



Global Re-introduction Perspectives: 2010

Additional case-studies from around the globe
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Lessons learned from a series of translocations of the archaic Hamilton's frog and Maud Island frog in central New Zealand

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Introduction

A series of re-introduction case-studies from which conservation management lessons have been learned are provided for two threatened terrestrial frogs that survive on islands in the Marlborough Sounds, New Zealand. Until translocation, Hamilton's frog (*Leiopelma hamiltoni*; McCulloch, 1919) were restricted to a small 300 m² rock bank on Stephens Island (Is.) and the Maud Island frog (*Leiopelma pakeka*; Bell, Daugherty & Hay, 1998) to a remnant 16 ha forest patch on Maud Island (Is.) These evolutionarily distinct frogs are in one of the two earliest diverging genera of modern Anura. Formerly regarded as *L. hamiltoni*, *L. pakeka* was described as a cryptic phylogenetic species based on allozymes and morphometrics. However, more recent partial 12s RNA and Cyt b sequences, showed little variation between them (<1% for Cyt b), so the taxonomic status of *L. pakeka* requires further resolution.

Maud Is. and Stephens Is. have remained free from introduced rats, suggesting that such mammalian predators have led to their extinction elsewhere. Sub-fossils show a species identified as *L. hamiltoni* was formerly widespread across both the North Is. and South Is. of New Zealand.

Transfers of *L. pakeka* began in 1984-1985, when 100 frogs were moved to a restored site at Boat Bay on Maud Is. (Bell *et al.*, 2004). Subsequent transfers beyond Maud Is. were of 300 *L. pakeka* to Motuara Is. in 2001, 101 to Long Is. in 2005, and 60 into Zealandia* Sanctuary, Wellington, in 2006-2007 (Bishop, 2005; Tocher & Pledger, 2005;

* - Zealandia (formerly known as Karori Sanctuary) is a predator-proof fully fenced urban wildlife sanctuary in Wellington on the North Is. of New Zealand



Hamilton's frog (above) & Maud island frog (below)

Lukis & Bell, 2007). In 1992, 12 *L. hamiltoni* were transferred to adjacent newly created habitat on Stephens Is. (Brown, 1994), then 71 frogs were transferred over 2004–2006 to Nukuwaiata Is. (Tocher *et al.*, 2006). Additional *L. hamiltoni* and *L. pakeka* have been held in captivity, where they successfully bred and young were reared, but no re-introduction of captive bred frogs into the wild has taken place. No breeding sites have been found for either species in the wild. In the 2009 IUCN Red List, *L. hamiltoni* is ranked 'Critical' and *L. pakeka* as 'Vulnerable', while under the current New Zealand Threat Classification System these two taxa are listed as 'Nationally Critical' and 'Nationally Vulnerable' respectively. No chytridiomycosis has been found in these two island populations, or in any transferred populations, and neither source population has declined under conservation management over the past 30 years.

Goals

- Goal 1: Identification of potential re-introduction sites within the species' historic range.
- Goal 2: Successful breeding of released individuals, and persistence of each translocated population.
- Goal 3: Sustainable populations established in a range of suitable habitats, free of introduced mammalian predators, and where the risk of chytridiomycosis is minimal.
- Goal 4: Through adaptive management, re-establish populations on mainland sites where the risks of mammalian predators is managed.
- Goal 5: Annual monitoring of source populations and regular monitoring of translocated populations.

Success Indicators

- Indicator 1: Self-sustaining populations established at re-introduction sites.
- Indicator 2: Overall geographical distribution of the species extended.

Project Summary

The earliest transfer of these species was a re-introduction trial of *L. pakeka* that took place in regenerating forest at Boat Bay on Maud Is. in 1984–1985 at a site that had lost its presumed former frog population as a result of habitat changes induced by farming. In 1984 the first 43 frogs were transferred, then a further 57 in 1985, all being released at the same location. Population sampling has occurred at least annually, revealing high survival of founders, increased mean body condition, most settlement close to the release site (<26 m), steady recruitment (locally-bred individuals now exceed the number released), and a rising population level (Bell *et al.*, 2004). This intra-island re-introduction represents the most successful transfer to date. Once the Boat Bay re-introduction had demonstrated that these frogs could be successfully transferred and established in a new location, a transfer of 12 *L. hamiltoni* took place on Stephens Is. in 1992, to a specially excavated 'frog pit' filled with rocks in remnant forest 50 m from the original site (Brown, 1994). A predator-proof fence was built around the new habitat to exclude tuatara (*Sphenodon punctatus*), a known predator, and the area was seeded with invertebrate prey (Brown, 1994). In 2004, a fenced tuatara-excluded corridor was created to connect the two sites, and



Left Image: Maud island the only location of *L. pakeka*, in 1984-1985, 100 frogs were translocated from remnant population “B” to forested gully “A”.

Right Image: Stephen’s island the only location of *L. hamiltoni*, which survived on a rock bank near the summit prior to translocation.

while some frogs homed back to the original site, between 1996 and 2000 at least three frogs remained in the new ‘frog-pit’. In 1997, in the first island-island transfer of *L. pakeka*, 300 adult frogs were translocated from Maud Is. to Motuara Is., and this new population has been regularly monitored since. In August 2002, 155 individuals were recaptured as well as 42 new recruits (Tocher & Pledger, 2005).

Given that the only population of *L. hamiltoni* amounted to c.300 individuals living in 300 m² on Stephens Is., there was much to be gained by establishing a population on another island but risks were greater because of the low numbers (Tocher *et al.*, 2006). A long history of monitoring the source population provided data for predicting which of nine hypothetical translocation scenarios was likely to produce the best result for the species (Tocher *et al.*, 2006). A translocation of 40 female frogs (20 adults and 20 sub-adults) along with 40 male frogs (20 adults and 20 sub-adults) was chosen as it provided a balance between risk of extinction in the donor population and probability of success in the translocated population (Tocher *et al.*, 2006).

Consequently, in 2004 the first 40 *L. hamiltoni* were moved to a new site on Nukuwaiata Is. Data-loggers had been previously installed there to confirm that a suitable microclimate existed, and boardwalks were erected so that the frogs could be monitored without disturbing the habitat. By 2006, 25 had been encountered, and sub-adults were growing at a normal rate (pers. comm. H. Cooper). With these promising results the final cohort of 31 frogs were captured on Stephens Is. and shifted to Nukuwaiata during 2006. The first new recruit to the new population was discovered in 2008 with eleven further juveniles found in 2009.

A third island population of *L. pakeka* was initiated in 2005 when 101 frogs were translocated to a prepared site on Long Is. Their initial movements and adaptation to the new site were followed showing that there was a tendency to disperse

downhill and that those shifted with near neighbors were just as likely to disperse as those released with unfamiliar frogs (Germano, unpubl. M.Sc., 2006). During the four years post-release, population numbers on Long Is. appear to be in decline, possibly due to poor habitat and kiwi (*Apteryx* sp.) predation.

In Zealandia, Wellington, 30 adult *L. pakeka* that had been held in captivity were placed in a 2 x 4 m predator proof mesh enclosure in February 2006. Their sizes (most >40 mm SVL) indicated they were predominately females, so 30 more frogs in the male size range (<40 mm SVL) were transferred from Maud Is. in October 2006, initially into another 2 x 4 m enclosure (Lukis & Bell, 2007). In April 2007, 58 surviving frogs were mixed into roughly equal numbers of males and females. Using an adaptive management approach, half were retained in an enclosure, the rest were released into the wild in adjacent forest, where there were at least two potential predators, the house mouse (*Mus musculus*) and little spotted kiwi (*Apteryx owenii*).

Survival in the enclosure remained high (27/29), but the number seen in the wild declined markedly, however, suggesting poor survival in the presence of even a limited range of predators. Despite this disappointment, by February 2008 the first breeding had occurred in the protected enclosure (two brooding males). Thirteen recently hatched larvae were moved to incubators to complete metamorphosis, eleven surviving until release into nursery pens at Zealandia in March 2008. In mid-March 2009, two males were found with a total of ten nearly metamorphosed young frogs, which again completed metamorphosis in incubators, before being placed in a nursery pen in Zealandia in late March.

Major difficulties faced

- Limited size of source population, requiring a modeling approach to determine optimal number to translocate to balance risks of over-cropping the source population against risks of insufficient pioneers in the transferred population - *L. hamiltoni* Nukuwaiata Is.
- Releasing low numbers (<30) could reduce likelihood of successful establishment - *L. pakeka* Zealandia.
- Probable predation from house mice (*L. pakeka*, Zealandia) and possibly little spotted kiwi (*L. pakeka*, Zealandia and Long Is.).
- In recreating suitable rocky frog habitats in sites of release, there may be a risk of inadvertently attracting mammalian predators e.g. house mice at *L. pakeka* release site in Zealandia.
- Finding suitable habitat on appropriate predator-free islands.

Major lessons learned

- The original Boat Bay transfer was a success and provides a model for future translocations - both *L. hamiltoni* and *L. pakeka*.
- Successful translocations require sufficient numbers and a mix of ages and sexes - both *L. hamiltoni* and *L. pakeka*.
- Founders likely to be at risk to potential mammalian/avian predators at mainland and island sites, so successful transfer likely to require exclusion and/or management of suspected predators. Remedial options at Zealandia

are to intensify house mouse control, or entirely eliminate mice, to exclude potential avian ground predators like kiwi by fencing, to provide more secure retreat sites around release area, to supplement release with a larger number of frogs (100+), and to consider a large fully enclosed predator-free release environment. Future island translocations should take into consideration potential conflicts with native predators and fencing should be used to help protect an establishing population at early stages - *L. pakeka* at Zealandia and Long Is.

- Construction of artificial rocky habitat piles or pits can enhance establishment in sites where such substrate is sparse or lacking, but may run risk of attracting predators where these occur – *L. hamiltoni* Stephens Is., *L. pakeka* Zealandia.
- These are K-selected species and long-term monitoring (>20 years) is required to confirm successful establishment – both *L. hamiltoni* and *L. pakeka*.
- Despite small home range sizes, these frogs can, and do, home following short-distance translocations. As homing instincts decrease with distance, future translocation should be at a sufficient distance to discourage homing.

Success of projects

Overall success summary, all transfers, both species (1984-2007):

Highly Successful	Successful	Partially Successful	Failure
1	2		3

L. pakeka, Boat Bay, Maud Is., Marlborough Sounds (1984-1985):

Highly Successful	Successful	Partially Successful	Failure
√			

Reason(s) for success/failure:

- 75% of 100 founders recaptured at least 6 months post-release.
- Mean body condition index of founders increased after release.
- Mean body size growth in founding population greater than in source population.
- Increasing numbers of individuals being caught during annual sampling sessions.
- Founders now comprise a smaller proportion of captures, 34% of founders were still alive after 25-26 years.
- Immature frogs regularly observed and 136 individuals known to have been recruited into the population by 2010-more than the number of founders (100).

Amphibians

L. hamiltoni, Stephens Is., Marlborough Sounds (1992):

Highly Successful	Successful	Partially Successful	Failure
			√

Reason(s) for success/failure:

- Increased local habitat and range of existing population.
- No breeding at new site.
- The majority of translocated individuals homed to the point of capture, and very few sightings have been made of the translocated frogs that remained at the new site.

L. pakeka, Motuara Is., Marlborough Sounds (2001):

Highly Successful	Successful	Partially Successful	Failure
	√		

Reason(s) for success/failure:

- Maintained large numbers of individuals, though longer term monitoring required to confirm.
- Evidence of breeding at the site.

L. pakeka, Long Is., Marlborough Sounds (2005):

Highly Successful	Successful	Partially Successful	Failure
			√

Reason(s) for success/failure:

- Possibly unsuitable or suboptimal habitat, with too few rocks to provide retreat and/or breeding sites, though longer term monitoring required to confirm.
- Possible predation by little spotted kiwi. Recapture numbers have decreased substantially and one frog was caught with recent damage to one side of its face, which may be evidence of predation. Kiwi have been noted at the frog site during every monitoring session.

L. hamiltoni, Nukuwaiata Is., Marlborough Sounds (2004-2006):

Highly Successful	Successful	Partially Successful	Failure
	√		

Reason(s) for success/failure:

- Local breeding, short-term success, but still too early to confirm long-term success.

L. pakeka, Zealandia, Wellington (2006-2007):

Highly Successful	Successful	Partially Successful	Failure
			√

Reason(s) for success/failure:

- Decline to extinction after release, despite high survival and successful breeding over two successive years by other frogs held in predator-proof enclosure.
- Probable predation from house mice and possibly little spotted kiwi.
- Low number of frogs released (29).

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A more detailed reference list can be obtained from the first author