following treatment comprising oral administration of fluids, B Vitamins and anti-inflammatory drugs. Since seabird vitamin supplements have been used, there have been no further cases observed. For further information refer to (Gummer et al. 2012c).

11.6.6. Dehydration and heat stress

Dehydration can be caused by not including enough water in the diet. Dehydration can lead to visceral gout and kidney disease. Hydration is important for kidney function. Water must be provided at the correct amount in the diet and in the atmosphere, as these are the only sources for transferred seabird chicks. Hydration can be maintained in warm, dry conditions or in any chicks of concern, by delivering

oral fluids (electrolytes) in between meals, and by considering adding more oil to the diet as a supplement.

Heat stress can be reduced or avoided in chicks in burrows if the appropriate burrow temperatures are maintained (refer to Section 9.2.5. Artificial burrow temperature). The humidity of burrows can be increased by spraying with water if required.

Comment [H33]: Need hyperlink

11.6.7. Eye infections/injuries

Signs of eye infections or injury include discharge, closed eyes, and also asymmetry in the way a chick may hold its head (when it is relying on vision in the undamaged eye). Staining of eyes can reveal abrasions or scratches which may or may not be treatable. It highlights the importance of: ensuring chicks are extracted carefully from natal burrows at the source colony and are given a thorough physical examination before they are included in the transfer; not including nest material in transfer boxes; and, keeping the eye area clear during hand-feeding.

11.6.8. Burrow hygiene

The amount of build-up of excrement in artificial burrows is dependent on the species and hand-feeding regime, and whether or not burrows require cleaning while chicks are in residence tends to be related to the weather/climate.

Burrows of daily feeders that process large meals regularly can become soiled much faster than burrows of species that are fed relatively smaller volumes less frequently. Burrows of daily feeders may need cleaning one or more times before the chicks fledge, especially if the weather is warm and maggots are accumulating in the excrement (to avoid any incidences of fly-blown chicks).

Nesting material may to be replaced if it gets too wet (e.g. from a chick being outside on a rainy night) or it is particularly soiled by excreta or regurgitations. It is important not to remove all the material because it holds the scent that may help the chick locate its burrow when returning from night-time excursions on the surface.

If there is any suspicion that a chick has died from an infectious cause, then the burrow should be blocked to prevent other chicks entering. Ideally such a burrow would be replaced with a new one before the next translocation, due to the difficulty of disinfecting wood and substrate. At the least all the old nest material should be removed and the box sprayed with a suitable disinfectant

11.7. Necropsy advice

With seabird translocation methods constantly evolving, it is normal practice to investigate all causes of death if it is clear they are not attributed to misadventure, by sending corpses for necropsy (refer to Section 17. Terminology and definitions). However, it is also very useful to examine any chicks that have died through injury by a known cause, so that body condition can be assessed and any physiological abnormalities identified, as these could be related to diet and hence chick management at the release site. This would need to be clearly stated to pathologists as an intention.

Ensure that protocols are in place for dealing appropriately with dead birds at the following levels:

- Immediate response—inspecting corpse for any external signs of cause of death, e.g. injury, missing feathers, staining (blood, faeces, regurgitate) around vent or head region; inspecting burrow for signs of abnormal faeces, or any regurgitate (collect any recent faeces and place in a plastic zip-lock bag); keeping corpse as cool as possible (avoiding freezing) until it can be dispatched for post mortem examination.
- Dispatching corpse to pathologists—using appropriate storage during transport and including case history.
- Interpreting and reporting pathology results—consulting with veterinarians and specialists; including outcomes in annual reports for the benefit of subsequent projects.

12. Data collection and reporting

12.1. Source colony Recce trip records

Example forms for recording data of chicks handled during Recce trips to the source colony can be found in Section 10.1 of the Companion Guide (Gummer et al. 2012a).

Primary data recorded on a Recce trip:

- Burrow number, location (mapped) and access to chick, so chick can be found easily on the collection trip
- Chick wing measurements to help plan transfer date(s)

12.2. Source colony collection trip records

Example forms for recording data of chicks handled during collection trips to the source colony can be found in Section 10.2 of the Companion Guide (Gummer et al. 2012a).

Primary data recorded when selecting chicks before the transfer day:

- Wing-length, weight and number of days to the transfer, to assess chick suitability for transfer
- Burrow number and location (mapped), and band number of chicks suitable for transfer

Primary data recorded when collecting chicks on the transfer day:

- Natal burrow number, band number, presence of adults, fence status at burrow entrance can be useful for some species —also recorded on transfer box
- Wing-length and weight (especially for marginal chicks), and whether or not the chick is transferred

12.3. Chick feeding and measurement records

Example forms for recording data of chicks handled/hand-fed at the release site can be found in Section 10.3 of the Companion Guide (Gummer et al. 2012a). Data for

each chick is recorded on a separate page so that progress can be followed each day in the field.

These record sheets, prepared before the transfer date, are held at the feeding station and may or may not need to be water-proof depending on shelter used. They are usually transported off site each day and used to plan for the next feeding day. The processing that is to occur for each chick on the next day is then clearly indicated on their respective page of records.

Data needs to be entered onto Excel spreadsheets—preferably on the same day or every other day—for eventual data analysis and for back up purposes. This is important in case original data is lost or damaged, as each chick is on an individual meal and blockade management plan.

An example of a chick feeding calendar used to help with planning of chick feeding days can be found in Section 10.4 of the Companion Guide (Gummer et al. 2012a).

12.4. Chick emergence behaviour and fledging records

A separate waterproof notebook is required for daily recording of fence status at each burrow (indicating whether or not the chick has emerged the previous night) and chick presence/absence following chamber inspection.

These records should then be copied immediately onto the individual chick record sheets (at the feeding station) so they can be easily referred to at feeding time, and copied onto Excel data record sheets daily.

When recording fledging data:

- Record fledging date as the date the burrow is found empty. (If using the day before the burrow is found empty as the fledging date, then this should be stated in all documentation).
- Assign missing chicks into one of the following three groups based on what you know of the features of the site and each individual chick (refer to 11.4.2 Assessing fledging success, and Section 11.5 Missing chicks):
    - **Chick likely to have fledged** at a later date and from an unknown location. These are chicks that have gone missing before completing the normal emergence period, but are close to meeting fledging parameters, and have enough reserves to last to estimated fledging time and to still depart within the known fledging weight range for the species. There must be plenty of safe, sheltered areas for it to 'hole-up' under until final departure.
    - **Chick likely to have perished** before or during fledging because its weight was at, or predicted to fall below the known fledging weight for the species before its estimated fledging time.
    - **Fate of chick is unknown** because it disappeared at a weight well exceeding the normal fledging weight range and has potential to survive to and after fledging IF it can find a safe, sheltered area to 'hole-up' under until final departure.

12.5. Analysis of chick data

When analysing chick fledging data, it is suggested that the data from chicks that have gone missing from their burrows prematurely is analysed separately from the data from chicks that are **presumed to have fledged successfully**. With every transfer there is likely to be a small proportion of chicks that are far too heavy to have actually fledged when they disappeared (i.e. likely to be 'holed-up' elsewhere at the colony site before finally departing on an unknown date), and a small proportion of light-weight chicks that disappear from their burrows well before expected and are compromised at fledging time (i.e. die before or shortly after fledging).

Data for such chicks (fledging weight and wing-length, emergence periods and time spent at the release site) will be unknown as final dates of departure cannot be established. Therefore, the last data recorded for these chicks should not be included in the analysis, as they bias the average fledging data and this in turn makes annual comparisons meaningless and targets difficult to set. (Note, however, that trimming exceptionally light and heavy chicks from the data can give the data that is 'expected' so must be done carefully and only if those chicks are presumed to have perished [too young] or departed at much later dates [too heavy and downy to have departed].)

Note: No matter how experienced the team, the premature disappearance of light-weight chicks can rarely be completely avoided and so there is no issue with declaring that this is suspected as happening to a proportion of chicks. It can give a clearer picture of project success when assessing the proportion of chicks that eventually return as adults.

Analysis of chick transfer and fledging data should include as a minimum the mean, standard deviation and range for the following (with sample size for each parameter):

- Transfer weight and wing-length—on transfer day, or day after transfer day (aim to be consistent each transfer year with when these measures are taken).
- Fledging weight on day before the night of departure—use pre-feed (base) weight and indicate if the chick received a final meal on the day before transfer. Data collected more than 1 day before fledging can be extrapolated, based on individual daily weight loss rates.
- Fledging wing-length on day before the night of departure (or sooner than this if wing has stopped growing).
- Down cover at time of fledging—this can be useful if it has not been recorded for the species before.
- Emergence periods—include the night of fledging as an emergence night.
- Total time spent at the release site.

Note: Some projects also record the total volume of artificial food each individual chick receives as this can help with on-going diet research/development. In addition, it can be very useful to record whether or not a chick has been exposed to rainfall during any emergence period and relate this to plumage condition after such exposure.

All of the above tend to be cross-referenced when birds start to return as adults, and this information importantly helps further refine protocols for subsequent projects.

13. Post-release site management

13.1. Managing vegetation

Vegetation may need to be managed annually at an artificial colony site to ensure that there are:

- Areas of ground free of dense vegetation, so that birds can walk easily to appropriate take-off sites. This may involve creating and managing 'pathways' that are wide enough for birds to pass from burrows to ridges, cliff-tops or suitable mature take-off trees, especially in regenerating vegetation.
- Open, safe areas where birds can land, i.e. free of dense scrub that birds can get entangled in. Although the risk of larger species getting strung up in vegetation when crash-landing are probably less than smaller (and lighter) species, it may still be beneficial to create open spaces, especially at sites where vegetation is planted/regenerating. This may involve:
  - Thinning some areas of under-storey in a forest situation so that birds can safely drop through the canopy to the forest floor. When thinning plants, it is important to allow for regeneration at the site by leaving small patches to naturally self-thin and avoiding removing all the saplings so that some can eventually replace the canopy cover and provide future take-off trees.
  - Weed-eating grassy, low-scrub areas so that birds can move easily on the surface to burrows.
  - Removing plant threats such as thistles, brambles or thorny plants in the vicinity of burrows, i.e. plants that could injure birds.

13.2. Maintaining sound systems

Sound systems need to be regularly checked, preferably at night, to ensure they are functioning, but also to check on volume.

- The volume should be loud enough for birds passing at sea to hear during unfavourable weather conditions. The system needs to be able to draw in new immigrants as well as provide a focus for returning birds.
- The volume should not be so loud that it is distorted and causes discomfort when listening.
- When translocated chicks are in residence, consider reducing the volume to make it more comfortable for the emerging chicks. Volume must be returned to normal levels once the chicks have all fledged, i.e. before the start of the next breeding season. (Note that when adults return, they can choose where they nest in relation to the sound system, whereas transferred chicks are allocated to burrows and must not be discouraged in any way from returning to them during the emergence period.)

- At sites where more than one sound system are playing (different calls to attract different species to different areas within the same site), careful consideration must be given to the respective volume of each system to ensure one does not compromise the other, i.e. one system must not dominate volume over the other as the target species of the quieter system may not hear the broadcast calls of their species.

13.3. Preparing burrows for next chick transfer

Open lids to air burrows and leave them exposed to sunlight for several days where possible to help freshen them before the next season's chick transfer. This must be done after the last transferred chicks have departed, and before any adults might return to prospect for nest sites.

13.4. Preparing burrows for returning adults

Returning birds can be monitored most effectively in artificial burrows. Artificial burrows need to be maintained on a regular basis. Priority tasks prior to the start of the breeding season are:

- Ensuring chambers and entire tunnel lengths are free of blockages/obstacles before birds are expected to return at the start of the breeding season. Nest material is best left undisturbed in most burrows so that the scent of birds remains as an attractant to prospecting adults. With regard to hygiene, there is time for the burrows to 'fallow' before birds return for the next breeding season. However, vets recommend: all burrows are aired (exposed to sunlight if possible); the burrow nesting material is removed after a transferred chick has fledged if there have been any health issues; or, the burrow is replaced or at least thoroughly disinfected if the transferred chick died from an infectious disease.
- Clearing around the burrow entrances so they are easily seen, and erecting stick fences for monitoring burrow activity (refer to Section 16.4.1. Burrow monitoring method).
- Clearing the tops of burrows so that burrows can be easily found and inspection lids lifted without debris falling in on birds.

Avoid building any nests, as the presence of new nesting material that has been dragged into the burrow (along with feathers and droppings) is a good indicator of adult presence.

14. Post-release monitoring

14.1. Purpose of monitoring

Post-release monitoring informs future management of translocated populations and can help to answer questions such as:

- Will the reintroduction be successful?
- Is management needed/sufficient?
- Will supplementary translocations be needed?

- Is genetic diversity sufficient?
- Do translocation techniques need refining?
- Does release site selection need refining?

Post-release monitoring and reporting also informs stakeholders from source locations that 'their' birds have been well taken care of.

Monitoring must relate back to the operational targets in the translocation proposal. The design of post-release monitoring needs to match the questions you are trying to answer and subsequent use of the data.

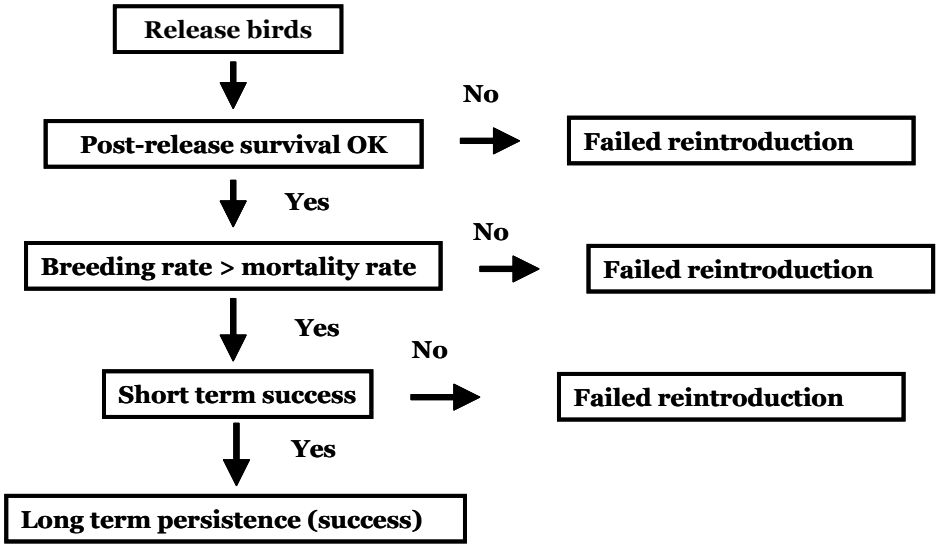
The need for monitoring is related to the uncertainties about the translocation; long-term success of petrel and shearwater translocations is yet to be achieved. In

addition, it should be noted that annual increases in the number of active burrows may be slowed down or prevented by other factors (e.g. interaction with other colonies, especially if large populations are in close proximity to the release site (Miskelly & Gummer 2013); food supplies at sea; climate variability).

Post release monitoring can inform: where translocation failure occurred (Figure 4); whether management can be used to prevent failure if the species is translocated to the site again; and if not, the feasibility of future translocations.

Alternatively, successful translocations provide useful information for future projects.

Figure 4. Determining the success or failure of a translocation (Parker et al. 2011)


Release birds
Post-release survival OK
No
Failed reintroduction
Yes
Breeding rate > mortality rate
No
Failed reintroduction
Yes
Short term success
No
Failed reintroduction
Yes
Long term persistence (success)

Note: Long-term persistence (success) for petrels and shearwaters is presumed to be a trajectory of breeding pairs increasing annually, especially after all the initial transferred F1 [1] birds have returned (e.g. this may take longer than 10 years for a species that takes 3–4 years to reach maturity). In addition, the colony is on course to be self-sustaining when the first release-site-bred chicks return to breed (e.g. this may be no sooner than 6 years after the first transfer for a species that takes 3–4 years to reach maturity), i.e. F2 birds are producing F3 generation birds. Anticipated population growth rates, however, should realistically reflect those of other wild populations of the species (e.g. the source population).

[1] 'F1' is the founder generation, i.e. the birds that were originally transferred. 'F2' are the offspring of the founder (F1) generation, i.e. release site-bred chicks. 'F3' are the offspring of the F2 generation.

14.2. Monitoring objectives

To assess project success, monitoring of release sites should be carried out on a long-term basis (i.e. in the order of decades) until the new colony is considered self-sustaining.

Basic monitoring efforts tend to include:

- Identifying adults—to determine return rates of translocated birds
- Banding new immigrants—to determine proportion of new immigrants to birds that fledged from the site
- Marking all burrows found—to establish breeding outcome
- Banding chicks—to facilitate future monitoring of birds of known age and origin

Monitoring may need to include an assessment for:

- Gender balance (if no breeding has occurred within an expected timeframe)
- Genetic diversity in later years (project dependent and only if considered necessary based on specialist advice). It is considered that only a single new migrant into a subpopulation (e.g. colony) would be required per generation to maintain genetic diversity (Mills & Allendorf 1996); this would be approximately once per decade for these species.

14.3. Monitoring for returning adults at source site

Monitoring the source population for any birds that may return there, instead of to the release site is a difficult unless the source population is already the subject of intense research or management. It can be very useful to determine if any translocated chick return to the source colony as adults, and can provide data on survival of translocated chicks in relation to 'control' parent-reared chicks and to return rates of chicks (as adults) to the release site.

14.4. Monitoring for returning adults at release site

14.4.1. Burrow monitoring method

Artificial burrows can be monitored for returning adults by day-time inspection of fences erected at burrow entrances. Fences need only consist of 2 or 3 thin sticks, which should not deter birds from entering burrows by being too firmly set. When fences are knocked down, chambers can be inspected for sign of activity: a bird; presence of fresh nesting material; petrel feathers; and/or petrel excreta. There may also be evidence of fresh digging near burrows.

14.4.2. Monitoring timeframes

The first monitoring for returning adults should commence at the earliest possible expected return date for an adult. For example, the earliest age that small gadfly petrel chicks have been known to return as adults is at exactly 2 years old, so monitoring can commence effectively during the second breeding season after the first chick transfer, i.e. one whole season is missed, but monitoring starts around the time that the third transfer cohort of chicks may be in residence. Some of the

smaller species have been known to return just a year after fledging (e.g. diving petrels; Miskelly & Taylor 2004)

Monitors should be aware that different individuals and birds of different ages may return to the colony as adults for the first time at different stages of the breeding season, and that first visits back to the colony are not necessarily at the start of the season but can occur during the incubation period, or even as late as the chick-rearing period.

The pattern of visitation to a natural colony by breeders and non-breeders of the translocated species (influenced by migratory and non-migratory behaviour) needs to be known to ensure the most effective monitoring schedule.

14.4.3. Day-time burrow monitoring frequency

As a rough guide, a minimum of weekly burrow checks throughout the season should pick up any sign of visiting adults, general burrow activity patterns, and status (breeding or non-breeding). Frequency can be decreased or increased depending on site logistics and project objectives.

More frequent monitoring will help to pick up more regular bird activity, and will narrow down key dates of breeding activity (pre-laying exodus periods, egg-lay dates, hatch dates).

The safest time to handle adults for identification is when they arrive at the colony for the pair-bonding/copulation period, prior to the pre-egg-laying exodus. However, the only hope of catching birds by day during this period is if burrow inspections are made on a daily basis across an extended period of weeks, and even then, non-breeders may never be captured. Because this is not feasible at many release sites, options include:

- It is becoming more common to identify adults during the incubation or brooding (guard) phase when birds are guaranteed to be present in burrows by day. However, it should be noted that this is a **high-risk procedure** that can result in egg (or chick) damage and may not be appropriate for some species.
- Night work tends to be more practical as more birds can be recaptured in a concentrated period of time (refer to Section 16.4.4. Night-time monitoring), and there is no risk of egg damage.

Refer to Section 16.4.5. Handling burrow occupants for identification, for recommended handling times during the season.

14.4.4. Night-time monitoring

Night-time monitoring is often preferred for adult identification, as there is no handling of eggs involved. Night-time monitoring usually involves catching birds on the surface or luring them out of burrows by call playback (species dependent). All birds are visibly marked so they are not handled a second time.

It is recommended not to overdo night monitoring to ensure that disturbance is kept to a minimum. For each species, there will be optimum dates and weather conditions to do night work through the season, to pick up breeders, and early and late-arriving non-breeders.

The level of night-time monitoring used may be dependent on how tolerant adults of a species are to being handled during the incubation period by day, i.e. how aggressive individuals are at this time and whether the egg is at risk of being damaged.

- Species that cannot be handled safely during incubation because there is a **high risk of egg damage** (e.g. larger aggressive species)—night-time monitoring is necessary to identify the majority of returning adults.
- Species that can be easily handled during the incubation period (with lesser risk of egg damage)—night-time monitoring is not essential, but may still be preferred to identify adults; most eventually become breeders and can be found in burrows by day (during incubation). However, night-time monitoring may be useful for the following birds:
  - Non-breeders may not stay in burrows by day or may do so on random occasions which are difficult to catch if burrow monitoring is not daily. Some night work may be required to catch such birds if wanting to obtain identities as soon as possible (as opposed to waiting for a subsequent season when those individuals might be breeding).
  - Breeders can be identified at night during the rearing phase if they have been missed during the prospecting or incubation periods.

The level of night-time monitoring may also be dependent on how tolerant adults of a species are to being captured at night on the surface or in burrows, and whether this activity may deter adults from returning to a burrow. The risk of disturbing adults arriving at the colony for the first time needs to be taken into account.

In addition, whether or not adults of a species choose to return to artificial burrows, or prefer to nest in natural sites will also influence the level of night-time monitoring required:

- Species that show a strong affinity to the site/burrow they fledged from, and a high rate of using artificial burrows—activity at artificial burrows can be easily monitored and the majority of birds can be retrieved from burrows by day (except non-breeders).
- Species that prefer to nest in natural burrow sites— night-time monitoring is often necessary to locate the burrows (e.g. by call and response).

14.4.5. Handling burrow occupants for identification

With a weekly or more frequent burrow monitoring regime, the breeding status of burrow occupants will become clear as the season progresses and a decision can be made about when birds can be handled for identification, based on the species tolerance of being handled.

When scheduling adult identification to occur during the incubation period:

- Choose a period during the peak incubation time to identify as many adults as possible in one trip

- Ensure handlers are experienced at extracting eggs and incubating birds from burrows, and returning eggs and birds to burrows. If necessary, seek assistance or advice from a seabird specialist.
- Visibly mark all birds so they are not handled a second time.
- Schedule a second trip between later to catch the partners that take over for the next incubation shift (timing of this second trip is dependent on the known incubation stint length for the species). Several repeat trips may be required to catch all the partners.

Alternatively, birds can be targeted for capture at night during the rearing period (post guard phase) (refer above to Section 16.4.4. Night-time monitoring). It may take at least 1 week to catch a pair of a species that does not visit nightly to attend the chick. Incoming adults may have a high chance of regurgitating if captured before they have fed their chick. It is best practice to capture such an adult after it has fed its chick, so that any small chicks do not miss out on a meal.

14.4.6. Using protected species detector dogs to find natural burrows

If it is suspected that birds are using natural burrows rather than artificial burrows, then a dog search using a trained protected species detection dog and handler can be attempted. It usually pays to wait until such a time when it is likely that several burrows might be found, e.g. several years after the final transfer, rather than in the earlier years of post-transfer monitoring when fewer birds have returned.

14.4.7. DNA sexing of returning adults

DNA sexing provides a high level of accuracy and can be carried out using blood or feather samples. Results usually take at least a week. Feather sampling is the least invasive and most commonly used method for gender assignment of returning adults in seabird translocation projects if required (refer to Section 3.5. Gender and genetics). The quill tip of the feather (where it contacts the skin) is the most important section of the feather; hence the feather must be pulled out, not cut. 'Down only' samples or cut feather samples are unlikely to yield DNA. Blood sampling for sexing would only be considered if samples had to be taken anyway for other purposes (e.g. health diagnostics or genetics).

14.4.8. Keeping burrow monitoring records

Keep records of location and activity for all burrows at the artificial colony including: all dates of burrow checks/inspections; all details of fence status, occupants (all species) and signs of activity. This data will be useful in subsequent monitoring years.

15. Terminology and definitions

Extirpated—Locally extinct. The species ceases to exist in a geographic area, although it still exists elsewhere.

Gadfly petrel—Medium to large petrels of the genus *Pterodroma*. Many species give high-pitched repetitive calls over breeding grounds at night (Heather & Robertson 2000). Generally oceanic; rarely seen near land except in the breeding season. Many species are highly migratory with two distinct foraging zones (one is used during the breeding season, and the other outside the breeding season; birds may not feed during the journey between the two feeding grounds), for example Chatham, Cook's and Pycroft's petrels. Others may be technically non-migratory yet highly dispersive (grey-faced petrels and Chatham Island taiko), because the foraging zones during and outside the breeding season are not distinct (i.e. they forage across all waters within their known range (adapted from Heather & Robertson 2000).

Comment [H34]: Would need to add in info about all the other groups if going with definitions.

Necropsy—The post mortem (after death) examination of a specimen to detect abnormalities and determine cause of death.

Philopatric—Species that return in consecutive years to the same breeding site or territory exhibit breeding philopatry or site fidelity.[2]

Procellariidae—The largest and most diverse family of seabirds; includes a wide variety from giant petrels to diving petrels, and gadfly petrels (*Pterodroma*). All have distinctive external nostrils encased in a tube on the top or sides of the bill.

RECCE trip—means Reconnaissance trip

[2] Taken from the Free dictionary: http://encyclopedia.thefreedictionary.com/philopatric (Viewed 6 December 2011).

Self-sustaining population—A population that is able to increase and/or maintain itself without additional management.

Supplementation— Addition of individuals to a population already present at the release site. Also referred to as enhancement, re-enforcement, re-stocking, enrichment or augmentation (based on the definition in the 1995 IUCN guidelines on re-introductions.[3])

Translocation—Translocation is defined in this document as the managed movement of live indigenous plants or animals (taonga) from one location to another. Translocation covers the entire process including planning, the transfer,

[3] IUCN. 1995: IUCN/SSC Guidelines for Re-Introductions. Prepared by the SSC Re-introduction Specialist Group, Approved by the 41st Meeting of the IUCN Council, Gland Switzerland, May 1995. http://data.iucn.org/themes/ssc/publications/policy/reinte.htm (viewed 22 July 2011).

release, monitoring and post-release management (up to some predetermined end point). A translocation can consist of one or more transfers.

Transfer—The part of the translocation that involves the physical movement of plants or animals from one location to another and their release or planting at the new site.

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16. Acknowledgements

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Pam Cromarty— Technical Advisor, Systems Improvement, DOC; Co-ordinator of the Department's Translocation Process, DOC

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Dr Matt Rayner—Seabird Specialist particularly small gadfly petrels (*Pterodroma*), Centre of Biodiversity and Biosecurity, School of Biological Sciences, University of Auckland

Denise Fastier—Ranger/Team Leader, DOC

Colin Bishop—former Ranger, Friends of Matakohe-Limestone Island; Ranger, DOC

Rob Dunn—Masters Student, University of Auckland

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