Guidelines for translocations of albatrosses and petrels

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SUMMARY

Translocation of albatross and petrel chicks and rearing them at a new location is a means of facilitating the formation of new breeding colonies, restoring colonies at sites from which species have been extirpated, enhancing total population size, increasing breeding distributions and preventing extirpation at existing sites where there are major threats. The strong philopatry in this order of birds make this kind of conservation action feasible. A translocation of the Short-tailed Albatross (*Phoebastria albatrus*) in Japan (Deguchi *et al.* 2012a, 2014a) provides some guidance for future projects involving surface-nesting albatrosses and petrels. Translocations require a long-term effort due to the extended fledging period of albatrosses and petrels, and the protracted period between fledging and recruitment. Translocations of a variety of New Zealand procellarids provide guidance for future projects involving burrow-nesting petrels (Gummer 2013).

Recommendations

1. Translocation of albatrosses and petrels should be considered as a conservation tool when populations can be enhanced by moving birds back to sites where they have occurred previously as part of an ecological restoration, or to assist colonization of a new site in response to threats at existing colonies.
2. To maximize the likelihood of success, careful consideration must go into site selection and preparation; health status, number and characteristics of birds to be moved; chick care at the new site; and post-translocation monitoring and management.
3. Project planning should include assessments of the effects of the action on the source population and on the birds to be moved, and effects on the ecosystem at the translocation site.

1. BACKGROUND

1.1. Translocation as a tool for conservation of albatrosses and petrels

Birds in the order Procellariiformes exhibit strong natal philopatry and high nest-site fidelity. These behavioural traits along with a protracted incubation and fledging period, and ground nesting habit, result in high vulnerability to both predation by introduced mammals and commercial exploitation by humans at the breeding colonies. Such predation has led to extirpation of many populations of petrels around the world and magnified the consequences of stochastic events such as hurricanes, volcanic eruptions, epizootics or fires at the remaining safe breeding sites. As anthropogenic climate change continues to alter landscapes at an unprecedented rate, protecting and enhancing existing populations nesting on low islands has also become increasingly compelling (U.S. Fish and Wildlife Service 2012 http://www.fws.gov/home/climatechange/pdf/CCStrategicPlan.pdf). Translocation is the managed movement of live indigenous plants or animals from one location to another. Translocation covers the entire process, including planning, the transfer, release, monitoring and post-release management (up to some predetermined end point) (IUCN/SSC 2013)

Seabird conservation practitioners are increasingly considering the transport of eggs or chicks to hand-rear and re-introduce them to former breeding sites or to move them to new sites outside their historical breeding range (assisted colonization), especially in situations where social attraction techniques are not adequate on their own. Guidelines for evaluating the appropriateness of such actions, planning, implementing, and monitoring them were adopted by the IUCN/SSC (2013). Gummer (2003) reviews the use of chick translocation as a method for establishing surface-nesting colonies of seabirds and highlights some of the differences between establishing colonies by moving surface-nesting species and the more commonly translocated burrow-nesting seabirds.

At least three ACAP species, Black Petrel (*Procellaria parkinsoni*) (McHalick 1999, cited in Gummer 2003), Short-tailed Albatross (*Phoebastria albatrus*) (Deguchi *et al*. 2012a, 2014b), and Chatham Albatross (*Thalassarche eremita*) (Taylor, 2000a; Bell, 2013; https://www.facebook.com/chathamtaikotrust; https://vimeo.com/85167666) have been translocated as chicks to re-introduce or initiate new breeding colonies. Another three have been involved in some aspect of translocation procedures or artificial rearing for technique development (Laysan Albatross, *Phoebastria immutabilis*, and Black-footed Albatross, *P. nigripes*) or to enhance an existing colony (Northern Royal Albatross *Diomedea sanfordi*). Several others have been identified in conservation planning documents as candidates for future re-introductions or assisted colonization including Black-footed Albatross and Laysan Albatross (U.S. Fish and Wildlife Service 2011), and it has been suggested that it might be appropriate to re-introduce the Spectacled Petrel (*Procellaria conspicillata*) to Amsterdam Island and the Tristan Albatross (*Diomedea dabbenena*) to Tristan da Cunha (http://www.acap.aq/en/news/news-archive/57-2012-news-archive/225-translocation-of-fluttering-shearwaters-to-new-zealands-mana-island).

1.2 Colony establishment in Procellariiforms

While some of the behavioural traits of the tube-nosed birds such as high natal philopatry and nest-site fidelity inhibit the acceptance and colonization of novel breeding sites, the strongly colonial inclinations of most of these species allow some of the standard techniques of social attraction (decoys and broadcast of acoustic stimuli) to be used either alone, in combination, or to reinforce active translocation of chicks to a new site. Jones and Kress (2012) reviewed 128 projects involving 47 different species of seabirds in most seabird families. They found that translocation of chicks had been most commonly employed in burrow-nesting species, most of them procellarids, whereas the family with the most successful assisted colonizations and re-introductions using acoustic and visual stimuli alone were the terns (Sternidae).

Despite their reputation for faithfulness to the natal colony there have been a number of instances of natural recruitment to sites at which albatross nesting had never been previously recorded. Laysan Albatross banded as chicks in the Northwestern Hawaiian Islands have established colonies at numerous several sites on Oahu and Kauai several hundred miles to the south in recent years. Both Laysan and Black-footed Albatross have also initiated colonies off the west coast of Mexico (Pitman 1985; Dunlap 1988). Since 2003 a few pairs of Antipodean Albatross (*Diomedea antipodensis*) have started nesting on the Chatham Islands outside their previous breeding range (http://nzbirdsonline.org.nz/species/antipodean-albatross). Once pioneers establish nests at a site, the social attractiveness of the colony to other prospecting birds increases.

Key methods used particularly for establishing new colonies of burrow-nesting procellariids are acoustic attraction, provision of artificial burrows of a design well-suited to the species, and chick translocation if sound alone fails to lure birds into a site. The majority of burrow-nesting petrels show only nocturnal activity on land, so decoys are not considered to be as useful at night to lure birds to a site, although they are occasionally tried in open settings.

While the challenges of ensuring site imprinting and the long prebreeding period before subsequent return to the translocated colony for Procellarifomes are daunting, if the new colony is distant from the source colony and prospecting birds rarely pass by, then the extra expense and difficulty of egg or chick translocation may prove necessary to establish a new breeding site.

2. TRANSLOCATION OBJECTIVES, SITE CRITERIA AND HEALTH CARE

2.1 Translocation objectives

The objectives of the translocation will guide and constrain site selection, and the source population for the translocation. Restoration or reintroduction projects will likely have fewer unintended consequences than translocation for assisted colonization to novel sites, but all efforts should be undertaken only after careful consideration of effects on native species and human activities, and with assurance of long-term commitment by stakeholders.

2.2 Site selection criteria

The conservation practitioners have the obligation to ensure the translocation site is safe and under a land management regime that provides protection in perpetuity with a management plan in place. The site should be:

- suitable with respect to topography, access to the ocean, strength and direction of prevailing winds, climate, features for ease of take-off and landing such as take-off trees for climbing petrels and open areas for albatrosses, nesting substrate, reasonable distance to adequate foraging grounds, and high enough in elevation to preclude periodic inundation from storm waves or high tides;
- free of predators and invasive species harmful to Procellariiformes or be fenced prior to translocations and regularly managed to control those detrimental species. The fenced areas must be large enough to meet the space requirements for take-off and landing;
- surveyed prior to the translocation for the presence of any endemic species (flora or fauna) that could potentially be disturbed by the project, or that could influence the success of the colony establishment attempt, such as another species of burrow nesting seabird at the site;
- not likely to be needed for translocation of another population of the same species that is genetically distinct but that may hybridize with the subject population;
- relatively free of man-made or natural obstructions to facilitate fledging and arrival and departure of conspecifics;
- have no history of disease outbreaks, particularly diseases that can be dormant such as pox virus and avian cholera;
- relatively accessible to biologists, to facilitate delivery of supplies and monitoring;
- free from other conflicting uses (e.g. local fishing, aircraft operations, city lights, busy roads, antennae, etc.), or conflict avoidance measures should be feasible.
- for critically endangered species, carefully evaluated with regard to the distance between source and translocation site so that the ability of individuals to encounter conspecifics (e.g. at sea or over land) is not compromised.

If other human activities occur in the vicinity of the selected site, local residents should be informed and educated about the project, and their input sought and considered.

2.3. Regulatory compliance

Prior to implementation, appropriate permits from all affected jurisdictions should be obtained for capturing and manipulating birds, as well as modifying the reception site. This may include permits from federal and/or state level offices, and review by bioethics and animal welfare committees. Any translocation between national jurisdictions may require additional permits, such as export and import permits for CITES listed species.

2.4. Healthcare, welfare and disease prevention

Provisions must be made for appropriate health care and the highest achievable welfare standards for translocated individuals during all phases. Detailed healthcare protocols should be in place and a veterinarian should be available to deal with sick or injured birds, as well as examine those that die (e.g. to perform necropsy, see 6.3). Expert consultation and review of proposed bird transport and rearing methods by bioethics and animal welfare committees are encouraged. Obtaining additional information on bird health and response to stress, such as that obtained by Deguchi *et al*. (2012b), is recommended to help inform and improve future efforts. However, increased handling of chicks for sample collection purposes alone should be avoided.

Pre-translocation disease screening of adults (as a proxy for their offspring) should be considered, particularly when baseline information for the site and/or species are lacking. Knowledge about the history of disease outbreaks in the target species as well as in sympatric seabirds at the origin and reception sites could further inform translocation decisions. For screening and surveillance, focus should be placed on diseases considered to be detrimental to albatrosses and petrels (see ACAP review of pathogens affecting albatrosses and petrels, Uhart *et al*. 2014). For more information on pre-translocation disease risk analysis, see Guidelines for Wildlife Disease Risk Analysis (OIE & IUCN 2014).

Bio-security recommendations and hygiene best practices must be adhered to at all stages of the translocation operation, and particularly at the reception site to avoid inadvertent introduction and transmission of pathogens to newly established colonies (for more information see ACAP Biosecurity and quarantine guidelines for ACAP breeding sites, Wolfaardt 2011).

3. SITE PREPARATION

3.1. Site preparation

Ideally, the site selected for the translocation should already have substrate and vegetation structure preferred by the species to be translocated. If there are species of plants that create collision hazards, or block the wind and cause over-heating by preventing convective cooling, they should be removed. For the Chatham Albatross translocation, nests simulating their natural sites were constructed of 45 liter planters filled with cement and then peat. For Short-tailed Albatross, no structures were used. Because the trials with Laysan and Black-footed Albatrosses had not resulted in any losses or premature fledging even though the colony site was adjacent to a cliff, the Short-tailed Albatross team did not consider that fencing was necessary (Deguchi *et al.* 2012a).

For burrow-nesting species, artificial burrows will need to be installed to accommodate translocated chicks and to provide suitable nesting sites for prospecting adults (see Section 6.1). If there are plant species that will preclude future natural burrow construction or compromise structural stability of those burrows, they should be managed as well.

3.2. Social attraction

For projects involving surface-nesting species, the reception site should be prepared with decoys resembling the target species (Figure 1c). For surface- and burrow nesters, it is also vitally important to have a sound system (solar-powered) continuously playing species-specific calls from existing breeding colonies programmed to play at times of the 24 hour cycle appropriate for the target species.

Figure 1a. Sound system speaker on Matiu/Somes Island, New Zealand. The burrows with rocks on have been visited by prospecting adult Fluttering Shearwaters. Photo: D. Cornick.

Figure 1b. Example of part of the sound system deployed at Mukojima Island to attract Short-tailed Albatross.

Figure 1c. Short-tailed Albatross decoys. Note different decoy poses and plumages.

Figure 1d. Chatham Albatross chicks on artificial nests with adjacent decoys (Chatham Taiko Trust).

The decoys and sound system serve two purposes: (1) they provide visual and auditory stimuli to the developing chicks, which may allow them to re-locate the site when they attain breeding age; and (2) the calls and visual cues may attract others of the species to the site from a distance, and at closer range, the visual cues may encourage the birds to land. Juveniles that were not reared at the site but have not yet bred, have the potential to increase the population at the new site. A number of Short-tailed Albatross sub-adults that were not reared at the Mukojima translocation site have visited there, including one female that paired with a translocated male and laid an egg there in 2013 and 2014.

4. TRANSFER GROUP

4.1 Age at translocation

Age of the chick at translocation is an important variable that needs to be optimized to allow chicks the longest time possible with their natural parents for species imprinting, transfer of gut flora, and expert parental care without losing the opportunity for the chicks to imprint on, and increase the probability that they will eventually recruit to the translocation site. Deguchi *et al*. (2014) selected albatross chicks that were an estimated 1 month of age (at the onset of the post-guard stage of chick development). In addition to thermoregulatory and nutritional benefits, rearing by parent albatrosses for the first month is likely to minimize the chance that the chicks will imprint on humans, and allows transfer of parents' stomach oil (and possibly unknown species-specific micronutrients and antibodies) to the very young chicks.

The decision to move Short-tailed Albatross chicks at immediate post-guard stage was based on the results of Fisher (1971). His experiments with Laysan Albatross indicated that birds moved to a new location just prior to fledging returned as breeders to the site where they hatched, whereas chicks moved (and cross-fostered) at one month of age tended to return to breed at the translocation site. The selection of an age of one month may be conservative, but the extra hand-rearing time must be weighed against the overall effort, as the success of the translocation depends very much on chicks returning to breed at the new site. For the largest albatross species with very long pre-fledging periods, older chicks (2-3 months) could potentially be moved.

To evaluate appropriate translocation age, an experiment has been initiated by the Chatham Island Taiko Trust. Chatham Albatross chicks were translocated to main Chatham Island in January 2014. Initially, 30 chicks were translocated in January 2014, followed by an additional 20 chicks eight weeks later to help test approximate age of natal site fidelity and imprinting on the translocated site. All 50 chicks fledged by May 2014, and the return rate of the two treatment groups will be compared.

Burrow-nesting seabird chicks are thought to gain cues from their surroundings following emergence from the burrow shortly before fledging. Locality imprinting is considered to develop during this emergence period. Chicks that have never ventured outside natal burrows can be successfully translocated to a new colony location. The assumption is that success is optimized if chicks spend the greater proportion of the rearing period with parents before being moved.

Colony sounds and odours may also play a role in chicks imprinting on their natal colony, and may explain why a proportion of translocated fairy prions (*Pachyptila turtur*) that returned did so to the vicinity of their natal burrows from which they had never emerged as chicks, rather than the translocation site (Miskelly and Gummer 2013).

All large scale translocations to date have been carried out using chicks instead of eggs because of the obvious advantages of allowing the natural parents to care for the young as long as feasible. A translocation of Laysan Albatrosses from Kauai to Oahu, Hawaii initiated in 2014 involves moving eggs that would be lost as part of a bird aircraft strike hazard reduction operation at an airport, to try and found a new colony http://www.hawaiimagazine.com/blogs/hawaii_today/2014/12/18/laysan_albatross_moli_kauai_oahu_new_colony. This technique will present more challenges, with concerns about nutrition, health and disease resistance, transfer of natural gut flora, body temperature control, and species imprinting.

4.2 Number of chicks in each translocation cohort

Factors important in choosing the number of chicks for a translocation are genetics, rate of growth of the new colony, size of the source colony, and the practical limitations of logistical capability and labor to care for the translocated chicks. Since albatrosses and petrels are long-lived and there are large numbers of immature birds at sea, it is unlikely that removal of chicks will have an effect on the viability of the source population.

It may be appropriate to move fewer chicks in the first year of a translocation while methods are being tested or refined, and then to scale up accordingly. In the first year of the Short-tailed Albatross translocation project (2008), ten chicks were moved. Based on the amount of time and effort required to raise these chicks, it was considered feasible to translocate 15 chicks in each subsequent year of the project (2009-2012). In addition, the effort involved in hand-rearing chicks can be spread over a longer period; in the first year of the Chatham Albatross, 30 chicks were transferred initially, and 20 others after a further 2 months.

In the New Zealand burrow nesting work, the recommended number of chicks to transfer to a new site in the first year of a project is generally 50 if the implementation team has limited experience, or there are anticipated logistical issues to resolve at the release site (Gummer 2013). If the species has never been translocated before, a trial *in situ* transfer of a small number of chicks (e.g. <10) at the source colony may be appropriate to test artificial burrow design and hand-rearing methods, or, if this is not feasible, then a preliminary translocation of a small cohort (<50 chicks) to the release site is considered.

A maximum of 100 chicks of burrow nesting species is considered appropriate to transfer in any subsequent year. A larger cohort size than this could lead to logistical issues, either at the time of chick collection and transfer from the source colony or when managing chicks at the recipient site.

4.3 Number of translocation cohorts

Translocation projects ideally should span several years to increase the number of translocated animals within the logistical and other capabilities of the project (especially given the demands of hand-rearing), and to reduce the risk associated with environmental stochasticity. The Short-tailed Albatross Recovery Team conducted translocations for five consecutive years, which corresponds to the minimum age of first breeding of this species. Full project costs and funding options should be carefully considered prior to initiating a translocation project to avoid premature termination due to lack of funding; in some cases, moving larger cohorts over a shorter duration may be preferable.

Several translocation projects in New Zealand have involved a minimum of 200 chicks of burrow-nesting species transferred over a 3−4 year period. With increased confidence in techniques, it is now considered advantageous to move even larger numbers to increase the pool of birds returning to the new colony site and the encounter rate of conspecifics, which will encourage adults to settle there (Gummer 2013). Supplementary translocations in later years may also need to be considered.

5. SELECTING, COLLECTING, AND TRANSFERRING CHICKS OR EGGS

5.1 Selection of individual chicks to be moved

Chicks selected for translocation should appear healthy. Note that contamination of eggs with the bacteria *Pasteurella multocida* (causative agent for avian cholera, a significant disease for albatrosses) may occur, and that chicks can appear as healthy but be carriers of this disease. Moving eggs or chicks from sites with no history of significant infectious disease outbreaks such as avian cholera, pox virus, or others, is recommended to avoid inadvertent translocation of these pathogens.

However, selection of only the boldest chicks should be avoided, as this could bias sex ratio. The Short-tailed Albatross Team chose less fearful chicks during 2009 and 2010 because in the 2008 cohort the most timid chicks regularly regurgitated throughout the rearing period. This choice criterion resulted in a bias toward males in the sample of this species. Some Royal Albatross chicks also showed this tendency to regurgitate. In the Chatham Albatross translocation the chicks all adjusted to supplementary feeding so selection on the basis of individual boldness was not a consideration. Efforts to maximize representation of different parents from different parts of the source colony in subsequent translocation cohorts will enhance genetic variety of the translocation group and may reduce the likelihood of pair bond disruption that repeated “breeding failure” might cause if chicks from the same parents were chosen more than once.

For burrow-nesting species, only chicks with a high chance of fledging in good condition at the recipient site are taken (unless all known chicks are to be moved). Chicks fledging in optimum condition have an improved chance of surviving and returning as adults. Chicks need to meet species-specific criteria on the day of transfer (Gummer 2013). Setting a transfer wing-length range ensures that only chicks of appropriate age are taken. Setting minimum transfer weights for different wing-length groupings ensures chicks can recover weight lost during transfer while adapting to the hand-rearing diet, and still fledge in optimum condition. In addition, it is vital that chicks have not emerged at the source colony, not even for a single night. The only two Chatham petrel (*Pterodroma axillaris*) chicks translocated after they were suspected as having emerged for 1 night from natal burrows, were recaptured back at the natal colony as adults (H. Gummer pers. comm.).

5.2 Chick capture and transport

Minimising the risks of overheating and injury in the carrying containers, and stress from unfamiliar stimuli, are major considerations for the chick capture and transport phase. Different species respond differently to being transported, and the consequences of not addressing these issues effectively can be fatal.

Albatross chicks on Torishima were captured when their parents were not present. A soft blanket was placed around the chick and it was carried to a specially designed padded transport container (Figure 2a and b). During pilot work with Black-footed Albatross chicks in 2007, a much simpler container was used, with no apparent adverse effects (Figure 2c). However, the sturdy, opaque padded boxes may reduce chick stress (while maintaining sufficient ventilation), especially during transport by helicopter.

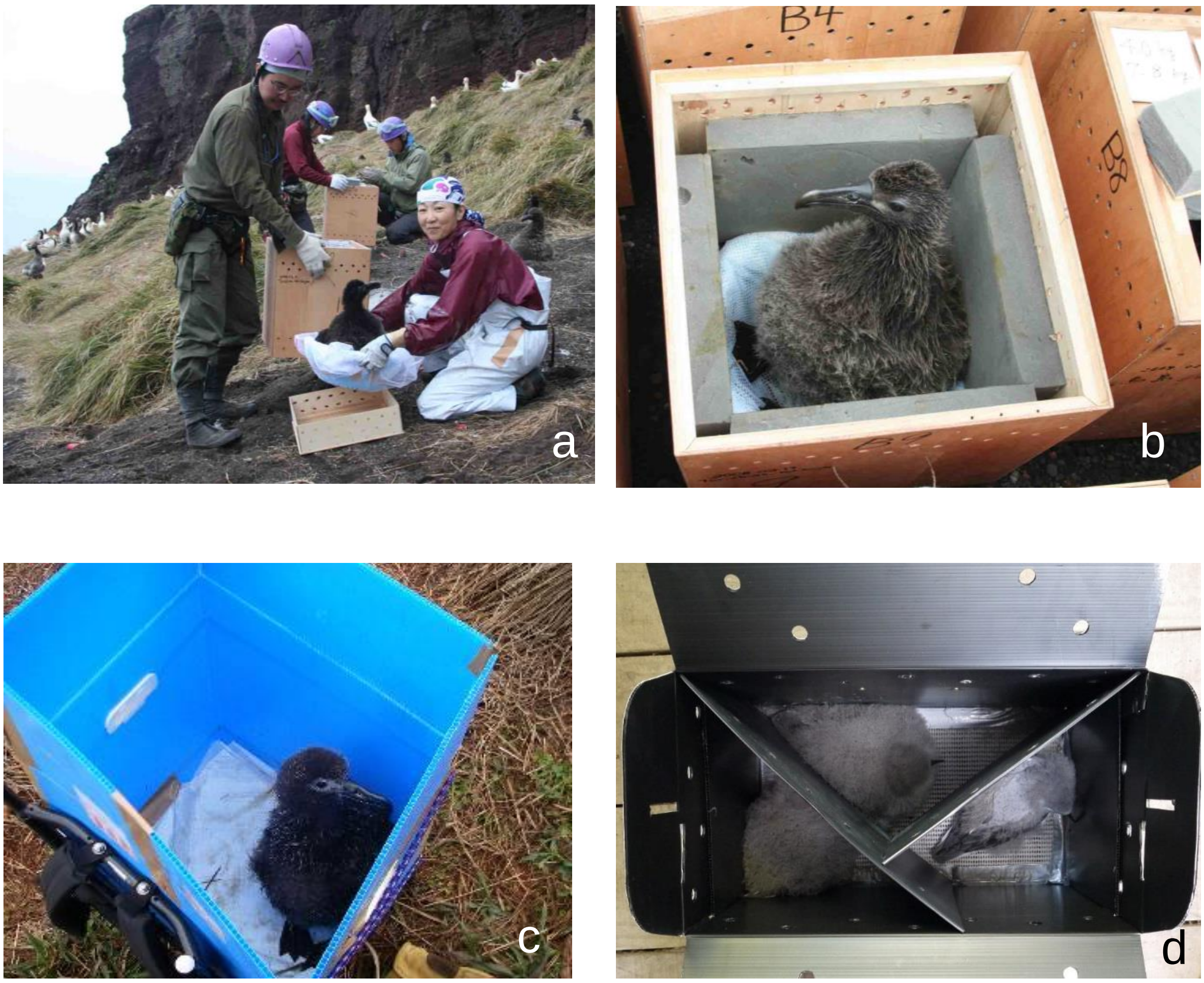

Figure 2. a and b Specially designed boxes used for Short-tailed Albatross transport. **c** Simpler container used for pilot work with Black-footed Albatross. **d.** Animal carry box with three compartments used to transfer Pycroft's petrels in New Zealand. Exterior walls are white to reflect heat. Note: use less tape than seen here to fix matting to floor so as to optimise drainage of excrement. Photo: H. Gummer.

The transfer box design used for most burrow-nesting petrel transfers in New Zealand is based on a standard pet (cat) box (Gummer 2013). There must be enough space and ventilation to avoid overheating issues, and to minimize wing and tail feather damage of the more advanced chicks. Boxes can hold one large chick, two chicks of a small-medium species with a single diagonal divider, three chicks with custom-made interlocking dividers (Fig 2d), or four chicks of a very small species with double diagonal dividers. Boxes also need to be heat-reflective, dark inside to reduce chick stress levels, and have flooring that provides grip and absorption of waste or regurgitant.

Minimizing transit time seemed to produce better results during albatross translocations in Japan. In a 2007 "mini-experiment" with Black-footed Albatross, Deguchi *et al*. (2014a) found that chicks moved to their new site quickly (within 2 hours) grew a bit faster and were slightly heavier at fledging than those that were held for 24 hours prior to release. This supported their decision to adopt the more expensive option of moving Short-tailed Albatross chicks from Torishima to Mukojima by helicopter (a 2-hour trip) rather than by boat (24-hour transit time). Transport mode for other species may vary, depending of the distance from the source to the new colony.

Chicks of burrow-nesting species that are tolerant to being transported tend to be transferred on single dates and have been moved by helicopter, aircraft, boat, and by road in New Zealand (Gummer 2013). However, multiple transfers are preferred for some species if they are logistically feasible and affordable, so that smaller groups of chicks are transferred on any one day, thus reducing the period between chick collection from the natal burrow and installation at the recipient site and avoiding transport during the middle (heat) of the day. This has proved most important for Northern diving petrels (*Pelecanoides urinatrix urinatrix*), a species particularly prone to stress and overheating, transferred in the early austral summer. Multiple transfers have the advantage of more chicks being available that meet transfer criteria if source populations are small, for example multiple transfers of Chatham petrels in any one season result in a larger overall transfer cohort compared to single transfers (Gummer *et al*. 2014a)

6. CHICK CARE AT THE NEW COLONY SITE

6.1 Holding facility and protection

At the release site Short-tailed Albatross chicks were placed on flat ground in a biologically typical spacing for the species, 5-10 meters apart. At the age of one month the chicks were not inclined to wander from the artificial nest site on which they were placed. Fisher (1971) found that Laysan Albatross could find their way back to their own nest site after being displaced as far as 75 meters by the age of 2 months. Chatham Albatross chicks moved prior to six weeks before fledging generally stayed on the artificial nests they were given, birds transferred at an older age were more mobile (Bell, pers. comm.) During a pilot study in 2006 using Laysan Albatross, a number of chicks were lost or weakened during a period of prolonged torrential rainfall shortly after translocation at a site on Kauai. In other climates, severe heat may be a concern. Thought should be given to providing some protection from the elements (shade or shelter) especially for young chicks. In extremely hot weather, spraying the birds with a fine mist of water may provide relief and protection from heat-stress. This method has been employed at the Northern Royal Albatross colony at Taiaroa Head, NZ, although used primarily during the guard stage (i.e., adult still with the chick in mid summer).

Safe and secure housing for translocated chicks of burrow-nesting species is provided in the form of artificial burrows. Essential requirements are that burrows are insulated from extreme temperatures, light-proof, water-proof and free-draining, and that chicks can be safely retrieved from all parts of the burrow. Burrows should also be as attractive as possible to prospecting adults, with safe access for monitoring future breeding attempts. In New Zealand, artificial burrows have been designed for use on flat ground in forests (Fig 3) and on sloping ground, e.g. above exposed cliff-tops (Fig 1a) (Gummer 2013). All chicks are blockaded into burrows for at least 2 nights after transfer, as a familiarization process (Gummer 2013). The pattern of blockade removal is influenced by pre-fledging behavior and is species dependent (refer to Section 6.4).

Figure 3. Flat-ground burrows (double lid type at the Chatham petrel artificial colony site, Pitt Island (Rangiauria). Photo by H. Gummer.

6.2 Feeding and handling regimen

The importance of administering oral (isotonic) fluids at transportation, to ensure chicks do not dehydrate, varies between burrow-nesting species. Relatively larger volumes may be accepted by chicks of species that are fed regularly (e.g. nightly) by parents, especially when transferred in hot conditions. Fluids are important for light-weight (for age) individuals of any species, especially if they have not been fed by parents on the night(s) before transfer. Tube-feeding fluids to very recently fed chicks of the less regularly fed species (e.g. small Pterodromas) is often avoided, especially if they are heavy individuals, due to the high risk of triggering oily regurgitations. However, heavy chicks are also vulnerable to heat stress so both risks need to be assessed for the species being moved.

When moving large numbers of chicks, it is usually more practical to give fluids on arrival at the release site. However, for some projects it may be appropriate to give fluids at time of capture before transportation, or even during the journey.

Feeding of albatross chicks began on the day after release at the new colony site, generally following the protocol outlined in the sections below.

In New Zealand, feeding regimes (meal size, composition, and frequency) for translocated burrow-nesting petrel chicks are tailored based on the biological traits of the species. These different regimes are presented in greater detail in Gummer (2013) and other referenced source documents. Usually feeding commences the day after transfer, but light-weight chicks of species that are fed regularly may benefit from receiving their first meal on arrival at the release site.

For all species, the objective is to mimic the growth trajectory of wild chicks and produce fledglings with the greatest possible probability of survival. Fledging wing-length and weight should fall within known ranges for the species.

6.2.1 Maintaining sanitary conditions

Maintenance of sanitary conditions is of utmost importance when hand-rearing chicks. Mortality attributed to infection in two Laysan Albatrosses during pilot work in 2006 may have been the result of food handling practices; and, food-poisoning and fungal infection in common diving petrels translocated within New Zealand in 1997−99 was attributed to inadequate husbandry technique (Miskelly and Taylor 2004).

Where perishable food items are used (e.g. albatross diet) they should be kept frozen in generator-powered ice chests (solar models are also available). The daily food supply is thawed in clean seawater 3–5 hours before feeding. With non-perishable diets (e.g. tinned products) and with vitamin/mineral supplements, the contents breakdown and expiry date must always be checked for each batch. Pet food and pureed foods (see below) should be kept on ice for transport to the hand-rearing site. At the site, the chilled containers can be warmed to slightly above ambient temperature to around 30°C which is closer to body temperature, in 50°C water prior to feeding.

The Short-tailed Albatross team used disposable gloves for preparing and administering food, and changed gloves between feeding each chick. Petrel chick-feeding teams in New Zealand consist of separate handlers and feeders, the latter focusing solely on food delivery and hygiene. A portable hand-washing station is always available, and operators regularly use anti-bacterial soap.

Separate feeding equipment should be used for each chick. Where this is less practical (e.g. feeding large numbers of petrel chicks on a daily basis), a meticulous disinfection and rinsing regime must be developed between chicks. In New Zealand, a broad-spectrum surgical disinfecting agent—Chlorhexidine—is used (Gummer *et al.* 2014b).

No feeding equipment should be reused without being sterilized. Albatross equipment was sterilized in 70% ethanol and soaked overnight in soap and chlorine solutions recommended for baby bottles (Miskelly and Gummer 2004), then rinsed and soaked in clean seawater prior to use. Petrel feeding equipment is thoroughly washed in very hot, soapy water, rinsed and soaked overnight in chlorine solution.

The Short-tailed Albatrosses were not fed when it rained heavily because the team could not maintain sufficient hygiene conditions for food and equipment. For burrow-nesting species, it is important to have a good shelter to operate under as some species must be fed daily, and it is preferable to handle birds out of direct sunlight.

6.2.2. Capture and handling

To minimize stress during feeding, noise should be minimized. Approach albatross chicks single-file to minimize visual stimuli. A soft fleece blanket can be used to restrain younger chicks during feeding. Petrel chicks can be safely transported from burrow to feeding station in dark carry-boxes to keep them calm. To avoid spoiling chick plumage and potentially compromising feather water-proofing, handlers must have clean hands or use a towel or disposable gloves. Excessive handling and prolonged restraint should be avoided because these events can induce several harmful effects characterized by neural, hormonal, immune, circulatory, and metabolic disturbances (Deguchi *et al*. 2014b).

Weigh and measure albatross chicks weekly prior to a daily feeding. A platform scale is recommended over a hanging scale for minimizing stress and potential injury to chicks. The body measurements useful for growth comparison with parent-reared chicks include lengths of wing, culmen and tarsus. The importance of obtaining these measurements to monitor growth should be weighed against the stress caused by the measuring process. Short-tailed Albatross chicks were measured once per week (Deguchi *et al*. 2012a.) These authors observed a great deal of variability between the amounts of habituation to handling among the three albatross species with which they worked.

Weight and wing-length are primarily recorded for chicks of burrow-nesting species to help plan meal sizes and schedule burrow blockade removal (Gummer 2013). The last weight and wing-length recorded is also used to assess whether a chick is likely to have fledged successfully or not when it is no longer found in its burrow.

If no other sampling occurs, pricking a vein (ie. foot) with a small gauge sterile needle and using commercial or Whatmann® filter paper to dry the blood drop allows for the collection of a blood sample sufficient for genetically sexing the birds (Quintana *et al*. 2003).

As chicks reach fledging age they should be individually marked to allow for long-term monitoring. Plastic leg bands with unique alpha-numeric codes that are proven to not affect the animal's survival and subcutaneous implantable transponders should be applied.

6.2.3 Diet composition

The diet fed to hand-reared albatross chicks should emulate the natural diet when possible and include plenty of variety to account for discrepancies in mineral balance of the diet. It should include supplements to compensate for the effects of freezing and then thawing food in running water or canning the food may have on its nutrient components such as thiamine and Vitamin E (Chrissy and McGill 1994). Dr. Tomohiro Deguchi and other researchers at the Yamashina Institute for Ornithology formulated a diet for feeding of translocated Short-tailed Albatross chicks. During the first 2–5 days post translocation chicks were given 80–156 g of pureed therapeutic pet food (Prescription Diet a/d™) and 300 ml of lactic Ringer's solution or physiological salt solution, diluted twice with spring water, daily to facilitate recovery from the stress of moving. Thereafter, chicks were fed darkedged-wing flying fish (*Cypselurus hiraii*), Japanese common squid (*Todarodes pacificus*), canned oil sardine, thawed Japanese sardine (*Sardinops melanostictus*) and Pacific krill (*Euphausia pacifica)* in the amounts shown in Table 1. The researchers hypothesized that wax esters in krill would increase water repellency of the chick plumage. These foods were pureed for young chicks (see section 6.2.4).

Table 1. Composition of diet fed to translocated Short-tailed Albatross

% Species fed each year	2008	2009	2010
Flying fish (*C. hiraii*)	51%	42%	22%
Squid (*T.pacificus*)	42%	40%	41%
Canned sardine	5%	---	---
Japanese sardine (*S. melanostictus*)			23%
Krill (*E. pacifica*)	2%	18%	14%

Chicks also received appropriate amounts of vitamin complex tablets (Mazuri Vita-Zu Bird TabTM, Mazuri Auklet VitaminTM) and 300–450 ml liquid containing 95% spring water and 5% clean seawater daily, for promoting development of chicks' salt glands.

The standard diet used in New Zealand for burrow-nesting petrels and shearwaters is a blended puree of Brunswick™ sardines in soy oil (106 g tin with contents: sardines 89%, soy oil 10% - replaced with a more nutritionally appropriate fish oil, salt <1% -), 50 ml water (pre-boiled >3 mins to ensure sterile), and Mazuri® Vita-zu seabird vitamin/mineral supplement (tablet Small 5M25; dose as advised). It is designed to feed chicks for the last third of the rearing phase prior to fledging. Variations to the standard tinned sardine diet successfully used on New Zealand projects include: adding more water (e.g. Northern diving petrels); and adding supplementary oils to provide additional energy and hydration (e.g. grey-faced petrels [*Pterodroma macroptera gouldi*]) (Gummer 2013).

New colony sites are being established in some remote New Zealand offshore island locations, and this was the driver to develop a diet that was practical in terms of transport, storage and preparation for hand-feeding, and suitable for fish, squid and krill-feeding species (Miskelly *et al*. 2009).

6.2.4 Amount of food administered

Short-tailed Albatross chicks have the most rapid growth rate that has been measured among albatross species (Deguchi *et al.* 2012). They were given 300–900 g daily of a mixture of these foods listed in Table 1 according to their daily metabolized energy per unit body mass (840 kJ kg^{-1}) estimated from related species (Hodum and Weathers 2003, Philips *et al.* 2003) and the energy density of each food. For the first 2-4 weeks of feeding, the food was pureed in a food processor to facilitate digestive absorption, adding 1–4 g of Avipro™ probiotic powder to reduce intestinal disorders. Thereafter, chopped or whole food was given. This feeding regime was continued until chicks were about 100 days old (mid-April), when chick body mass was at its maximum. The amount of food was then gradually reduced by 50–66% to reduce chick body mass by 20–30% prior to fledging. Amounts were limited to 100–300 g food and 30–300 ml of liquid every two or three days for 2–3 weeks prior to anticipated fledging.

Chicks of burrow-nesting species that are normally fed on a nightly basis by their parents will need daily feeding following translocation. For chicks that are not fed nightly but at irregular intervals (e.g. gadfly petrels), feeding frequency must be identified for each individual. Chicks can generally be put onto a standard regime that works for the species (e.g. once every 3 days). However, the standard regime will not suit all individuals and some chicks may need to be fed more or less often to allow appropriate weight changes, and avoid the risks associated with over-feeding (e.g. ventriculitis, regurgitation).

Following a gradual introduction to the new diet, over-feeding is avoided by setting a maximum meal size for each chick and a maximum daily weight gain appropriate to the species (Gummer 2013). A chick's response to feeding helps identify when meal sizes should be reduced. Identifying effective minimum meal sizes and a maximum allowable daily weight loss allows a very gradual decline in weight prior to fledging, so that chicks can fledge at optimum weight when they 'feel' ready. Feeding translocated petrel chicks small amounts right up to fledging is common practice, i.e. parental desertion periods do not need to be replicated.

Feeding guides developed for a range of New Zealand petrel species present several meal plans for one species based on chick size and weight at transfer, i.e. meal plans account for the different conditions chicks of the same species arrive in on transfer day (Gummer 2013).

6.2.5 Feeding method

Short-tailed Albatross chicks were always handled by two persons during feeding, one person restraining the chick, the other administering the food or liquids. The pet food and pureed foods were put into individual empty 350 ml caulking gun cartridges and fed to chicks with a caulking gun, through a silicon tube (internal diameter: 9 mm) inserted down the esophagus (Figure 4a). 450 ml syringes (used for lamb nursing) fitted with a silicon tube (internal diameter: 5 mm) were used to provide liquid (Figure 4b). Chopped and whole foods were also administered wearing gloves (Figure 4c). After a trial of feeding whole squid to chicks in the natal colony without trouble the Chatham Albatross team decided to proceed directly to feeding whole food to the translocated chicks.

Figure 4a. Use of caulk gun for feeding pureed food to young chicks **4b**. Use of lamb-feeding syringe for providing liquids

Figure 4c. Hand-feeding squid chunks to older chick

Figure 4d. Hand-feeding fluttering shearwater chick using plexi-syringe and custom-made Teflon crop tube. Photo: D. Cornick.

Two main syringe/crop-tube systems have been used in New Zealand for the burrow-nesting species: 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; and disposable catheter-tipped syringes (up to 50 ml) with catheter or other tubing (Gummer 2013, Gummer *et al*. 2014b). Feeding whole pieces of tinned sardine is not recommended for petrels as it is slow and can cause spoiling of plumage.

6.3 Health monitoring

As well as the physical health check made prior to transfer, a full physical examination should be given when chicks arrive at the release site, and at any point thereafter where there is unexpected or unusual chick behavior or posture, or any other signs of illness. This includes secretions from the eyes, difficult respiration, weakness and lethargy, lack of appetite, diarrhea or abnormal feces, and signs of dehydration. It is recommended that an experienced avian veterinarian is on site for the duration of the project.

The Short-tailed Albatross translocation team collected blood samples to determine the sex of translocated individuals, to compare 9 different blood chemistry parameters with those in naturally reared chicks (Deguchi *et al.* 2012a,b), and to characterize the effects of transmitter attachment and handling on hand-reared chicks (Deguchi *et al.* 2014b). These measures provided insight into health status of the artificially reared birds indicating better nutritional status in hand-reared birds than those raised by wild parents but evidence of possible muscle damage or capture myopathy in birds handled for transmitter attachment. Feathers can also be used for DNA sexing rather than blood as they easier to collect. It is recommended to pluck 3-5 contour or flank feathers (side of body under wing) avoiding hand contact with the quill tip (the part used for sexing). Feathers can be stored dry or frozen, or the feather bases snipped off and placed in 70% ethanol.

All efforts should be made to minimize incidences of regurgitation, and to handle chicks in such a way that regurgitant can be projected away from the body. For burrow-nesting species, there may be fatal consequences: soiling of plumage spoiling water-proofing and insulation; possible asphyxiation; and, aspiration of food particles leading to respiratory illness. Burrows should be carefully inspected for signs of regurgitation, especially while chicks adjust to a new diet and feeding regime, and to ensure chicks are passing normal faeces and urates.

Other serious health issues that practitioners must be aware of when hand-rearing chicks of burrow-nesting species, include: ventriculitis/proventriculitis (caused by gut stasis or food contamination); aspiration of food (caused by regurgitation or poor feeding technique); and dehydration and heat stress. In addition, appropriate first-aid treatment must be available as chicks can injure themselves during the emergence period, in particular tree-climbing species that engage in practice take-off flights.

Poor plumage condition can be an indication that a chick is not effectively preening; lack of preening behavior may be caused by an underlying illness or parasite loading which may require investigation. Birds can be stimulated to preen by spraying them with water.

Preventative mass medications (ie. deworming) should be avoided. However, careful monitoring or parasite loads (particularly external parasites) is recommended. Sick birds must be kept in isolation and strict hygiene precautions implemented (ie. using a separate set of utensils for feeding) to avoid inadvertent spreading of infections during routine handling, feeding and monitoring of chicks. Treatment and intensive care of sick birds should be provided as needed under veterinary guidance.

Complete necropsies and sample collection should be performed on all chicks that die during the translocation process to determine the cause of death. This will enable the correction of human-induced (or other) mortality factors in future efforts. Mortality of other species at the reintroduction site during translocation efforts should be similarly investigated as they may act as early warning sentinels, therefore allowing preventative actions for translocated animals. Teams are encouraged to prepare species and site-specific necropsy protocols, acquire necessary training and secure appropriate supplies and equipment (i.e. Nitrogen dewar) for such purposes prior to translocation events.

6.4 Pre-fledging behaviour in burrow-nesting species

Chicks of New Zealand species are not allowed to exit burrows before they have reached the minimum known first emergence wing-length for the species (emerging species), or are just short of the minimum known fledging wing-length (species fledging on the first night outside the burrow). Blockade removal strategies have been developed to ensure that any chicks disappearing from the burrow site prematurely will not perish and still have a good chance of fledging, even if at the lower end of the target fledging weight range for the species. Secondary criteria are species-specific and include weight, wing-growth rates and down coverage (Gummer 2013).

Strategies are necessary because projects rarely have daily access to a trained species detection dog and handler that can find any missing chicks. Lighter chicks that need to be fed daily are at the greatest risk if they can no longer receive meals, and some species are more prone to disappearing than others (e.g. Fluttering Shearwaters [*Puffinus gavia*]; Gummer and Adams 2010).

For critically endangered species, radio-transmitters can be attached to individual chicks of concern, so they can be found for feeding if they fail to return to their burrow before daylight, and removed before predicted fledging date if appropriate (e.g. Chatham Island Taiko [*Pterodroma magentae*]; Gummer 2013, Gummer et al. 2014c).

7. POST-TRANSLOCATION MONITORING AND MANAGEMENT

7.1 Monitoring translocated chicks’ post-fledging survival and behaviour

Transferring Procellariiform chicks to a new colony site is just the beginning of a long process of colony establishment that depends on survival of the translocated birds, their recruitment to the new colony site, and the social attraction of other pre-breeding individuals that will accelerate the growth of the colony into a viable population.

7.1.1 Satellite telemetry

Deguchi *et al*. (2012, 2014), compared the movements of half the translocated Short-tailed Albatross fledglings each year with those of parent-reared fledglings from Torishima, using Microwave Telemetry 22 g solar powered 106 GPS/Argos PTT-100 satellite transmitters. These devices, which comprised less than 1% of the bird's body mass, acquired six global positioning system (GPS) locations per day, at 2 to 4 hr intervals, and transmitted locations via Argos every 3-days. Tracking devices were either Tesa-taped to the back-feathers (Figure 4) or attached by harness with Teflon ribbon. They recommend the use of satellite telemetry to compare the movements of translocated vs. parent-reared birds for at least the first year or two of the project. The number of subsequent years to continue telemetry depends on available project funding and on weighing the importance of the information to be gained against the potential risks, especially for critically endangered species.

Figure 5. Short-tailed Albatross fledged in 2009 with satellite transmitter observed at sea, October 2009.

One important finding that has recently emerged from Short-tailed Albatross fledgling telemetry work is that all post-fledging mortalities from both Torishima and Mukojima have been females (R. Suryan pers. comm. Table 2).

The cause of this extreme female-biased mortality of SAT-tagged individuals is unknown. It could be that the transmitters comprise a slightly greater percentage of body weight of females at fledging. However, the 22 g transmitters comprised less than 1% of the mass of any of the male or female fledglings. Other possibilities are that females have a greater stress reaction to transmitter attachment or that female fledglings naturally suffer greater post-fledging mortality (Deguchi *et al.* 2014b). This differential mortality that may be related to handling stress may be an argument for avoiding the use of telemetry in translocated populations of highly imperiled species.

Table 2. Female biased short-term post-fledging mortality in Short-tailed Albatross fledglings satellite-tagged over 5 year period (Deguchi *et al.* 2014b)

	Hand-reared (Mukojima)		Naturally-reared (Torishima)		Result
Survival to sustained flight	**87% (27 of 31)**		**84% (26 of 31)**		***p*** **= 0.40** *z^2 Test*
	♂	♀	♂	♀	
Mortality sex ratio [# tagged]	**0 [n=17]**	**4 [n=14]**	**0 [n=12]**	**5 [n=19]**	***p*** **= .0064** *z^2 Test*

7.1.2 Radio-telemetry

Radio telemetry is an alternative to satellite telemetry, particularly for smaller species that require smaller, more light-weight devices. In New Zealand, radio-transmitters have only been attached to a small proportion of translocated chicks of two large gadfly petrel species (Grey-faced Petrels and Chatham Island Taiko) to confirm fledging success from fenced release sites in the first transfer year(s), i.e. to check that chicks were not becoming grounded outside the predator-excluder fence. Devices were taped to either tail or back feathers.

Use of radio-telemetry is considered high risk to chicks, especially if device attachment causes feather loss just prior to fledging. They should be attached as close as possible to the time of first emergence when feathers are nearer to completing growth and chicks are less likely to interfere with them. If the emergence period is lengthy, devices may need to be moved further up the feather shafts, closer to expected fledging date, to ensure they are secure (back or tail attachment) and closer to the bird's centre of gravity (tail attachment).

7.1.3 Camera surveillance

If the translocation site is inaccessible or cannot be manned once the operation is complete, a camera system that allows remote access by satellite or collects data that can be retrieved later is extremely helpful for documenting the visits of non-SAT-tagged birds to the colony and observing their interactions with other birds. The Short-tailed Albatross project benefitted greatly from the interest of NHK TV Japan. This TV station ingeniously installed satellite-linked video cameras in the decoy area (Figure 5a). These devices have provided a wealth of information about behavior of the birds and identification of non-translocated visitors. We recommend installing some sort of camera system to capture events that may only occur when humans are not present (Figure 5b).

Trail cameras with movement sensors are set up at burrow entrances and used effectively to monitor burrow activity at remote establishing colony sites in New Zealand (e.g. Chatham Petrels; Bell *et al*. 2013).

Figure 6a Satellite-linked video camera inside STAL decoy; **6b** Image captured with video camera of male from 2008 translocation copulating with unmarked female 4 years later.

7.1.4 Burrow monitoring

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 burrow monitoring schedule (Gummer 2013). At all times this must be balanced with minimizing nocturnal disturbance to the colony site as birds of different ages may visit the colony for the first time (as adults) at different times throughout the breeding season. If a species has a low rate of occupying artificial burrows, then searches must be done for natural burrows, which considerably increase monitoring effort.

7.2 Colony maintenance

During the Short-tailed Albatross translocation operations the chicks being reared served as the strongest attractants to other prospecting birds. The presence of human caretakers interferes with this social attraction somewhat but it is still important and a good argument for engaging in several years of chick rearing at the recipient site. After the final translocation, the decoys and sound system must be maintained and employed each year throughout the breeding season to attract both returning translocated birds and prospecting birds that fledged from other sites. Using these stimuli to attract the target species is even more important to ultimate success in the years following completion of the translocations, because: (1) the visual stimulation of the chicks will no longer be present to attract new recruits, and (2) the sounds of a breeding colony may provide essential cues to guide translocated birds back to the new colony site. Observations in the Mukojima colony confirm the intense interest that subadult birds have in the decoys and the speakers actively emitting

Short-tailed Albatross vocalizations in 2013 (J. Jacobs pers. comm). Documented visits to the site increased between 2008 and 2009 after the sound system was repaired.

Monitoring for hazards such as introduced mammals, dense or deleterious vegetation and insects (particularly those that can directly harm the birds or those that may act as vectors of disease) must be continued and if anything is detected appropriate management of the threat should be undertaken. Similarly, if ectoparasites are a problem, some type of control should be implemented (options should be developed and tested under veterinary supervision).

In addition to maintaining the sound system at new colony sites for burrow-nesting species, artificial burrows also need to be maintained on a regular basis to ensure they are safe and attractive to prospecting and breeding birds. Odour may be important in helping to lure prospecting adults to the site, so burrows are not cleaned out but left to fallow. Exposing the inside of used burrows to sunlight after translocated chicks have vacated the colony site is thought to be beneficial for hygiene.

Some prospecting adults may arrive at the site in between or during chick translocation operations. Avoid using any visited burrows for accommodating chicks; extra burrows may need to be installed.

7.3 Measuring success

Establishment or restoration of colonies of Procellariiforms is a long-term commitment and markers of success must be incremental. These metrics also are necessary for refining protocols. Milestones that can be quantified include:

- Proportion of chicks that survive capture and transfer to new site
- Proportion of chicks that fledge from the colony
- Body condition of fledged chicks
- Annual survival of translocated chicks
- Sex ratio in chick groups translocated
- Proportion of translocated chicks that return to the new colony from which they fledged
- Proportion of the translocated birds that recruit to the new site
- Proportion of translocated birds recaptured or observed at the source population site
- Number of prospecting birds fledged from other colonies that visit the site
- Number of those birds fledged from other sites that recruit to the new colony
- Reproductive performance (hatching success, fledging success) of birds breeding in the new colony
- Natural recruitment of chicks raised completely in the new colony

The translocation of Short-tailed Albatross to Mukojima Island is the first such conservation action for a surface-nesting Procellariiform bird that has been monitored closely enough to measure these values. Deguchi *et al*. (2014) reported that all 70 Short-tailed Albatrosses transported from Torishima to Mukojima over a 5 year period survived the trip and that 69 of the 70 chicks survived to fledging. In the 2014 translocation of 50 Chatham Albatross chicks all birds fledged. Post-fledging survival of Short-tailed Albatross chicks carrying PTTs from colony departure until sustained flight was 85% and not significantly different between hand-reared and naturally reared chicks. Total visits to the breeding colony by translocated birds and birds fledged elsewhere have increased yearly and birds from the first cohort have exhibited reproductive behavior. Between February 2011 and May 2014, 20 of the 69 fledglings (29%) have returned to visit Mukojima at least once. In late 2012 the first Short-tailed Albatross egg was laid by a naturally reared female paired with a hand-reared bird from the 2008 cohort. A second egg was laid by the female of this pair in late 2013. Neither egg hatched but this reproductive behavior is occurring earlier than expected. Neither bird of this pair has yet developed full adult plumage. A well-studied translocation of another surface nesting seabird, the Audouin's Gull (*Larus audouinii*), to a new colony site in order to enhance the metapopulation of that species was deemed a failure because even though survival rates of the translocated birds were comparable to those of wild birds in the population and there were some social attractants in place at the new site (decoys and non-flighted conspecifics), the neighboring natural colonies proved more attractive to the hand-reared birds and they did not recruit to the release site. The authors attributed this to either the strong attractiveness of adjacent established colonies or some recognition of differences in habitat quality between the new site and established colony areas (Oro *et a.l* 2011). The prognosis for the first completed translocation of a surface nesting Procellariiform bird may be better due to different phylogenetic tendencies in colony establishment behavior between Larids and Diomedeids.

Translocations involving hand-rearing of burrow-nesting Procellariids have been underway in New Zealand since the early 1990s (Bell *et al*. 2005; Miskelly and Taylor 2004). Eight species from four different genera were translocated by 2008 (Miskelly *et al*. 2009) and one more species has been translocated since. Techniques have been developed and established for most of these species to a level where health issues are minimal and all transferred chicks fledge at parameters similar to naturally-raised chicks, or even exceeding the quality of naturally-raised chicks.

One of the most encouraging project results to date is for Chatham Island Taiko; 70% of the 21 chicks transferred over 2007 and 2008 have been recaptured as adults (M. Bell, Chatham Islands Taiko Trust, pers. comm. 2014). Up to 20% of translocated cohorts of Chatham and Pycroft's Petrels translocated in the early-mid 2000s have returned to their respective release sites as adults (H. Gummer and G. Taylor pers. comm.) and establishing populations are now reliant on the very slow recruitment of chicks naturally raised at these sites and of any new immigrants. Supplementary transfers may be considered to boost numbers if deemed necessary. Recruitment of immigrant Fluttering Shearwaters to Maud Island and of chicks raised there is not currently sufficient to sustain colony growth (M. Bell, pers. comm., 2013). Techniques for this species were improved during translocations to Mana Island (2006−2008) and have resulted in some encouraging survival rates (48% of 91 chicks from 2007 recaptured so far as adults), and breeding results on Mana Island (146 chicks fledging in the first 9 years of breeding; H. Gummer pers. comm.).

Supplementary transfers have already been implemented or planned for other species. An additional cohort of Hutton's Shearwaters (*Puffinus huttoni*) was translocated to the establishing colony site coinciding with the return of original translocated cohorts (http://www.huttonsshearwater.org.nz/, viewed August 2013). Miskelly & Gummer (2013) report that 20 of 240 fairy prions transferred by 2004 were recovered at the release site, but

25 translocated birds attracted back to the abundant source population. In addition, there has been a very low level of recruitment of non-translocated birds at the new colony site. Supplementary transfers of fairy prions to Mana Island are scheduled for 2015 and 2016.

Miskelly & Taylor (2004) report that 17% of common diving petrels transferred in the late 1990s were recovered at the release site. However, this project has shown the highest recruitment rate of non-translocated birds compared to all other New Zealand species, with 80 immigrants recorded within 11 years of the first chick translocation (Miskelly *et al*. 2009).

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