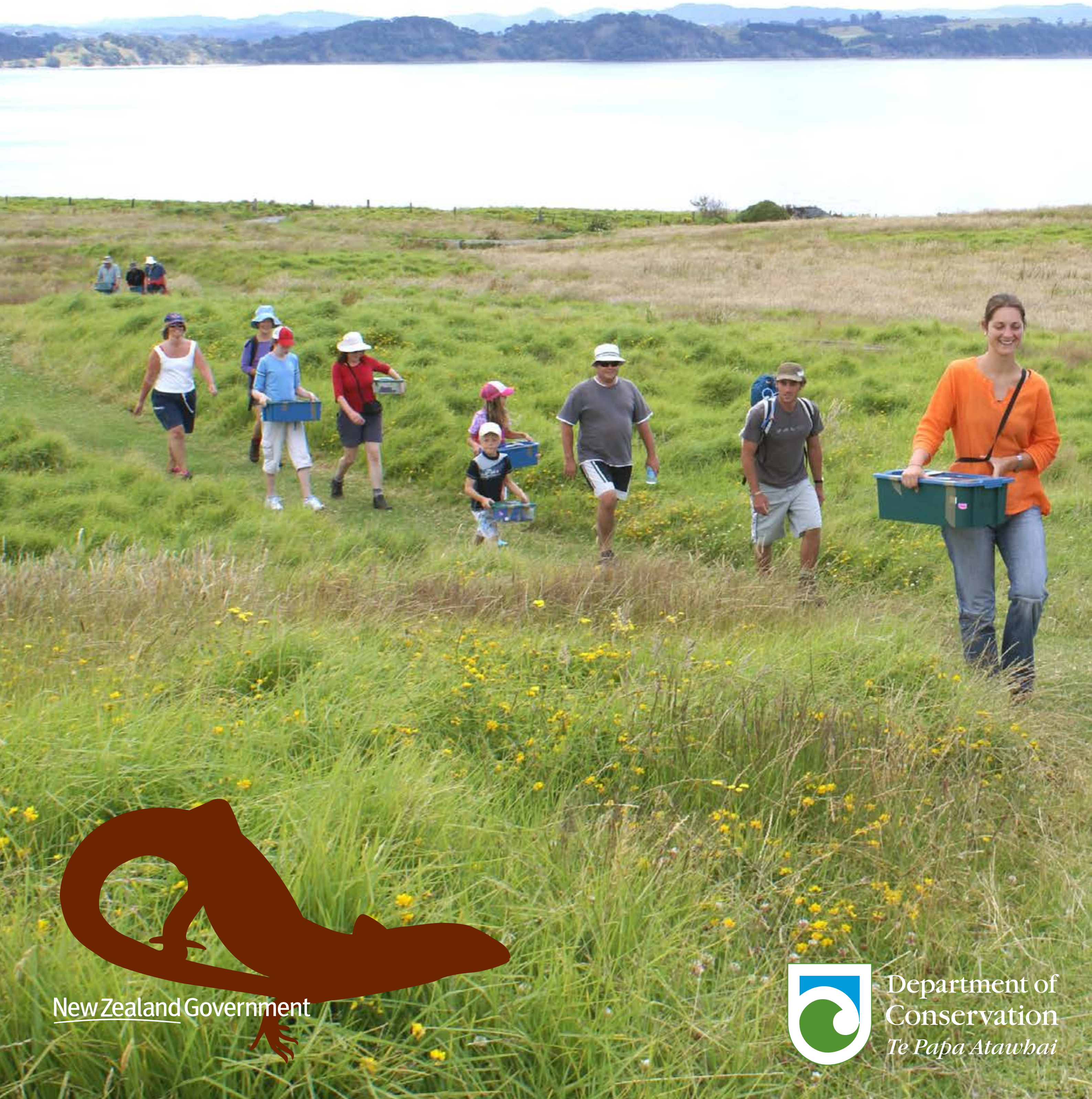
Guidelines for conservation-related translocations of New Zealand lizards

Department of Conservation Lizard Technical Advisory Group



Cover: Release of lizards, Limestone Island (also called Matakohe), near Whangarei. *Photo: Ben Barr.*

ISBN 978–1–98–851465–9 (web PDF)

This report was prepared for publication by the Creative Services Team; editing and layout by Lynette Clelland. Publication was approved by the Manager, Terrestrial Ecosystems Unit, Department of Conservation, Wellington New Zealand.

Published by the Department of Conservation, PO Box 10420, The Terrace, Wellington 6143, New Zealand.

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1. Introduction

This document has been written by the Department of Conservation's (DOC's) Lizard Technical Advisory Group (TAG). Its purpose is to provide advice about appropriate lizard translocations[1] for conservation purposes within New Zealand. Given the increased interest in lizard translocations across the country, and the reality that lizard stocks are not limitless, this document (and supporting material) provides over-arching guidance about which lizard stocks and sites are highest priority for translocations in New Zealand, both to maximise species recovery, and to ensure that ecological integrity is maintained at restoration sites. Applications to the TAG for advice on lizard translocations will then be assessed against these guidelines on a case-by-case basis.

Published reviews of translocations undertaken in New Zealand indicate that in excess of 1000 wildlife releases have occurred since reasonable records have been maintained (Sherley et al. 2010; Miskelly & Powlesland 2013). While many people perceive the success rates of translocations to be high, the reality is that reintroduction biology is a developing science and success rates for wildlife translocations worldwide usually fall within the range of 26–46%. New Zealand translocations have similar success rates (7–44%) (Miskelly & Powlesland, 2013), depending on the taxa involved. Success is commonly defined as the population at the translocation site having at least half of its breeding adults produced at the new site (see Sherley et al. 2010). Because lizards breed slowly and take several years to reach maturity, this can take years to achieve, even for highly successful translocations. Confirmation of translocation success is also made harder by the highly cryptic lifestyles of many lizard species.

However, without considering salvage translocations[2], there are indications that New Zealand reptile translocations are likely to have a high success rate. Deeming translocations of a single species between the same two locations on multiple dates to be a single translocation, Sherley et al. (2010) examined 12 translocations of geckos. Of these, seven have shown indications of success (long-term survival and/or breeding confirmed), and some of the remaining five may yet be found to have succeeded. Most of the translocations for which establishment has not been confirmed involved the introduction of the highly camouflaged green *Naultinus* spp. geckos to islands. Sherley et al. (2010) examined 26 translocations of skink species. Of these, 25 had some preliminary indication of success (although many of these had not yet achieved the criterion that the majority of the resident breeding animals are locally born). Although some earlier tuatara (*Sphenodon punctatus*) translocations failed, all those undertaken in the 1990s and since show at least preliminary signs of success (e.g. survival, breeding). Therefore, apart from green geckos, the success rate of recent reptile translocations motivated by species recovery or ecological restoration seems very high. However, it is important to realise that most of these translocations were into absolutely ideal conditions on islands where mammalian predators (lizard predators and competitors) had recently been eradicated. This will not necessarily be the case in other situations, for which the success rate may therefore be much lower.

These technical guidelines will assist the lizard TAG in providing high-quality, consistent and up-to-date advice in response to conservation-related lizard translocation applications. They can also be used to assist groups with planning their translocations, and writing the translocation proposals. The guidelines draw on the combined expertise of the TAG to provide best practice for conservation-related lizard translocations in New Zealand. They should not be used as a substitute for site- and lizard-species-specific advice; rather, they should be used to complement such advice.

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1 Translocation is defined by DOC as the managed movement of live plants or animals (taonga) from one location to another. Translocation covers the entire process, including planning, transfer, release, monitoring and post-release management (up to some predetermined end point). A translocation can consist of one or more transfers.

2 A salvage is defined by DOC as the permanent removal of lizards from their habitat to another site in order to protect them from displacement or death caused by negative activities to them or their habitat(s).

Information about translocations and writing a proposal is available at http://www.doc.govt.nz/get-involved/run-a-project/translocation/. The TAG is available to help with species and site-specific planning of translocations, but it is expected that translocation managers will use these guidelines to support their translocation planning. It is recommended that the TAG is consulted at an early stage to make sure that the species and sites under consideration are sensible and ecologically appropriate, and that the best practice guidelines outlined in this document are taken into account during planning.

2. Animal welfare requirements

In order to ensure the welfare of animals during translocation and to maximise the chance of a successful translocation outcome; the team of people carrying out the translocation needs to include members with suitable training and experience in the capture, handling, holding and release techniques that will be used. These expert operators are needed on site to demonstrate techniques and provide advice to less experienced team members (such as volunteers).

When handling wildlife, the animal welfare provisions of the Animal Welfare Act 1999 and its welfare codes[3] (e.g. Transport within New Zealand) must be met. Note that these best practice guidelines have been produced to improve the likely success of translocations of lizards, and thus promotes a high level of care of the reptiles and a consideration of general animal welfare. However, it does not attempt to address each of the minimum standards listed in welfare codes.

3. Types of conservation-related translocations

3.1 Reintroduction to predator-free sites

The most common type of translocation is re-introduction[4] to a predator-free[5] site. In this type of translocation, lizard species are released into an area within their historic range (refer to section 3.4). Predator-free sites include several offshore islands and predator-exclusion fenced sanctuaries[6]. Other mainland and island sites have an ongoing commitment to predator control at a level expected to protect lizards sufficiently to allow an increase in their population (for example, Reardon et al 2012).

Lizards subject to a translocation may originate from a wild population or populations, from captive stock (when the original provenance of the stock is known), or a mixture of both. The translocation of barking geckos (*Naultinus punctatus*) from the Wellington-Hutt Valley region and from captivity to Mana Island and Matiu/Somes Island in the same region, are examples of wild translocations supplemented with known-origin captive stock onto islands from which predators had been eradicated (DOC, unpubl. data). The translocation of jewelled geckos (*Naultinus gemmeus*) into Orokonui Ecosanctuary, Dunedin, is an example of a wild to fenced sanctuary translocation (A. Tocher unpubl. data, 2009).

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3 www.biosecurity.govt.nz/regs/animal-welfare/stds/codes (viewed 1 August 2016)

4 See Appendix 1 for a glossary of terms relating to translocations.

5 It is possible that there are acceptable population thresholds of predators in relation to survival of lizards but these are unknown to date. Tests to determine a threshold would be carried out on less threatened species; in high-quality habitat sites; and with a high level of predator control occurring year round. Mice are likely to be significant predators; however, mouse-control techniques are currently ineffective.

6 Note that predator-exclusion fenced sanctuaries have intermittent incursions of predators, some of which are not ever fully eradicated, e.g. mice at Zealandia (Wellington) and Orokonui Ecosanctuary (Dunedin). Because of the continued presence of predators, these sites may not be suitable for some lizard species.

3.2 Supplementation of existing wild stocks (by either wild-to-wild or captive-to-wild translocations)

This type of translocation is used to boost genetic stocks of a remnant population, or to improve the genetic base of an already translocated population when there is a concern about founder effects. Founder effects or genetic bottlenecks resulting from extreme reductions in population size can be overcome by increasing genetic diversity of the establishing population through the addition of more lizards. Supplementation differs from 'multiple releases' (refer to section 9.4).

3.3 Salvage of a lizard population

Salvage translocations include 'mitigation translocations' in the current IUCN terminology (IUCN 2013), but may not equate exactly to them, although ideally will. Many salvage operations do not meet usual translocation standards and are normally motivated by a requirement to mitigate the impacts of habitat clearance through the Resource Management Act. Salvage translocations are not covered by these guidelines (refer to Key principles for lizard salvage and transfer in New Zealand, DOC 2016).

Ornate skink, *Oligosoma ornatum*. *Photo: DOC Image Library.*

Salvage is rare in the context of conservation-related translocations and tends to fall outside DOC's usual activities on land administered by it. An example of a salvage translocation occurred recently in the Wellington area, where cats were catching a lot of ornate skinks (*Oligosoma ornatum*) (Fig. 1). A publicity campaign encouraged the public to rescue ornate skinks brought in by cats. DOC translocated these skinks to Matiu/Somes Island (in Wellington Harbour) in a piecemeal manner between 2006 and 2010 with the aim of establishing a new population at this predator-free site.

3.4 Introduction of a species to an area outside its known geographic range

The most unlikely translocation type, and those generally discouraged by the TAG and others (e.g. Griffith et al. 1989), are those that seek to translocate lizard stock from the wild or captivity to areas outside their known, or likely historic, geographic range.

Two types of introduction that may be considered appropriate in the future but have not so far occurred for New Zealand lizards are ecological replacement and assisted colonisation. Ecological replacement is the intentional movement and release of an organism outside its indigenous range to perform a specific ecological function previously carried out by a similar species no longer found at the site and not available for translocation (IUCN 2013). Assisted colonisation is the intentional movement and release of an organism outside its indigenous range to avoid extinction of populations of the focal species (IUCN 2013).

4. Genetic structuring within lizard species

Lizards to be translocated into an area must be shown to be a close match, in terms of species and local genetic stock, to the resident population at the destination site.

Many lizard species in New Zealand display strong geographic genetic structuring; i.e. there are clusters of genetically distinct populations in different geographic areas within the range of many individual species. Genetic structure should be preserved as far as practicable because the current geographic distribution of a species, and the phenotypes observed, mask underlying genetics that result from important evolutionary processes. There are demonstrated benefits in protecting genetically distinct populations (Weiser et al. 2013) even if they are small and difficult to detect – they add to the robustness and diversity of the wider population, and they may be more suited or adapted to local environmental conditions. They may also have unique features not found over the rest of the species' range (e.g. the dimorphic population of the forest gecko (*Mokopirirakau granulatus*) on the Denniston Plateau).

Various terms are in common usage in the literature to describe populations of a genetically structured species: terms include 'management unit' (MU), which are units of larger 'Evolutionary Significant Units' (ESUs), genetic stocks, populations, subpopulations, and metapopulations (a 'population of populations', each of which interact at some level). Mixing of ESUs and of populations should be avoided to maintain the genetic integrity of all populations. To avoid mixing ESUs when planning translocations of lizards, the following principles should be applied:

- Freely mix populations that are now artificially isolated but would previously have been part of the same contiguous and more widespread population (e.g. barking geckos) from different native vegetation remnants in the Wellington area).
- Freely mix genetic stocks to restore modified or changing environments or for introductions into novel environments (e.g. Cook Strait and northern populations of tuatara could, hypothetically, be mixed for reintroduction to the central North Island).
- Occasionally mix subpopulations that would previously have been linked by intermittent gene flow in a metapopulation structure (e.g. western populations of Otago skink (*Oligosoma otagense*) from different locations in the Lindis Pass area). Excessive mixing may mean loss of local population structure including possible local adaptations. However, movement of small numbers of animals from time to time may be used to mimic the rare natural dispersal between populations that would have occurred when the habitat was more intact.
- Do not mix populations that have remained separate over an evolutionarily significant length of time[7] (tens of thousands or more years, e.g. eastern and western populations of Otago skinks). An exception to this rule would be if it was the only way to rescue a genetically compromised population (e.g. supplementation of a remnant population that was showing signs of inbreeding depression).

Sometimes there will be doubt about the genetic status of a population and its appropriateness as a source for lizard translocations; in such instances genetic confirmation is needed. If there is an existing remnant population at the release site, its morphology and genetics need to be compared with those of the source population for the translocation. A close match is needed in these circumstances. More often there will be no existing remnant population, in which case this

[7] Key references are Chapple et al. (2009) for skinks and Nielsen et al. (2011) for geckos.

matching process is less critical. However, it is still beneficial to match the population that was previously present as closely as possible, as this population will have been adapted to the local conditions. Tail tips can be taken (refer to the DOC Standard Operating Procedure for sampling reptilian tissue (DOC 2010)) to determine the population's relationship to other populations of the species, and ultimately to inform decision-making. In the absence of robust genetic data, a source population should be the closest population to the release site. If there remains some uncertainty, then we advocate using the precautionary principle and not undertake the translocation unless there is a clear conservation priority for the species.

5. Consultation

Consultation with local tangata whenua is essential and consultation with other stakeholders is also often required.

For DOC-led translocations and for the permitting process, DOC has an obligation, under Section 4 of the Conservation Act 1987, to give effect to the principles of the Treaty of Waitangi. DOC staff are required to consult with iwi that may be affected by the translocation of lizards. For community-led conservation-related lizard translocations, consultation with tangata whenua affected by the proposal and other stakeholders is important to ensure ongoing support and to maintain strong working relationships. Failure to engage with all stakeholders can put future translocations at risk and delay the permitting process (refer to DOC, 2012: Translocation guide for community groups DOCDM-363788).

Do not assume that recommendations made by the Lizard TAG have involved any consultation with affected parties such as iwi or land owners. The TAG only considers technical matters. It is the responsibility of each applicant to carry out a full consultation with all affected parties (e.g. tangata whenua) as soon as their translocation proposal is written.

6. Planning and preparing for translocation and release

6.1 Habitat suitability

The habitat at the release site must be adequate to meet all the needs of the lizards at the time of release. Selection of habitat must take into account vegetation growth, environmental and land management changes, in order for the lizards to persist at the site in the future.

Notwithstanding the predator issues detailed in sections 6.2–6.4, the following criteria identify key matters that need to be considered when assessing the adequacy of habitat at the release site for lizards. The release site must:

- Be subject to a long-term commitment to implement conservation activities for the benefit of the establishing population of translocated lizards.

- Have a very low probability that the same lizard species is extant at the site.
- Contain appropriate high-quality habitat (predominantly indigenous vegetation) that is contiguous and large enough in area to support the translocated lizards into the future.
- Contain appropriate high-quality habitat for all life history stages of the lizard species.
- Provide sufficient food, cover and retreat sites for the establishing population of translocated lizards. Note: for predator-free sites, invertebrate food resources may need up to two years to recover after predators have been removed (Watts et al. 2011).
- Be buffered from intermittent climatic extremes, such as drought.
- Be accessible and favourable for post-release monitoring (refer to section 10).

6.2 Predator-free status / biosecurity

To date, only one peer-reviewed, published study has demonstrated the recovery of New Zealand lizards using predator control alone (Otago skinks and grand skinks (*Oligosoma grande*) at Macraes Flat; Reardon et al. 2012). Another study on an island with mice (*Mus musculus*), rats (*Rattus* spp.), stoats (*Mustela erminea*), and cats (*Felis catus*), but without weasels (*Mustela nivalis*), or possums (*Trichosurus vulpecula*) has shown that forest geckos occupy artificial covers almost twice as often at a site where predators are controlled than at a site with no predator control, indicating that the gecko population is benefiting from the predator control (Bell et al. 2012). At Zealandia, where mouse numbers are controlled annually and other mammalian predators are excluded, slow but sustained recovery of ornate skinks has been demonstrated (R. Romjin pers. comm.). There are indications that ngahere geckos (*Mokopirirakau* 'southern North Island') at Zealandia are also responding – research recorded thirty ngahere geckos under 200 closed-cell foam covers checked seven times during a two-week period in March 2013 at Zealandia (T. Bell & S. Herbert, unpubl. data). In contrast, only five ngahere geckos were recorded in the reference site – Wright's Hill Reserve, Karori – using equal sampling effort. However, at many sites no measureable benefit to lizards has been seen after control of mammalian predators – perhaps because lizard populations were initially so low at these sites that it would take a very long time for the population to grow enough to become detectable. There is an urgent need to understand the exotic mammalian predator density thresholds required to maintain and increase lizard populations, although it is assumed that most predators have a negative effect, even at relatively low densities. For these reasons, the TAG does not recommend translocation of lizards into sites that are not 'predator-free', or cannot be easily maintained predator-free through biosecurity. The TAG believes it is appropriate to consider translocations into sites that have a demonstrated effective high-intensity multi-species predator control regime that will protect a translocated lizard population.

A high risk of predator reinvasion remains at some sites after eradication has occurred. Many islands are within swimming capability of many predators, or predator-exclusion fences can be compromised or fail (e.g. mice at Zealandia). Biosecurity procedures – or 'preventative' predator control – at these sites are often more stringent than at sites with a low risk of reinvasion. For sites where new eradication/control techniques have been tested, there needs to be an independent assurance that the eradication is confirmed as successful. This is because many lizards have an extremely low tolerance to mammalian predation, and even species that co-exist with mammalian predators at the source location might have difficulty establishing new populations in their presence elsewhere.

Tuatara and indigenous avian predators – such as kingfishers (*Todiramphus sanctus*), kiwi (*Apteryx* spp.), saddlebacks (*Philesturnus* spp.) and weka (*Gallirallus australis*) – may impact on the potential success of the translocation and therefore the selection of a release site (van Winkel 2008) (refer to section 6.4).

6.3 Post-predator eradication stand-down period before translocation of lizards

In the presence of predators, a lizard population can sometimes persist, yet in such small numbers that it is undetectable. To be sure which species of lizards do and do not persist at a potential translocation site, at least 10 years should be allowed to elapse after predator eradication to allow these populations to increase to detectable numbers. Translocations of species that may have survived at the release site should not take place until this stand-down time and subsequent surveys have been completed, thus minimising the chances of translocating species already present.

At release sites where little is known about the lizards that were once present, or those that may still be present but are hard to find, there are risks that if a suitable stand-down is not adhered to any remaining populations may be lost with the introduction of a new genetic stock through translocation. These risks entail:

- Loss of regional populations and rare alleles.
- The dilution of a locally-adapted population.
- Competition between species not adapted for co-existence.
- Limiting options for future translocations.

Such risks can be managed by imposing a minimum 10-year stand-down period; the stand-down commences at the time predator-free status is declared (following from predator control) and ends after 10 years of continuous predator-free status and significant search effort for resident lizards.

As illustrated by the following examples, any potential translocations should not be considered until at least 10 years have elapsed after predator eradication (including mice), **and** comprehensive lizard surveys have been undertaken. There may occasionally be some exceptions to this rule (e.g. for urgent conservation of a highly threatened species which is very unlikely to have persisted in the presence of mammalian predators), but all potential exceptions require a thorough assessment of the risks and clear justification.

The rationale behind the 10-year stand-down comes from the observation that it can take many years of intensive survey before an assurance can be given that a lizard species is present (or not). For example, southern North Island speckled skinks (*Oligosoma infrapunctatum*) were found in a 2 ha predator-free enclosure built in a farming landscape at Cape Kidnappers, 50 years after this species was last recorded c. 15 km away at Waimarama Beach. On Tiritiri Matangi Island – an island subject to intensive research and high visitor numbers – common geckos (*Woodworthia maculata*) were not detected until c. 13 years after rodent eradication.

6.4 Order of release of species when enacting a translocation for site restoration purposes

Within the current and likely historic range of a lizard species, predator-free sites are scarce, and lizards are frequently a secondary consideration for site restoration to more charismatic species. Predator-free mainland sites and predator-free islands are commonly subject to ecosystem restoration. Restoration plans can help to define the order in which species will be released to a site.

However, there is a need for more research on the effects of competition and predation from other lizard species and other indigenous species.

Key matters to consider before lizard releases include:

- Conservation urgency.
- Impacts of competition, predation and displacement.
- Body size and fecundity of translocated lizards.
- Adequate food resources and places for shelter at the release site.
- Long-term management plans for the release site (habitat restoration, further translocations of lizards and other species).

6.4.1 Conservation urgency

As a general principle, when translocation of multiple lizard species is planned for a predator-free site, priority should be given to the lizard species of highest conservation urgency. Body size, perceived competitive edge or predation threat should be a secondary consideration. Conservation urgency is a subjective test that the TAG uses to determine which lizard stocks and sites are priorities for translocations, in order to both maximise species recovery and ensure that ecological integrity is maintained for restoration sites. Threat status (as per Hitchmough et al. 2016 or any subsequent update) is a primary consideration for the TAG when applying this test, and when considering competition, predation, body size, and fecundity issues (detailed below) it is recommended that a more cautious approach is taken for threatened species ('Nationally Vulnerable', 'Nationally Endangered', and 'Nationally Critical' categories, as per Hitchmough et al. 2016).

6.4.2 Competition and displacement

Research on other taxa suggests that, immediately following a translocation, lizards will be disorientated, prone to more frequent movements, and more vulnerable to extremes in weather and predation than a more established population. This is supported by data on Otago skinks at the Mokomoko Sanctuary in Central Otago, where a second cohort of released skinks yielded to substantially higher levels of mortality than the first cohort already established when mice invaded the site (Norbury et al 2014). Therefore, a lizard population establishing after translocation may require relief from competition and predation from conspecifics already present at the site, other lizard species and other indigenous species, in order to maximise the chances of translocation success, even if they are known to cohabit at other locations.

It is important to consider that sites subject to active restoration – in terms of having received multiple species through translocation – are not necessarily good imitations of 'natural systems'. At such sites, in the absence of their natural predators some species, including some lizard predators, can reach unnaturally high numbers (e.g. tuatara, large-bodied lizards, pūkeko (*Porphyrio porphyrio*), kingfishers, saddlebacks, kiwi, and weka – refer to section 6.4.2). The presence of high numbers of potential lizard predators and/or competitors at a release site may well render the site an unsuitable candidate for lizard translocation unless measures are taken to either exclude predators/competitors from the release site, or to contain translocated lizards in some way.

In section 6.5, methods are outlined for using fences to contain lizards that have been translocated; along with ways of excluding some indigenous predators (both approaches may be desirable in some circumstances). Following establishment of the lizard population (with or without fences), some consideration must also be given to factors that may influence persistence of the population (such as increases in indigenous bird populations as time goes on, and future translocations of indigenous fauna).

6.4.3 Body size and fecundity

In both skinks and geckos, larger-bodied species may prey on and competitively displace smaller-bodied species; however, larger-bodied lizards tend to be high priority for translocation to predator-free sites due to their vulnerability to exotic mammalian predation. This vulnerability is, in part, simply because their larger size makes it harder for them to hide successfully from predators. Larger species also take longer (sometimes several years longer) than smaller species to reach maturity, and this increases the time between generations and so decreases the rate at which their populations can increase. Furthermore, many, but not all, larger species are often less fecund than their smaller relatives, producing fewer offspring because they have smaller litter sizes or do not breed every year, or both. Smaller skinks benefit from reaching maturity more quickly, from (usually) breeding every year and, in some species, from having large litters. Similarly, smaller geckos have the advantage of reaching maturity more rapidly than larger geckos and usually breeding every year; however, individuals of all gecko species have no more than two offspring per year. Compatibility issues between different translocated species can be avoided simply by separating the release sites for the different species; even in quite small areas, this can provide an opportunity for each species to start establishing before encountering the other.

6.5 Release method

In 2009–10, the use of release pens was trialled successfully for the first time for jewelled geckos within Orokonui Ecosanctuary (A. Tocher, unpubl. data). The objective of the pens was to contain translocated animals within the release site in an effort to deter them from moving out into the wider expanse of the reserve and risking becoming lost to the establishing population. The pens achieved these objectives, and a viable population is establishing at the release site. Recent follow-up research at Orokonui Ecosanctuary has shown that jewelled geckos that are initially contained within pens are less likely to move away from the release area, compared with geckos that are subject to a 'hard' release (not penned) (Knox & Monks 2014). The release pens developed at Orokonui Ecosanctuary are simple, cheap to construct, easy to install and open to the elements. Further details of these pens are provided in Monks et al. 2017 (https://www.doc.govt.nz/Documents/getting-involved/translocation/best-practice-guidelines-for-green-gecko-translocation.pdf).

Lizard fences are routinely used in Australia to keep lizards contained (O'Shea 2013). Various types of lizard fences have also been successfully developed in the United Kingdom, where they are designed to exclude lizards (particularly slow worms) from development sites, rather than containing them (go to http://www.herpetosure.com/solutions/fencing-solutions/slow-worm-fencing).

The use of release pens is likely to be recommended for containing green geckos (*Naultinus* spp.). More research is required on their benefits for other geckos and for skinks. Conservation managers should remain abreast of research in this area because techniques are developing rapidly. In contrast to green geckos, there are numerous examples of successful translocations of *Woodworthia* and *Dactylocnemis* geckos and of skinks where pens were not necessary. There are circumstances when the use of release pens may not be appropriate and, indeed, counter-productive to the translocation goals (e.g. at sites where it is unwise to contain newly translocated lizards due to threats from climatic extremes, competition, predation or poaching). There may be a case, in certain circumstances, to use fences to separate species from each other. This strategy has been employed on Stephens Island where the indigenous Hamilton's frog (*Leiopelma hamiltoni*) is semi-contained behind a tuatara exclusion fence, because tuatara are super-abundant on Stephens Island and have been shown to prey on the very rare frogs.

The almost immediate dispersal of the released lizards has been a problem for some translocations (e.g. Whitakers skink (*Oligosoma whitakeri*), on Stanley Island, Mercury Islands group), but not others (e.g. Whitakers skink on Korapuke Island, Mercury Islands group, (Towns 1994); Duvaucel's gecko (*Hoplodactylus duvaucelii*) (Fig. 2) translocated to Tiritiri Matangi and Motuora Islands, Hauraki Gulf, (van Winkel 2008)). When translocated lizards disperse from the release site, two immediate problems arise:

- Post-release monitoring is extremely difficult to achieve as released animals cannot be located and the success of the translocation cannot be ascertained.

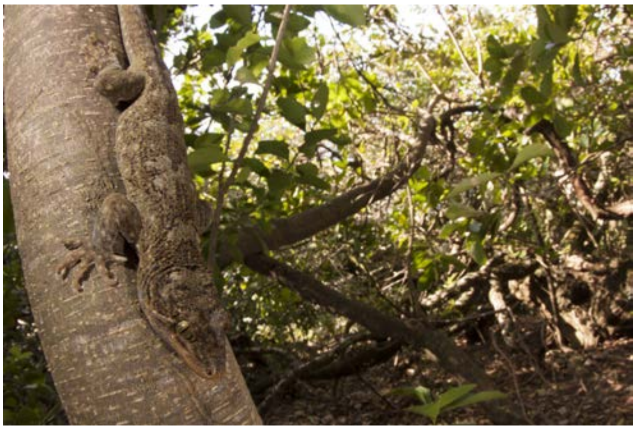

Figure 2. Duvaucel's gecko, *Hoplodactylus duaucelii*, after release. *Photo: D. van Winkel*

- Released animals, presumably due to stress, disorientation and homing instinct, may be motivated to disperse over large distances. Whether they ever find one another after dispersal is not known, but it seems sensible to assume that some of these animals are lost, at least in the short-term, to the establishing population.

There are also instances where lizards have been translocated and released and have required no form of containment, e.g. robust skinks (*Oligosoma alani*) released onto Stanley Island (Towns 1999), Duvaucel's geckos onto Mana Island (Jones 2000) and Fiordland skink (*Oligosoma acrinasum*) onto Hawea Island, Fiordland (Thomas & Whitaker 1995).

The use of fencing at a release site to exclude potential predators is only successful if the released lizards remain within the fenced area. In the absence of a release pen, highly mobile lizard species can breach predator exclusion fences, depending on the choice of construction materials. Wire hex netting excludes kiwi and weka, for example, but allows lizards to move freely through the fence. Note: the fence design and construction materials used must not harm birds foraging close to them.

6.6 Preparation of the release site

6.6.1 Long-term restoration of sites

Some lizard species have very specific micro-habitat and climatic requirements that evolve after many decades. For example, chevron skinks (*Oligosoma homalonotum*) and striped skinks (*Oligosoma striatum*) preferentially inhabit moist sites often in streams (Neilson 2002), and robust skinks require deep soils with high leaf litter moisture content, or dense seabird burrows. In contrast, many diurnal skinks require sunny, open sites and are absent from areas with closed canopy vegetation. A number of lizard species with requirements for large forest tracts live on forest-covered inshore islands and are not suitable for translocation to smaller seabird-dominated islands (e.g. *Naultinus* and many *Mokopirirakau* geckos). On smaller islands, these species may be naturally competitively excluded by very dense resident populations of Pacific (*Dactylocnemis pacificus*) and/or common geckos.

The natural microhabitat required may take many decades to establish. Likely changes over time need to be taken into account; for example, there is no point releasing a terrestrial species requiring sunlight into a site where plantings or natural regeneration will eventually grow up to form a closed canopy. Artificial plantings often go through a phase of having a very dense, closed canopy with little understory or groundcover; at this stage they are unsuitable for most, if not all, lizards.

6.6.2 Providing artificial cover

For some translocations, the habitat at the release site is adequate for the lizard species, but there is a need to augment it to support the translocated lizards over the initial 'settling in' stage and also to assist with post-release monitoring (detection of the translocated lizards). Artificial cover (either permanent[8] or temporary) can be laid out at the release site prior to the translocation, locally sourced fruiting shrubs can be planted for additional food, and dense, locally sourced indigenous grasses, divaricating shrubs, spiny plants and dense wiry vines can be planted out for further cover.

In fragile systems, such as seabird islands, elevated boardwalks may be constructed to assist post-release monitoring of the translocated lizards whilst protecting the habitat from being crushed by the observers.

7. Source populations

7.1 Wild sources

The TAG recommends, wherever practicable, undertaking wild-to-wild lizard translocations, rather than captive-to-wild. Wild-to-wild lizard translocations have been demonstrated to be the most successful both in New Zealand and internationally (Fischer & Lindenmayer 2000; Germano & Bishop 2009). The wild source population should meet both of the following criteria before being deemed suitable for cropping[9] for the purposes of translocation:

- The population is a genetic stock suitable for the chosen release site (e.g. within known and likely historic range; refer to section 4 for guidelines for mixing genetic stocks); and
- The population can sustain cropping and is unlikely to be permanently adversely affected by the cropping for translocation purposes (ideally informed by pre-translocation monitoring).

If data on the population status of the source population are limited prior to harvest, a range of management options may be used to ensure the source population is not adversely affected:

- Undertake monitoring to estimate population size (e.g. mark-recapture estimates) and model impacts of cropping or, if the lizards are reasonably abundant, record the number seen when walking a standard transect or spending a standard time searching (Fig. 3).
- Utilise expert opinion, especially from technical experts most recently familiar with the encounter rate of the species at that site.

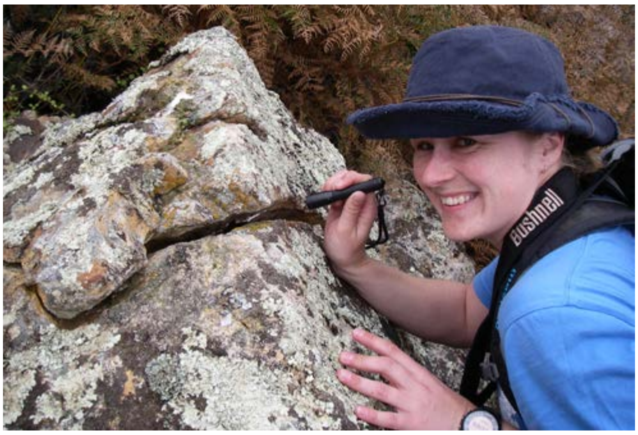

Figure 3. Herpetologist checks a rock crack to find geckos.
Photo: Marieke Lettink, Fauna Finders.

- The lizards captured at the site can be 'filtered' to only include, for example, sub-adults or juveniles, i.e. those individuals that contribute least to the productivity of the source population. The trade-off with this strategy is that it limits initial growth in the translocated population due to the time lapse before maturity (Tocher et al. 2006).

[8] Permanent artificial cover cannot be used as a tool to measure changes in the establishing population over time (e.g. changes in occupancy rate) because any increase in population size which could be reflected in the greater occupancy rate of the artificial cover, is confounded by increased use of the covers through familiarisation with them, i.e. an increase in occupancy does not necessarily mean the population is increasing.

[9] Cropping is used interchangeably with harvesting and is defined in Appendix 1.

- Only collect one third of the lizards encountered and release all others at the site where they were encountered. This strategy ensures the majority of lizards remain at the source site (but good communication between team members is necessary to ensure that it is strictly adhered to).

7.2 Captive sources

Wild sources are generally preferred for translocation (refer to section 7.1 and Germano & Bishop 2009) but captive sources do provide a number of logistical advantages. For cryptic species, or those at very low abundance, finding enough wild animals for a translocation can be difficult (e.g. ornate skinks and ngahere geckos around Wellington for translocation to Matiu/Somes Island). For these species, it makes good sense to collect animals as and when the opportunity arises and 'stock-pile' and breed them in captivity until a critical number is available for release.

Captive breeding[10] of rare species can provide sufficient numbers for release and lessen impact on source populations. In this case, the genetics of the captive population needs to be well managed to maximise the diversity of founding animals. Long-term captive colonies can result in lizards undergoing phenotypic changes that may not be useful in the wild (e.g. lowered sprint speed in captive Otago skinks Connelly & Cree 2008).

Using captive stock as a source for translocation to the wild often relies on the provenance of the captive stock being known. In some instances, however, mixed provenance may be suitable if there has been large-scale loss of local populations in the wild (i.e. no lizards of appropriate provenance exist). An example of this is robust skink (*Oligosoma alani*) reintroductions over the central and lower North Island, where all populations became extinct some time ago. In this case it would be appropriate to use either a single genetic stock from a northern population, or a mix of multiple stocks for reintroduction to maximise genetic variation and capacity for future adaptation to the new site. The level of genetic difference between populations can provide guidance as to whether mixing source populations is appropriate or not – expert opinion should be sought.

7.3 Captive and wild mix

On occasions, a mix of wild and captive-bred animals are used together in a translocation. An example is the translocation of barking geckos and ngahere geckos to Matiu/Somes Island; wild animals collected opportunistically were supplemented by captive-bred animals from parents of known geographic origin.

[10] The Captive Management Standard Operating Procedure (DOC, 2008) provides guidance on captive programmes.

8. Capture and transfer

8.1 Capture and care of lizards during temporary captivity

All captured lizards can be held individually for short durations in dampened cloth bags, but must be kept cool at all times (inside a chilly bin if ambient temperatures are higher than c. 10°C). Put multiple cloth bags into one larger hard-sided container to protect the lizards. If they are to be held for more than 3 days, put the lizards inside hard-sided containers perforated with air-holes. They should be offered food (soft fruit and/or invertebrates) and provided with damp leaf litter or paper towels to maintain high humidity, and again, be kept cool at all times. These containers must always be opened inside a larger deeper container – such as a large bucket or fish bin – to avoid accidental escape.

Ideally, all lizards will be captured at the source site and released into the release site on the same day. However, as long as temperature and humidity are managed appropriately, lizards are usually more robust and amenable to being held in temporary captivity than small birds. In practice, however, this tends not to occur and typically multiple collection days are required to allow the desired number of lizards to be obtained for translocation. Regardless of the capture techniques employed – these differ for each species and sometimes for the same species in different habitats – lizards need to be kept safe from each other, from accidents (e.g. trampling), and from extremes of temperature, from the moment they are captured until they are safely released. A series of potential hazards related to the release of translocated lizards, many of which also apply to the capture stage, are listed in section 9.1.

The level of habitat disturbance caused by capture activities must be considered, as habitat must remain suitable for the survival of the lizards that will be left behind.

TAG guiding principles for ensuring the safe capture and temporary captive-care of lizards include:

- Capture lizards during their 'active season' when the weather is suited to activity in the targeted lizard species (Fig. 4). This is especially important for lizards that live in cold climates. Also, lizards need to be released with sufficient time to become established before the onset of winter.
- For short-term captivity, captured lizards should be placed separately inside clean calico lizard bags[11] and taken to a central location in perforated 2 L hard-sided containers (with lids on). Lizards in lizard bags should not be carried unless they are within hard-sided containers, to ensure the safety of the lizards.
- For longer-term captive care, where lizards require feeding

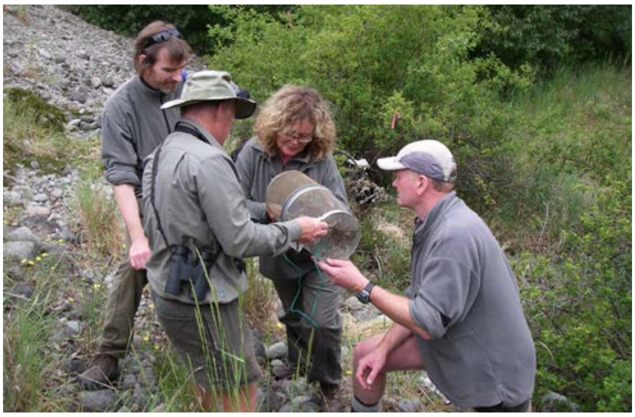

Figure 4. Checking a gee-minnow trap in early summer.
Photo: Marieke Lettink, Fauna Finders.

[11] These can be purchased for c. $5.00 each from the National Banding Office, P.O. Box 108, Wellington 6140. Email: bandingoffice@doc.govt.nz

and access to water, they can be housed separately in hard-sided containers with a moist paper towel for shelter. Care must be taken to avoid lizards leaping out when they are fed – deep containers are best (e.g. 4 L liver pails). Alternatively, smaller containers can be opened inside a larger deeper one from which lizards cannot easily escape.

- It may be possible to keep more than one lizard in each container, but this will depend on a range of factors such as the level of aggression within the species, size of each individual (small individuals may be eaten or injured by larger ones), sex, temperature and amount of cover. Adults should be held individually; juveniles can usually be safely held in small groups of similar-sized individuals (Fig. 5).
- For storage, lizards are transferred inside the hard-sided containers to insulated bins (e.g. polystyrene bins) where the internal temperature is kept below 10°C at all times (Fig. 6).
- The acceptable length of holding times in hard-sided containers may vary; seek advice from experts familiar with the particular lizard species.

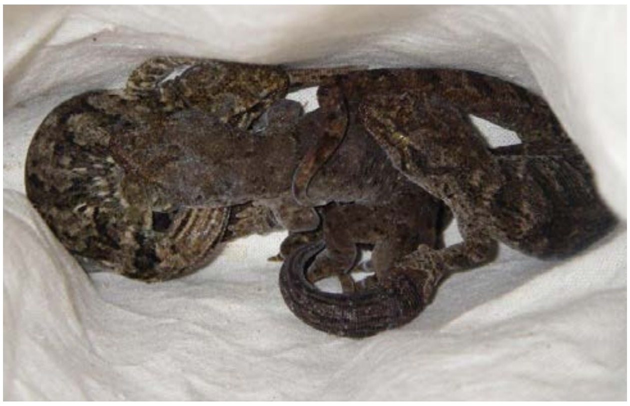

Figure 5. Canterbury geckos, *Woodworthia* cf. *brunnea*, a species suitable to be held in the same bag, with individuals of similar size. *Photo: Marieke Lettink, Fauna Finders*.

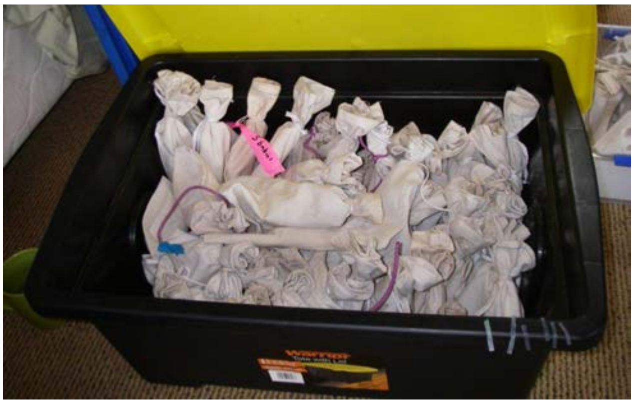

Figure 6. Canterbury geckos in individual cloth bags and protected by hard-sided container, awaiting transportation to release site. *Photo: Marieke Lettink, Fauna Finders.*

8.1.1 Composition of transfer group

Very often the number and age/sex composition of the lizards destined for translocation is dependent solely on which lizards happen to be captured at the source site. However, the translocation will have greater chance of success if a more considered approach is taken. The transfer group composition can be designed during the planning phase with the aim of maximising the success of the transfer. For example, faster establishment of a population may result if the transfer group is biased towards gravid females. When the females give birth, the release site becomes the natal site for the newborns (which carry genes from their fathers, who may not otherwise be represented in the translocated population). Also, it is presumed that the newborns will be less inclined than the transferred adults to move away from their natal site and the establishing population (refer to sections 6.5 and 9.3).

The issue of homing and its potential to affect the likely success of a translocation is an important consideration in New Zealand, where lizards show extreme longevity (Bannock et al. 1999). When translocating lizards with suspected or demonstrated homing tendencies, it may be beneficial to release younger lizards that have not yet developed strong associations with a home site (Tocher & Brown 2004; refer to sections 6.5 and 9.3). Both geckos and skinks have been shown, in experiments and anecdotally, to readily return to their original home site over distances of up to 100 m (Marshall 1983; J. McIntosh pers. comm.) and, in one case (a Duvaucel's gecko), over 1 km (Jones 2000). However, in longer distance translocations many species have shown no evidence of attempted homing (e.g. Lettink 2007). As well as an attempt to home, translocated lizards may leave a site because the habitat is not satisfactory for them, and it is usually impossible to determine which factor was the driver.

Bishop & Germano (2009), in their comprehensive review of herpetological translocations, found no correlation between the number of lizards released and the outcomes of translocations. The TAG recommends aiming to translocate as many lizards as possible (O'Shea 2013 but see Griffith et al. 1989), with a minimum of 30 individuals in total. However, a number of New Zealand reptile transfers have introduced nearly double this number, in the hope of improving the chances of the population establishing (e.g. the translocation of 70 tuatara, from Stephens Island to Karori Wildlife Sanctuary (now Zealandia) in 2005). Sherley et al. 2010 summarised New Zealand lizard translocations up until 2010 and showed that the majority of successful translocations had involved at least 30 individuals. There are exceptions: 14 robust skinks established on Korapuki Island (Towns & Ferreira 2001) and 19 Duvaucel's geckos established on Tiritiri Matangi Island (van Winkel 2008). However, for their long-term security and protection from founder effects, these smaller translocations would benefit from supplementation to increase genetic diversity (refer to section 3.2).

8.2 Data collection and disease screening

Any health screening required as per the Wildlife Health Standard Operating Procedure must be completed before translocation.

All location data must be sent for inclusion in the DOC Herpetofauna database (herpetofauna@doc.govt.nz)

At a convenient time, but while they are still at the source site, captured lizards should be weighed (Fig. 7), measured to the nearest 0.1 mm (snout-vent length; Fig. 8) and subjected to a health screen. Weights and lengths provide useful baseline measurements that can be compared with data collected during post-release monitoring (refer to section 10).

The Wildlife Health Standard Operating Procedure (DOC, 2010) should be followed and provides more information than is included in this section. In brief, a health screen includes a physical examination to check for scars, blemishes, mites, injuries and condition. Cloacal swabs or blood may also be taken (consult wildlife vets for the relevance of these tests for each translocation).

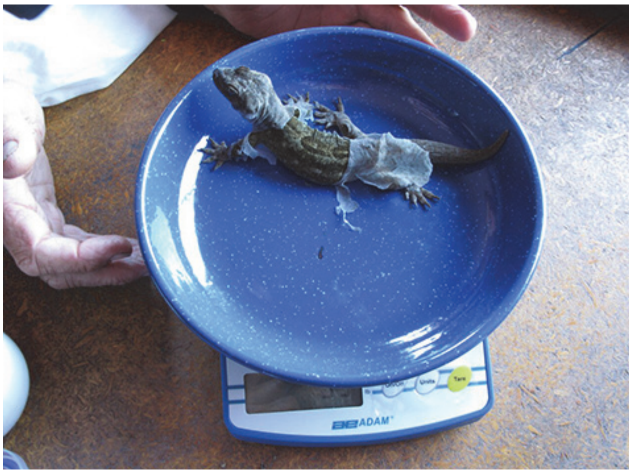

Figure 7. Duvaucel's gecko, *Hoplodactylus duaucelii*, being weighed. *Photo: Barry Dent, Fauna Recovery NZ.*

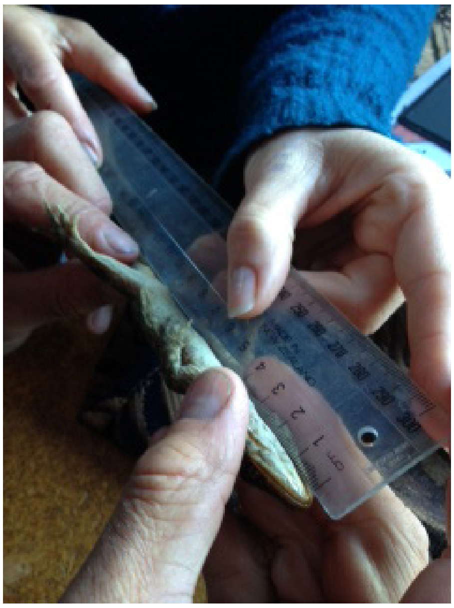

Figure 8. Measuring a Duvaucel's gecko. *Photo: Barry Dent, Fauna Recovery NZ.*

Lizards can be photographed to allow individual identification at future dates. Photographs are particularly useful for species where individuals have distinctive markings that can be used to help identify them during post-release monitoring.

All location and collections data must be sent for inclusion in the DOC Herpetofauna database, which has a translocation module (herpetofauna@doc.govt.nz).

9. Release

Each lizard must be carefully extracted from its cloth bag to avoid injury to its claws, handled gently to avoid injuries (such as tail loss), and released separately as quickly as possible into a suitable individual retreat. Bystanders must be kept away from the immediate release site. Release should take place in weather that is warm enough to permit normal activity but not so hot as to risk heat stress in the unfamiliar surroundings. Release should not take place in very dry conditions.

9.1 Hazards to lizards upon release

The TAG recommends that one person take responsibility for the release, to ensure potential hazards are well managed through careful and deliberate planning. The release process can be a time of great excitement amongst the wider community involved in the transfer and may be attended by many people who are not familiar with lizards. Potential hazards to avoid include:

- Trampling or crushing of released lizards under loose rocks.
- Prolonged handling (e.g. when showing the lizards to bystanders) which can cause heat stress because of the warmth of the hands.
- Rough handling resulting in tail loss and other serious injuries (e.g. damage to developing young in gravid females).
- Claw loss/bleeding/infection resulting from incorrect extraction of lizards from cloth bags.
- Lizards running up sleeves without being noticed and being injured or inadvertently moved off site.
- Releasing lizards into inappropriate release sites, which is likely to increase their motivation to move.
- Releasing individual lizards too close to each other. This can be a problem for some species (e.g. the release of two adult males into the same refuge, or an adult male with a newborn – in some species the male could eat the newborn).
- Lizards remaining in their transport containers. Prior to leaving the release site, check all transport containers for overlooked lizards.

9.2 Release into a wild site

The timing of capture and release is addressed in section 8. When releasing translocated lizards into the wild (i.e. not into a release pen), the general principles to adopt are:

- Release animals at times suitable for the species, and during appropriate weather conditions. Follow release strategies that have proven to be effective elsewhere.
- Release all lizards into the predetermined release area.
- Take your time and select the very best release site for each animal – do not rush.
- Release animals individually under separate rocks or into different shrubs within the release area.

9.3 Release into pens

Releasing lizards into a pen (see Monks et al. 2017; https://www.doc.govt.nz/Documents/getting-involved/translocation/best-practice-guidelines-for-green-gecko-translocation.pdf) is currently recommended for *Naultinus* spp. only (refer to section 6.5), although recent research suggests penning may be beneficial for forest geckos (Monks, pers. comm.).

9.4 Multiple releases

Multiple releases involve the deliberate translocation of an initial cohort, then follow-up releases of one or more cohort(s) in the future. Multiple releases are consistent with DOC's definition of translocation that can involve '…one or more transfers'. This situation commonly arises when the desired numbers of lizards are not captured at the source site (e.g. the species is very cryptic, or at low density), or when there are not enough animals available at one time (e.g. concern that cropping all of the lizards required for translocation at one time will have impacts on the source population). 'Multiple releases' differ from a 'supplementation' because they are part of a planned multi-stage release; in contrast, a supplementation is triggered by a perceived need to boost the genetic stock of a population (refer to section 3.2).

There is limited research information to guide recommendations on the relative pros and cons of multiple releases (although see Norbury et al. 2014) versus a single release; but common sense suggests that the release of the second cohort (or further cohorts) should occur into adjacent (but connected) habitat, and not at the release site used for the original release. Given the current state of knowledge, the TAG has no preference for multiple releases or otherwise, and post-release monitoring is advocated for translocations that address this information gap (refer to section 10).

10. Post-release monitoring

Given the lack of information currently available on lizard translocations, some level of post-release monitoring will be needed to help inform future translocations. For some lizard species, low-intensity monitoring may be sufficient if information is already readily available on how to carry out a translocation, and what the response of the species to translocation is likely to be (i.e. outcomes are predictable).

Post-release monitoring covers a spectrum of activities, from casual searches to regular, formal, structured monitoring regimes involving a research component (Sherley et al. 2010). A well-designed post-release monitoring programme can inform future management by providing answers to many of the questions raised in these guidelines (e.g. providing information on how the lizards respond to being released and the tendency for a particular species, or animals of specific age or sex, to move away from a release site).

Figure 8. Radio transmitter attached to a Canterbury gecko (*Woodworthia* cf. *brunnea*) to facilitate monitoring. *Photo: Marieke Lettink Fauna Finders.*

A simple post-release monitoring method will reveal trends in population growth, and whether breeding occurs every season. Regardless of the type of post-release monitoring to be carried out, the release area needs to be permanently marked or geo-referenced in some way. The post-release monitoring needs to be linked to an area on the ground – recording the search area is vital to avoid part searches being assumed to be full searches, and giving a false indication of rate of sightings. As time goes on and the lizards begin to spread out, it will be important for observers to record where they find lizards. At a minimum, sightings within the area routinely searched should always be recorded. It is then possible to keep track of sightings within the release area and determine long-term trends.

More formal post-release monitoring methods are described in a series of modules on the DOC website; search 'Lizard toolbox' at http://www.doc.govt.nz/. Any person planning for a lizard translocation should seek advice on the requirements for post-release monitoring.

11. Species unsuitable for translocation

11.1 'Naturally Uncommon' and 'Data Deficient' species

All New Zealand lizards were assigned an updated threat ranking in 2015 (Hitchmough et al. 2016). There are currently ten 'Naturally Uncommon' and seven 'Data Deficient' lizard species, and the TAG recommends that none of these are suitable candidates for translocation for the following reasons:

- 'Data Deficient' species are not currently well enough known to allow the appropriateness of any release site to be assessed, and are very difficult to find. For 'Data Deficient' species, the no translocation recommendation is likely to change as more information becomes available.
- 'Naturally Uncommon' species are ranked as such because they are currently occupying all or most of their historic range. It is therefore not appropriate to translocate them more widely (refer to section 3.4), outside their natural range. Note that there will be occasional instances when a suitable release site is available within the range of 'Naturally Uncommon' species (e.g. a predator-managed site on Stewart Island for the small-eared skink (*Oligosoma stenotis*)).

12. Acknowledgments

These guidelines collate knowledge that has been built up over many decades and we thank all people involved in lizard translocations and research who have contributed to it.

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Appendix 1

Glossary of terms

Captivity – Any situation where wildlife is or is potentially prevented from escape, and where regular and frequent management intervention (e.g. feeding, animal health maintenance) is required to maintain animal health and welfare.

Cropping/harvest—The act of capturing and removing lizards from an established source population.

Founder effects – In population genetics, the founder effect is the loss of genetic variation that occurs when a new population is established by a very small number of individuals from a larger population.

Genetic stock – Refers to a unique genetic entity.

Introduction – The intentional release or accidental dispersal by human agency of a living organism outside its known range, i.e. release to a site that the species has never been before. The intentional release for the purpose of conservation is also known as conservation introduction (based on the definition in the 1987 IUCN position statement on translocations[12]).

Previous range – The previous distribution of a species including:

- The documented distribution of a species from historically recorded sources.
- The inferred post-glacial range of a species prior to documented recording. This may include archaeological and sub-fossil evidence.

Predator-free – It is possible that there are acceptable population thresholds of predators in relation to survival of lizards but these are unknown to date. Tests to determine a threshold would be carried out on less threatened species; in high-quality habitat sites; and with a high level of predator control occurring year round. Mice are likely to be significant predators; however, mouse-control techniques are currently ineffective.

Reintroduction – The intentional movement of an organism into part of its known historic or prehistoric range from which it has disappeared or become locally extinct. Also referred to as re-establishment (based on the definition in the 1987 IUCN position statement on translocations[13]).

Release site – The release site is the spatial area where the transfer population is to be released (i.e. the transfer destination).

Restoration – The practice of renewing and restoring degraded, damaged or destroyed ecosystems and habitats in the environment by active human intervention and action.

Source population – The source population is the group of individuals that includes the transfer population prior to the transfer.

Supplementation – Addition of individuals where the species already exists 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 reintroductions[13]).

Transfer – The part of the translocation that is physically moving the plant or animal from one location to another, and its subsequent release or planting at the new site.

Transfer population – The group of individuals (of a species) transferred to the release site.

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[12] IUCN 1987: IUCN Position Statement on Translocation of Living Organisms https://portals.iucn.org/library/node/6507 (viewed 1 August 2016).

[13] IUCN/SSC Guidelines for Reintroductions. Prepared by the SSC Reintroduction Specialist Group, Approved by the 41st Meeting of the IUCN Council, Gland Switzerland, May 1995. https://portals.iucn.org/library/efiles/edocs/PP-005.pdf (viewed 1 August 2016)

Translocation – Translocation is defined in this guide as the managed movement of live plants or animals (taonga) 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). A translocation can consist of one or more transfers. (Note that this definition varies from that used in the 1987 IUCN position statement on translocations[13], and the 1995 IUCN guidelines on reintroductions[13]).

Translocation Proposal Form – The form used in conjunction with this guide. It acts as an application form for the translocation and most of the permits required by DOC.