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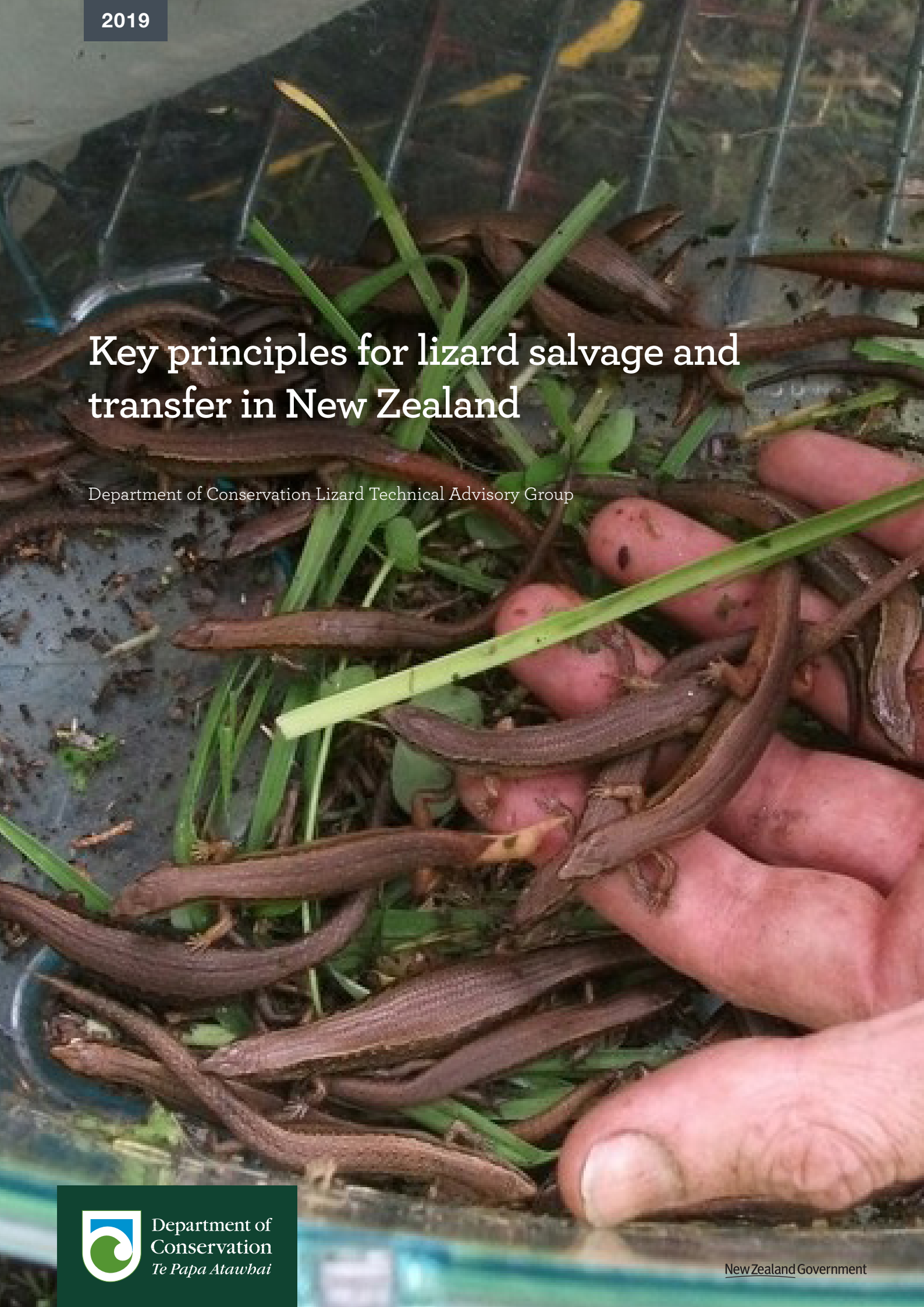
Key principles for lizard salvage and transfer in New Zealand

Department of Conservation Lizard Technical Advisory Group



Department of Conservation
Te Papa Atawhai

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Cover: Copper skinks (*Oligosoma aeneum*) salvaged in Auckland . *Photo: Well-Connected Alliance.*

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Department of Conservation, PO Box 10 420, Wellington 6143, New Zealand

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Copper skinks (*Oligosoma aeneum*) salvaged from Waterview motorway project, Auckland, being held in a terrarium on the way to their purpose-built relocation site. *Photo: Well-Connected Alliance*.

1. Introduction

This document is intended to guide ecological consultants who are working with developers undertaking projects that will impact New Zealand's native lizards. It covers the mitigation practice of lizard salvage. Lizard salvage is still relatively new in New Zealand, therefore methodologies do not reflect extensive scientific study; instead, they are presently based on the 'best guess' of experienced ecologists. Thus, the information provided here should not be considered 'best practice' but as 'developing practice' that should be improved and tested over time.

Development and habitat loss or alteration have been major causes of decline for many of New Zealand's indigenous lizard species and the threats associated with these activities continue. Lizards are present at many sites proposed or scheduled for development. However, with careful planning and appropriate management, impacts on lizards can be avoided or reduced. One tool that can be used to protect lizards is their removal (salvage) from the footprint[1] of a development and transfer to suitable sites where they can establish viable populations.

This document describes nine principles that should be adhered to when an application for lizard salvage and transfer resulting from a proposed development project is being audited or lizard salvage is being planned and implemented by ecologists. These principles should be followed for all development-related salvage and subsequent transfer operations.

Catching geckos from rock retreats. *Photo: D. Matheson, Abseil Access*.

The nine principles relate only to indigenous lizard species[2] and do not apply to non-indigenous species such as the plague skink (*Lampropholis delicata*). They do not cover marine reptiles, nor do they address translocations where conservation is the primary purpose (see instead https://www.doc.govt.nz/globalassets/documents/getting-involved/translocation/translocation-best-practice-lizards-1.pdf).

[1] Development footprint, development site and impact site can be used interchangeably and refer to the entire site proposed for impact or development and from which lizards are to be salvaged.

[2] Or species equivalents (e.g. nominal species awaiting formal description), as per the most recent New Zealand Threat Classification System List for reptiles (at time of writing this is Hitchmough et al. 2016; https://www.doc.govt.nz/globalassets/documents/science-and-technical/nztcs17entire.pdf), which is to be used as the authority for taxonomic recognition (species status and management units) for lizards in New Zealand.

Lizard salvage and transfer addresses the entire process, i.e.

1. Assessments of the impacts of proposed developments on lizards and exploration of alternatives (e.g. avoidance of lizard habitat).
2. Planning of salvage operations and assessment and approval of these proposals by the appropriate authorities.
3. Preparing habitat at release sites, capturing lizards at impact sites, temporary captive care (if required), data collection, transport to and release at receiving sites.
4. Post-release monitoring, contingency implementation as appropriate, and reporting back to the Department of Conservation (DOC) (and/or other consent authorities).

The most successful lizard salvage operations involve applicants engaging with DOC and other specialists early in their project's development process. This ensures that the applicant and DOC gain a clear understanding of each other's perspectives before any development activities get underway, which is more likely to result in timely and effective salvage operations and thus better conservation outcomes for lizards. However, most lizard salvage and transfer applications originate after development consents have been granted under the Resource Management Act, 1991 (RMA) and related plans (e.g. in Lizard Management Plans imposed through consent conditions) and this often constrains outcomes for the lizards.

DOC has a mandate under the Wildlife Act 1953 to authorise or decline and impose conditions on any salvage and transfer activities that involve absolutely protected wildlife, which includes all species of indigenous lizards. Additional requirements may apply to applications under the Conservation Act 1987 (e.g. concession applications), the Crown Minerals Act 1991 (access agreements), the Reserves Act 1977, or all three simultaneously for some large-scale developments on land administered by DOC. See https://www.doc.govt.nz/get-involved/apply-for-permits/apply-for-a-permit/ for further information. DOC can also impose conditions on concession agreements and access agreements. Lastly, DOC has an obligation under Section 4 of the Conservation Act 1987, and therefore under the Wildlife Act 1953 (an enactment of the Conservation Act 1987), to consult fully with relevant iwi, a process that runs in parallel with any consultation undertaken by a developer. Permit application forms and instructions are on the DOC website: Authorisation information

2. Definitions

For the purposes of this document, salvage is defined as the permanent removal of lizards from their existing location to another site to protect them from displacement or death caused by activities that have negative effects on them or their habitat.

Lizard salvage is a mitigation activity; it is intended to reduce the severity of the impact of these activities. Salvage is not avoidance or remediation and is conceptually different from biodiversity offsetting (offsetting activities deal with residual adverse effects of a development on biodiversity values; that is, those effects remaining after all avoidance, remediation and mitigation activities have been applied). Offsetting activities are outside of a 'mitigation package'. It is therefore inappropriate, and indeed misleading, to consider lizard salvage and transfer as an offset activity.

A Lizard Management Plan, in the context of a Wildlife Act Authorisation, is part of an application. It provides the necessary detail on what will be undertaken. Because salvage is a type of translocation, the Lizard Management Plan can serve the same purpose as a translocation proposal (for more detail see: https://www.doc.govt.nz/get-involved/run-a-project/translocation/.)

Measuring a forest gecko (*Mokopirirakau granulatus*) salvaged from the footprint of a quarry expansion project, Auckland. *Photo: Tonkin & Taylor Ltd.*

Auckland green gecko (*Naultinus elegans*). *Photo: Tonkin & Taylor Ltd.*

Salvaged Auckland green geckos (*Naultinus elegans*). *Photo: Tonkin & Taylor Ltd.*

3. Nine principles for lizard salvage

The nine principles[3] are as follows:

1. Lizard species' values and site significance must be assessed at both the impact (development) and receiving sites.
2. Actual and potential development-related effects and their significance must be assessed.
3. Alternatives to moving lizards must be considered.
4. Threatened lizard species require more careful consideration than less-threatened species.
5. Lizard salvage, transfer and release must use the best available methodology.
6. Receiving sites and their carrying capacities must be suitable in the long term.
7. Monitoring is required to evaluate the salvage operation.
8. Reporting is required to communicate outcomes of salvage operations and facilitate process improvements.
9. Contingency actions are required when lizard salvage and transfer activities fail.

Each principle is described and discussed below and should be addressed in all Wildlife Act applications. The application form may need to be supplemented with a translocation plan or documents such as a Lizard Management Plan (especially if these have already been produced for the resource consent).

Note: these principles apply to both impact and receiving sites (see Principle 6).

To ensure lizard salvage has a chance of success, all nine lizard salvage principles must be met

Good practice was not met in the following example when scrubland vegetation containing jewelled geckos (*Naultinus gemmeus*) was cleared without any consideration of lizards. Even after the shrubs they lived in had been felled and bulldozed into piles for burning, over 20 geckos were able to be caught from the piles. An unknown number of geckos were killed during the clearance and subsequent burn-off.

Example of a poorly executed salvage. *Photo: H. Frank, M. Lettink.*

[3] These are listed in generally step-wise order. Note, however, that some may be addressed concurrently and others at any stage of the process, so that your proposal may not address all nine individually or in this order.

Principle 1: Lizard species' values and site significance must be assessed at both the development and receiving sites

Assessment of lizard species' values includes, but is not limited to, gathering information on species presence and distribution, relative abundance and habitat use at both the impact (development) and receiving sites.

Most lizard species are extremely difficult to survey in the field and can be overlooked, even by experienced herpetologists. Therefore, it is essential that the quantity and quality of field work carried out with the specific intent of documenting species' presence and then estimating their numbers is sufficient. The information you provide in the salvage and transfer application needs to allow assessment of whether the search techniques employed are appropriate for the potential species at the sites (see DOC Herpetofauna Inventory and Monitoring Herpetofauna link) and whether they will be undertaken with sufficient effort and by adequately qualified personnel so that all species present are likely to be detected. In addition, the receiving site(s) must be thoroughly assessed to ensure they can receive and maintain the newcomers

DOC requires this information to determine whether a salvage and translocation proposal adequately identifies the lizard species likely to be at the sites, and to be able to assign appropriate conditions to any Wildlife Act Authority that is considered. The application should mention the personnel carrying out the searches, the number of hours that will be spent searching, the time of the searches (day/night, time of year), the weather conditions deemed suitable for searches, the search techniques to be used, and include maps showing where searches will be carried out. The application must list the lizard species likely to be found at the sites during visits designed for the specific purpose of a lizard survey, based on desktop reviews of relevant reports, journal articles, the Bioweb Herpetofauna database (to request data: https://www.doc.govt.nz/our-work/monitoring-reporting/request-monitoring-data/), and local/expert knowledge. Lizard species likely to be present, their threat status (as per Hitchmough et al. 2016 or subsequent updates), likely numbers of each species (if this can be determined), micro site, and habitat use are mandatory components of an application.

Applicants must recognise that the Bioweb Herpetofauna Database contains presence-only data; lack of a species record at a particular site does not necessarily imply a true absence. The database can't always be guaranteed to have the most up-to-date information available and records of species within a geographic region should inform potential species lists for a given site. Neither does the database always capture important subpopulation information. Some species records are now known to represent multiple species – each possibly having a different threat status – or species with subpopulations whose protection is considered important to ensure genetic diversity and thus long-term persistence of the species. Interpretation involving these sorts of issues requires detailed expert knowledge. Data extracted the Bioweb Herpetofauna database must be reconciled with the most recent species threat classifications. To ensure that any assessment of lizards is robust, DOC considers Hitchmough et al. (2016), or subsequent updates, to be the most up-to-date authority with which to reconcile Bioweb Herpetofauna data. The precautionary approach should be adopted when assessing lizard species present at a development or receiving site. If a species is not found during field survey but suitable habitat exists at a site, and either Bioweb Herpetofauna or expert knowledge confirm the species occurs or likely occurred there, its presence at the site should be assumed[4].

Site significance for lizards

It is important that the assessment of lizards at both the development and receiving site(s) includes a formal site significance assessment relating to the lizard species, or assemblage of lizard species, present. There are two perspectives to consider when carrying out a site

[4] Unless the context allows for an alternative interpretation.

significance assessment: those of DOC, which issues the Wildlife Act Authority (for any proposal involving indigenous lizards), concession or access agreement (if the proposal includes land managed by DOC); and those of the relevant regional and territorial authorities, which are reflected in Regional Policy Statements, Regional Plans, and/or District Plan(s). For all salvage and transfer applications, DOC species recovery plans and any other species management documents (such as iwi plans for taonga or management documents under the Conservation Act 1987) should also be used for significance assessments.

Checking an artificial cover object (ACO) in Eglinton Valley, Fiordland. *Photo: Jo Monks.*

Assessments of significance using the ecological significance criteria in regional and district plans and regional policy statements may be complex, subjective and variable throughout the country. It should not be assumed that granting of a consent under the Resource Management Act will automatically ensure permission being granted under the Wildlife Act (noting that conditions may also be different) and for this reason, early engagement with DOC is vital.

The quality of the survey effort will influence assessments as much as the the people carrying out field work and/or assessments who can differ on what is significant in terms of lizards. It is best practice, when undertaking an assessment, to separate-out lizards from other species that may also have been recorded – the assessment should clearly relate only to lizards.

At times, assessments need to be made with inadequate field information. Desktop reviews for lizard species vary greatly in quality and, as noted above and repeated here for emphasis, it is not considered best practice to rely only on the Bioweb Herpetofauna database when assessing a site for lizards.

Pre-development surveys and adequate planning are essential

Its not always obvious where lizards live

The 110 lizard species found in New Zealand all have different habitat requirements and many are very flexible in their habitat choice. It's possible for some lizards to reach high densities in both native vegetation and exotic weeds. Many lizard populations live exclusively in exotic weedy areas. Surveys before development projects start are essential for understanding what species are present in an area and their relative abundance and distribution.

ACO established in weedy riverbed habitat to detect lizards. *Photo*: *H. Frank.*

In the following example, an area of dry riverbed habitat was not surveyed for lizards before it was cleared

The area was an expanse of undisturbed riverbed habitat that had a mix of native scrub species along with a significant amount of weeds (such as broom and gorse).

Lizard habitat prior to clearance. *Photo: H. Frank.*

Clearance underway. *Photo: H. Frank.*

Clearance complete. *Photo: H. Frank.*

Lizards were discovered after clearance was underway

After scrub clearance had started, the area was found to have high numbers of a lizard species ranked as 'At Risk, Declining' under the New Zealand Threat Classification System (NZTCS). Mechanical clearance resulted in near total loss of the population. Once the lizards had been noticed, small areas of habitat left undisturbed by initial clearance activities (cutting and piling of scrub) were searched by people moving rocks by hand. Any lizards found were captured and held in containers.

Lizards being salvaged during clearance. *Photo: H. Frank.*

Mitigation measures were unplanned, constructed in a hurry and inadequate

Because of the lack of planning pre-development, there was inadequate mitigation. The work that was possible involved creation of new habitat (large piles of rocks on bare ground), but it was not of sufficient scale to mitigate the almost complete loss of the population, with very few lizards remaining to populate the new habitat. Further, because lizards were only found at the end of the development process, habitat creation was rushed. Native vegetation suitable for lizards was planted well after lizards were relocated into the new habitat, so this artificially created habitat did not have time to develop the specific microhabitats required by the lizards. It is very likely that there was additional post-release mortality.

Lizards being released. Note absence of plantings. *Photo: H. Frank.*

Students helping with restoration plantings. *Photo: H. Frank.*

Principle 2: Actual and potential development-related effects and their significance must be assessed

All development-related effects that involve disturbance and possible death of indigenous lizards are deemed 'significant' by DOC and all of these activities require a Wildlife Act Authority.

The RMA provides a useful set of definitions of effects, and inclusion of this sort of analysis is useful for a Wildlife Act application. (see 'A Guide to Preparing a Basic Assessment of Environmental Effects, Ministry for the Environment, 2001'). Appropriately, however, there is no fixed recipe for an assessment of effects on the environment (AEE), and the scope and detail must reflect the scale and significance of likely effects of a proposed development on the lizards at a site whilst also considering the unique features of the development site and the proposed activity.

An assessment of effects is a vital aspect of a salvage and transfer proposal as it helps determine the degree of mitigation required. All assessments should be free from bias (e.g. down-playing of potential adverse effects) and predicted impacts should be clearly stated as such. Any uncertainties should be acknowledged. The assessment should not only consider direct effects (Appendix 1) but also indirect effects on lizards 'left behind', which may not necessarily form a viable population in the long term following development. Cumulative effects also need to be considered to assess the context of the salvage and transfer proposal beyond the development footprint.

Mixed broadleaved forest supporting Auckland green and forest geckos which was felled as part of a quary expansion, Auckland. *Photo: Well-Connected Alliance*.

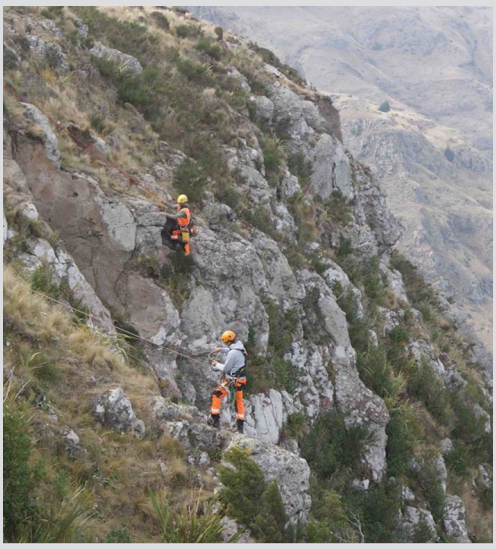
Principle 3: Alternatives to moving lizards must be considered

Given that best practice lizard salvage and transfer processes in New Zealand have yet to be established, are not well-tested, can be time-consuming and costly, and can delay the development of a site for many weeks or months, it makes good sense to ensure that they are used as a last resort. Lizard salvage and transfer is only appropriate if avoidance and remediation measures have not resulted in, or cannot result in, no-net-loss of lizards from the development area. Therefore, DOC requires evidence that due consideration has been given to alternative options to preserve lizards where they occur naturally. Adequate justification for disregarding any available options must be provided.

Salvage may not be the best option

Unstable rock face

An unstable rock face was posing a human safety risk as rocks were threatening to fall off the steep rock face onto a walking track and needed to be removed. However, the whole rock face, including the loose rocks, was providing excellent habitat for lizards and survey information suggested the lizard population was large across the entire rock face. In this case, lizard salvage was not considered the best option, primarily because the site was dangerous and specialist abseiling and safety skills were required to access it, meaning that a herpetologist could not be used to salvage the lizards.



Rope access technicians on unstable rock face
Photo: D. Matheson, Abseil Access.

Compensation rather than salvage

Instead of salvage, a comprehensive compensation package was proposed. New habitat was created on site and some limited salvage took place using rope access technicians who had the skills required to enter the steep site but who were not skilled herpetologists. Inexperienced herpetologist are generally not encouraged to do salvage work, and the mitigation package acknowledged the likely lower success of salvage using inexperienced staff.

Training carried out

A skilled herpetologist ran a training session where access technicians were trained in species identification, where to find lizards for salvage and correct handling. They were also given protocols on what to do with lizards after they were captured. In this case the focus of the mitigation was not in the salvage but in the wider benefit that the compensation package brought for lizard conservation.

Herpetologist training rope access technicians in correct lizard handling and salvaging techniques.
Photo: D. Matheson, Abseil Access.

Principle 4: Threatened lizard species require more careful consideration than less-threatened species

All indigenous lizard species in New Zealand are absolutely protected under the Wildlife Act 1953, but for lizard species of very high conservation concern (i.e. 'Threatened' or 'At Risk', see Fig. 1), salvage and transfer proposals must meet the criteria for conservation-led translocations (DOC Lizard Technical Advisory Group 2018).

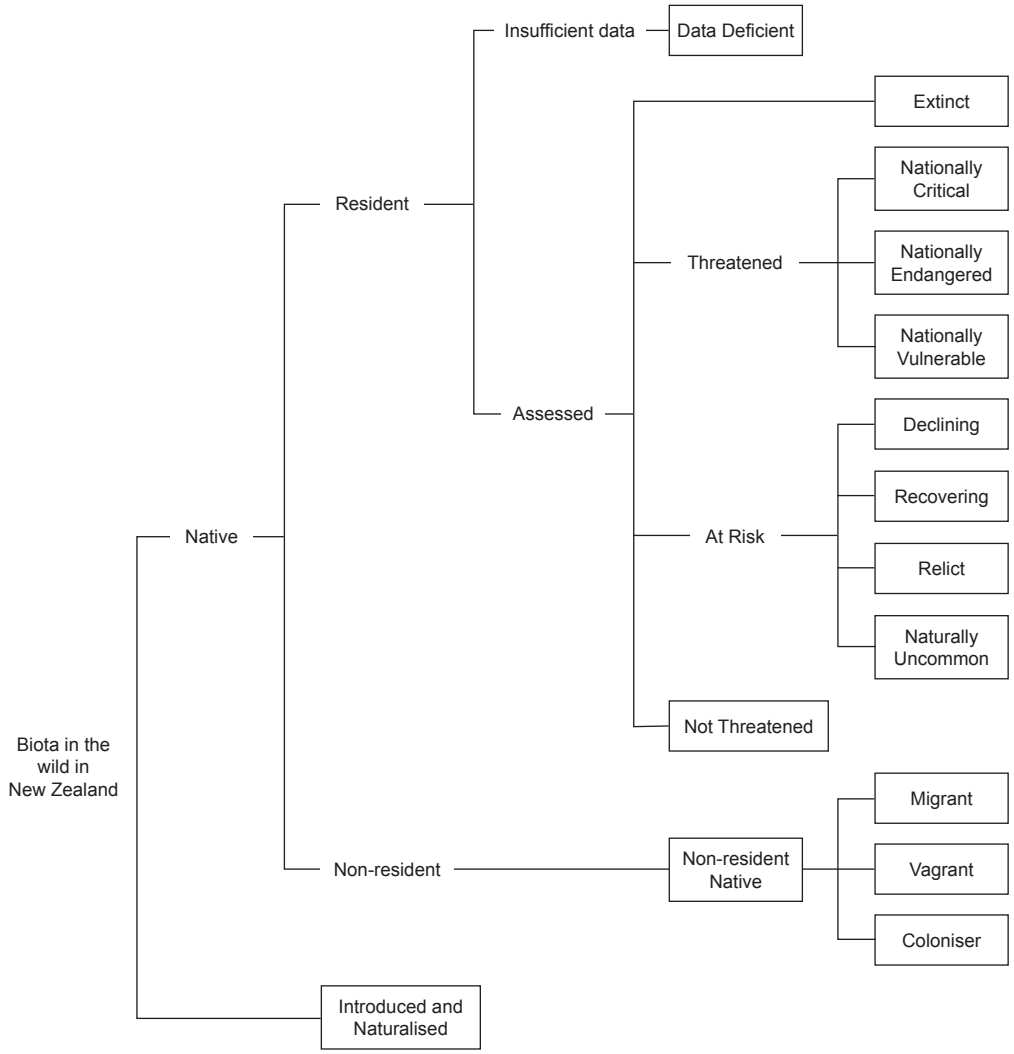


Figure 1. Structure of the New Zealand Threat Classification System.

Principle 5: Lizard salvage, transfer and release must use the best available methodology

While salvage and transfer can be used to save some individuals from a development site, DOC is primarily interested in protecting existing populations by ensuring they are able to re-establish elsewhere. Any transfer must meet the minimum requirements of translocations as outlined in the International Union for the Conservation of Nature (IUCN) translocation guidelines (IUCN/SSC 2013). Salvage must also follow the requirements of DOC's translocation permitting process. A mandatory component of any salvage and transfer application is a detailed description of why the salvage is needed, the salvage techniques proposed for each of the lizard species to be salvaged (which, importantly, must include a detailed assessment of the release site), and post-release management (covered in Principles 7–9).

Salvage methods include capture and collection techniques, temporary captive care (if required) and holding, transportation, health screening, data collection and release protocols. Principles 7–9 cover post-release activities; these are just as important as the transfer activities, as they ensure that viable populations become established. The DOC Herpetofauna toolbox (DOC Herpetofauna Inventory and Monitoring Herpetofauna link) can assist with determining which sampling methods should be employed for each species and habitat combination.

The IUCN translocation guidelines provide the best guidance on how to approach salvage; however, they do not distinguish between salvage- or conservation-related translocations. There is little New Zealand-based research data to guide best-practice lizard translocations. The approach adopted depends on the objectives of the salvage proposal and, in particular, how much it contributes to the attainment of no-net-loss in lizard values.

To maximise the number of salvaged animals, salvage should be undertaken over multiple 'salvage events' and these should only stop after at least three unsuccessful salvage attempts under appropriate field conditions. Using people with herpetological skills and experience is critical to the success of this process. Even using the best methodology, a high proportion of lizards will remain undetected, so compensation for any loss of lizards and/or their habitat will be required. The only published study that has attempted to quantify the portion of lizards caught during monitoring showed it was highly variable and usually low (< 50%; ranged from 0.002 ± 0.001 (SE) to 0.470 ± 0.069), even with reasonable monitoring efforts (Lettink et al. 2011). We can therefore assume that only a portion of the population will be caught during salvage.

As a last resort, some of the remaining undetectable lizards may be recovered by having a herpetologist present to capture lizards fleeing from earthworks or revealed when large objects are moved while work is being undertaken (destructive searches). In addition, a post-vegetation-clearance search for remaining lizards or for those that attempt to return to their home site can be carried out.

The guideline for conservation-led translocations (DOC Lizard Technical Advisory Group 2017) provides more detail on methods for the capture, temporary holding and release of lizards following translocation, as do the IUCN Translocation Guidelines.

Canterbury geckos (*Woodworthia brunnea*) in box awaiting release. *Photo: Marieke Lettink.*

Principle 6: Receiving sites and their carrying capacity must be suitable in the long term

The receiving site is generally poorly considered in lizard salvage applications, yet it is one of the most important elements of a salvage. The receiving site must allow for growth of a sustainable population, have legal protection and remain suitable over time for the lizard species in question.

A salvage and transfer proposal needs to have particular regard to the following components when selecting a receiving site:

1. **The site must be ecologically appropriate and have long-term security**
   - It must be suitable through time for the lizard species being salvaged.
   - The numbers and patterns of habitat use of lizard species already present at the receiving site must be understood (e.g. there must be an existing population of the species being salvaged adjacent to the receiving site, or enough assurance that there will be adequate animals salvaged to establish a genetically viable population).
   - It must be an appropriate distance from the salvage site to ensure lizards cannot move back into harm's way[5] (lizard exclusion fences in combination with traps can be used to keep lizards out of development areas), but as close as possible to ensure lizards are moved to site(s) that very closely resemble those that they have come from in terms of microhabitat and climate.
   - Post-release monitoring must be achievable if appropriate (see Principle 7 below).
   - The location must be within the species' natural geographic range. It is unlikely that DOC would support lizards being transferred to areas outside their known or likely historic geographic ranges.
   - There must be no mixing of genetically structured populations.
2. **The habitat at the site must be suitable for the salvaged species**
   - It should be predominantly indigenous vegetation that is sufficiently large and continuous to support both the translocated lizards and the eventual established population over all the species' life history stages.
   - It must contain sufficient resources (food, cover, retreats) for both the salvaged lizards and the eventual established population, be buffered from climatic extremes (drought, cold) and not located in areas that are prone to flooding or coastal erosion.
   - There must be sufficient resources for both resident and translocated lizards or 'improved' for lizards to ensure resources are available.
   - Ongoing management must improve habitat for lizards over timeframes that are ecologically relevant.
3. **The site must provide protection from predators**
   - Habitat at the site must be secure from predators or effective pest control must be in place to allow the salvaged lizards to establish a population.
   - Where predators have been eradicated, there have to be appropriate biosecurity procedures to stop them reinvading.
4. **The site must be protected from future human disturbance**
   - Land tenure at the site must ensure long-term protection from disturbance.

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[5] Lizard fences are routinely used in Australia to keep lizards contained. 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 (see http://www.herpetosure.com/solutions/fencing-solutions/slow-worm-fencing).

The issues identified under Principle 1 are also relevant here and should be referred to.

Control of all mammalian predators, including mice, is likely to be needed to allow salvaged lizards to establish and their population to recover. Mechanisms should be in place to ensure pest control can continue beyond the life of the development project to ensure long-term persistence of the salvaged population at its new site. It may be overly onerous for a development proponent to commit to pest control in perpetuity, but a receiving site needs be set up in such a manner that ensures future occupants/landowners continue pest control (e.g. via covenants).

There is much uncertainty around the fate of lizards in mainland sites once the predator control is reduced or ceases (e.g. at the end of a development project). It is likely all benefits of the pest control will be reversed at this stage, unless the habitat contains sufficient protective cover. One project at Whangamata showed recovery in lizard numbers post-release and while predator control was carried out, but a rapid decline to presumed extinction after predator control stopped (C. Wedding pers. comm.). Given that the loss of lizards over the footprint of a development is often permanent, relying on limited-duration predator control as a mitigation tool at receiving sites for salvaged lizards may potentially 'short-change' the lizard populations of an area. Cumulatively, these short-duration pest control events contribute to a net loss of New Zealand lizards and lizard habitats.

Effective predator control to provide long-term benefit to lizards is very difficult to achieve. However, meaningful reduction of predators prior to and during the establishment phase of salvaged (or other translocated) lizards may be beneficial if it enables them to discover suitable retreats in their new environment without intense predation pressure (Norbury et al. 2014). In this way, predator control has a defined role over a specific period to support the transferred lizards through the establishment phase. Adding suitable habitat for lizards may also be necessary and/or beneficial (Bogisch et al. 2016), but this method has not yet been widely tested to determine whether it can be successful and detailed monitoring would be required if use of this technique is proposed.

Newly-created habitat will require enhancement or augmentation using one or more of the following methods:

- Provision of suitable and permanent cover to provide refuges safe from predators.
- Plantings of eco-sourced vegetation, especially lizard food plants.
- Translocation of trees, boulder fields, slash and debris from the development site.
- A combination of these methods.
- Pest control.

Augmentation of habitat is undertaken regularly, but the effectiveness of the method has not yet been tested and trial augmentation or detailed investigation is recommended prior to a development commencing, or augmentation following a robust and testable scientific method. There needs to be assurance that enhancement methods will be successful in providing long-term support to all species of salvaged lizards, including the eventual established populations. Also, if habitat is to be enhanced, extension and enhancement of existing lizard habitat is (usually, if not always) better than building it from scratch.

Different approaches can be used when releasing salvaged lizards. These are listed below in order of preference (based on what we know at present about the advisability of using them):

1. Release into 'empty' and predator-free lizard habitat. 'Empty' habitat refers to a suitable area that no longer supports the species or supports so few individuals of the species that they have not been encountered for ≥ 20 years. Enough salvaged individuals have to be released to form a genetically viable population. The habitat is free of mammalian predators (rodents, mustelids, hedgehogs, possums, cats) and/or is subject to effective pest-mammal control in perpetuity (e.g. a pest-fenced and/or intensively-managed eco-sanctuary).

2. Release into 'occupied' habitat where mammalian predators are absent, or effectively controlled in perpetuity. 'Occupied' habitat refers to an area that contains or may contain low densities of either the same lizard species or other species that occupy the same niche and can thus impact the establishment of the salvaged lizards. 'Occupied' habitat may also be suitable unoccupied habitat within dispersal distance of nearby lizard populations. It can provide further suitable and safe habitat if the cause of the initial decline in lizards has been managed.
3. Release into low-density 'occupied' habitat that has undergone enhancement in the form of the addition of newly-created habitat that is suitable for the species in question (and which has been established long enough to become suitable). Release of salvaged lizards coincides with a 'cover' of predator control of limited duration, to assist establishment. 'Occupied' habitat may also be unoccupied habitat within dispersal distance of nearby populations that provides suitable and safe habitat (i.e. the cause of the initial decline has been managed).
4. Release into sites (including empty habitat patches) that have been improved from previously unsuitable sites. For grassland lizard species this may include areas where grazing has been excluded, but little else done. This option is generally not recommended unless specific ecological conditions allow for it.
5. Release into 'empty' lizard habitat outside of predator-controlled areas. Receiving sites with no current lizard populations need to be viewed with caution unless the factors that led to the decline and removal of previous lizard populations are well understood and can therefore be managed for the salvaged population. This option is generally not recommended.
6. Release into suitable lizard habitat created from scratch.

Direct transfer of salvaged lizards from the impact site to the receiving site is preferred when possible. Temporarily housing lizards in captivity for later release into the wild is only approved in exceptional circumstances (e.g. where there are concerns over possible disease in the salvaged lizards). Receiving site options 4–6 above are not considered appropriate as the primary mitigation option but can be used legitimately to minimise any residual effects that achieves no-net-loss in other ways.

Looking for scree skinks (*Oligosoma waimatense*)
Photo: Marieke Lettink.

The quality of receiving sites is critical to the success of salvage translocations

Lizards were present in stone piles on a farm

Isolated piles of stones (cleared from paddocks) had been accumulated on a farm decades ago. After an initial assessment it was found that some piles had lizard populations but some did not. It appeared that stone piles with a lot of silt and soil mixed in didn't provide sufficiently deep cover for lizards and had therefore proved unsuitable as refuges pver the years, but when silt and soil were absent they had provided refuges for lizards well after the surrounding paddocks began to be used for intensive agriculture.

Southern grass skink (*Oligosoma* sp.) living in a stone pile. *Photo: H. Frank*.

Some of these piles needed to be removed to allow access for irrigators

After assessment, several of the occupied piles were left undisturbed, thus maintaining the lizards in their secure refuges. Where piles had to be removed, they were carefully dismantled by experienced herpetologists, and lizards were caught as they were exposed. The rocks in unoccupied piles were used to enhance occupied piles (removing the unsuitable silts and soil).

Shifting a stone pile and catching lizards. *Photo: H. Frank.*

After removal, about 60 skinks caught. *Photo: H. Frank.*

New piles were created and habitat enhanced

New piles were also created adjacent to existing occupied piles, which extended and enhanced existing habitat rather than fragmenting populations further. Native plants known to benefit lizards were planted around all of the stone piles, enhancing the area by creating additional food and habitat for lizards. New stone piles were located in areas safe from likely future developments or impacts (such as adjacent to road reserves and at property boundaries). Overall, the outcome of this salvage and mitigation work was an increase in the area of habitat available to lizards, less-fragmented populations and habitat enhanced with suitable native vegetation.

Unloading stones to extend an existing row. *Photo: H. Frank.*

New stone row (left) and old stone row (right). *Photo: H. Frank.*

Planting new lizard habitat. *Photo: H. Frank.*

Stone row completely removed for pasture. *Photo: H. Frank.*

Principle 7: Monitoring is required to evaluate the salvage operation

The international literature indicates that translocations of amphibians and reptiles undertaken for mitigation of development activities presently have very low success rates (e.g. Germano & Bishop 2008). Even the principles in this document are not based on salvage data but are instead based on results from conservation-related translocations. Thus, post-release monitoring of salvaged lizards must be carried out to inform future translocations and, given salvage methods have not been tested in New Zealand, to gather more New Zealand-specific data. Post-release monitoring requires clear objectives prior to initiation. The Department of Conservation Herpetofauna toolbox at https://www.doc.govt.nz/our-work/biodiversity-inventory-and-monitoring/herpetofauna/ can assist in planning post-release monitoring.

Principle 8: Reporting is required to communicate outcomes of salvage operations and encourage process improvements

As a condition of a Wildlife Act Authority (and most resource consents), a detailed report on the salvage and transfer operation and any post-release monitoring must be sent to DOC and iwi. For large-scale projects involving multiple species and/or significant sites, interim reports and/or liaison are also appropriate to ensure that milestones and performance standards set out in the Wildlife Act Authority are met. For these larger projects, reporting should also include progress against any lizard mitigation and/or management plan objectives relating to the development, including post-release monitoring objectives.

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

Principle 9: Contingency actions are required when lizard salvage and transfer activities fail

If mitigation measures are not successful there is still an obligation to ensure the project achieves no net loss of lizard populations. Contingency actions (what to do if things go wrong) should be identified from the outset but are commonly omitted in lizard management plans. Even the best-laid plans can go wrong and, given that many of the methodologies involved in salvage and transfer are still untested, they carry an inherent risk of failure. As such, it is essential that contingency actions are identified in applications for lizard salvage and transfer. Contingency actions must be designed with careful thought and a genuine commitment to implementing them if they are needed. Their main purpose is to ensure that there is no net loss of lizards and lizard habitat post development, should lizard salvage and transfer fail or be only partly successful.

Contingency actions, if required, must undergo the same scrutiny as any salvage and transfer event that they replace. Conditions imposed in the Wildlife Act Authority should signal a requirement that contingency actions represent a fresh proposal.

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Appendix 1

Common effects on lizards associated with development

Development-related activity/consequence	Effect on lizards and lizard habitats
Afforestation	Habitat loss, habitat quality reduction, displacement
Deforestation	Habitat loss, habitat quality reduction, displacement
Domestic stock exclusion	Habitat change, possible displacement, possible change in predator-guilds
Dust and vibration	Habitat change, possible displacement, diet changes.
Earthworks	Habitat loss, displacement, injury, death
Fire	Habitat loss, displacement, injury, death
Flooding	Habitat loss, displacement, death
Grazing-domestic animals	Habitat loss, habitat change, possible displacement, trampling, possible change in predator guilds
Habitat relocation	Habitat loss, displacement, injury, death
Herbicides	Unknown
Irrigation	Habitat loss, habitat change, possible displacement, possible change in predator guilds
Light/glare	Habitat change, possible displacement, diet changes
Pesticides	Decreased survival, possible sub-lethal and lethal effects if ingested
Ploughing/cultivation	Habitat loss, displacement, injury, death
Quarrying/rock removal	Habitat loss, displacement, injury, death
Roading/realignments	Habitat loss, habitat change, possible displacement, possible change in predator guilds
Salvage and transfer	Can be managed with experienced herpetologist, but include overheating, overcrowding, competition, displacement, injury, death
Tourism/visitor impacts	Disturbance, trampling, poaching, displacement, reduction in reproductive output
Vegetation clearance	Habitat loss, displacement, injury, death
Weed encroachment	Habitat loss, habitat change, possible displacement, possible change in predator guilds