THREATENED SPECIES RECOVERY PLAN 63

Native frog (*Leiopelma* spp.) recovery plan, 2013–2018

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Department of Conservation
Te Papa Atawhai

Cover: Archey's frog (*Leiopelma archeyi*) on kiwikiwi (*Blechnum fluviatile*). *Photo: Kate McKenzie.*

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Foreword

The former Waikato Conservator of the Department of Conservation (DOC) formally approved this threatened species recovery plan in 2013. A review of the plan is due in 2017, or sooner if new information or technology leads to a significant change in management direction. This plan will remain operative until a new plan has been prepared and approved, or will become redundant if recovery is achieved and management effort enters a 'maintenance phase'.

The Native Frog Recovery Group prepared this plan in conjunction with people interested in or affected by this plan, or with an expert knowledge of these species. Drafts have been sent to relevant DOC regions for comment and to people or organisations with an interest in conservation management of native frogs. Changes to the plan were made as a result of that consultation.

The Recovery Group will review progress in implementation of this plan and will recommend to managers any changes that may be required in management.

The recovery planning process provides opportunities for further consultation between DOC, tangata whenua and others regarding management of these species. Comments and suggestions regarding conservation of native frogs are welcome and should be directed to the Native Frog Recovery Group via any DOC office or to the Manager, Terrestrial Ecosystems Team (Science and Capability Group, Department of Conservation, PO Box 10420, The Terrace, Wellington 6143). Those interested in being more involved in management of native frogs or in receiving information should also contact the Recovery Group.

The Recovery Group consists of people with knowledge of the ecology and management needs of these species. The role of the Recovery Group is to provide high-quality technical advice that achieves security and recovery of these species.

Threatened species recovery plans are statements of the Department's intentions for the conservation of a particular species of plant or animal, or group of species for a defined period.

Recovery plans:

- Are proactive and operational in nature, focusing on specific key issues, providing direction, and identifying recovery actions for managers and technical workers.
- Set objectives to secure from extinction and recover the species, and outline measurable actions needed to achieve those objectives.
- Are primarily used by DOC staff to guide their annual work programmes; however, they also provide a forum for planned initiatives with tangata whenua, community interest groups, landowners, researchers and members of the public.
- Stimulate the development of best practice techniques and documents, which can be transferable across similar species recovery programmes.

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Native frog (*Leiopelma* spp.) recovery plan, 2013–2018

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Abstract

Native frogs were formerly widespread and common throughout New Zealand. However, they are now much reduced in range, with remnant populations only occurring on the mainland of the North Island and on several islands in the Marlborough Sounds. The current agents of decline are thought primarily to be introduced mammalian predators, disease and habitat modification. The current recovery plan covers the period from 2013 to 2018 and sets in place the actions required to move into the next phase of recovery management for all four extant native frog species (*Leiopelma* spp.). In this respect, the plan spans a transitional phase to consolidate the security of the species and set the platform for their broader recovery.

Keywords: *Leiopelma*, native frog, species recovery, threat classification, evolutionary significant unit, agents of decline, research, management, tangata whenua, community relations

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1. Introduction

The native frogs of New Zealand possess some of the most ancestral features of any living frogs in the world. Four extant species are formally recognised: Archey's frog (*Leiopelma archeyi*), Hochstetter's frog (*L. hochstetteri*), Maud Island frog (*L. pakeka*) and Hamilton's frog (*L. hamiltoni*).

Native frogs were formerly widespread and common throughout New Zealand, including lowland habitats. However, they are now much reduced in geographic and altitudinal range, with remnant populations of the terrestrial Hamilton's frog and Maud Island frog only occurring on predator-free islands in the Marlborough Sounds, and the terrestrial Archey's frog and the semi-aquatic Hochstetter's frog being found in scattered locations on the mainland of the North Island.

The first native frog recovery plan was published in 1996 (Newman 1996). That plan spanned 5 years and led to the formation of the Native Frog Recovery Group. Over this period, frog recovery work focused on establishing new populations of the island species, and developing survey and monitoring techniques.

In the later years of the 1996 plan, a disease caused by the amphibian chytrid fungus (*Batrachochytrium dendrobatidis*) was discovered in Archey's frog, which coincided with serious declines in one population (Bell et al. 2004c). Therefore, since this time, research on amphibian disease and the establishment of captive populations have been additional foci for frog recovery work.

In 2004, the achievements of the 1996 native frog recovery plan were reviewed (Tocher et al. 2004) and the preparation of a new plan was recommended. This document is based on that review, while also taking into account more recent information on the status of and threats to native frogs.

2. Plan term and review date

Term of the plan: 5 years, from July 2013 to July 2018.

Review date: July 2017.

3. Context

3.1 Overview of species

3.1.1 Taxonomy

Native New Zealand frogs (*Leiopelma* spp.) represent a unique evolutionary lineage among amphibians and are thought to be the most archaic frogs in the world (Roelants et al. 2007). Three species are extinct (*L. auroraensis*, *L. markhami* and *L. waitomoensis*), with subfossil remains from *L. markhami* dated at around 200 years BP (Worthy 1987a), which suggests that this species was extant during the early colonisation of New Zealand. Four formally described species are still present in New Zealand: Archey's frog, Hochstetter's frog, Maud Island frog and Hamilton's frog.

The separation of Maud Island frog and Hamilton's frog as distinct species has been the subject of some debate (see Bell et al. 1998a; Holyoake et al. 2001). Furthermore, recent DNA analyses conducted by Gemmell et al. (2003) and Fouquet et al. (2010b) suggest that Hochstetter's frog may consist of at least 13 evolutionary significant units (ESUs); and Gleeson et al. (2010) found ten highly distinctive genetic groups and recommended that management should focus on maintaining these distinct populations. Since more genetic research is required to reveal the level of speciation within the Hochstetter's frog group, these populations have been referred to as ESUs throughout this plan.

3.1.2 Species ecology and biology

All leiopelmatid frogs are carnivorous and eat invertebrate prey items, such as beetles, mites and spiders (Kane 1980; Bell 1995; Eggers 1998; Ziegler 1999; Shaw et al. 2012). They are long-lived (e.g. > 30 years) and produce small clutches of eggs under favourable conditions—although not necessarily every year (Bell 1985, 1994; Bell & Pledger 2010). All species are cryptic and mostly nocturnal, spending the daylight hours under logs or rocks, although some Archey's frogs may be seen during the day. All species also show high site fidelity and have small home ranges (Brown & Tocher 2003; Tocher et al. 2006), although broader scale movements have been recorded (Tessier et al. 1991; Slaven 1992; Tocher & Pledger 2005). There is evidence that Maud Island frogs may communicate through chemosignals (Lee & Waldman 2002; Waldman & Bishop 2004).

While the main stronghold populations of native frogs are found in unmodified areas of native forest on both predator-free islands and the mainland, subfossil evidence indicates that the current distribution may not reflect the optimal ecological requirements of these frogs (Worthy 1986, 1987a, b, 1993; Worthy & Holdaway 1994; Fouquet et al. 2010a). Their distribution is likely to be influenced by a suite of factors, including physiological parameters (Cree 1985), ecological parameters, and past and present agents of decline (Newman 1996; Perfect 1996; Thurley 1996; Bell et al. 2004a; Perfect & Bell 2005).

Archey's frog is the smallest species (snout-vent length (SVL) ≤ 40 mm). It currently occurs in moist native forest from c. 200 to 1000 m above sea level (a.s.l.). It is terrestrial and is not associated with streams or creeks. Archey's frogs lay small clutches of yolky eggs in moist sites under stones or logs. Individuals exhibit parental care, with the tailed froglets remaining on the back of the male frog for several weeks until metamorphosis is nearly complete (Bell 1985). This species can reach densities of up to 4.8 frogs per m^2 in the Coromandel (Bell 1997) and emerges at rates of up to 77 individuals per 100 m^2 in Whareorino (Daglish 2010).

Hochstetter's frog is a small, robust frog (SVL < 48 mm). Unlike the other native frogs, it is semi-aquatic, spending most of the day hidden under stones or logs within, or near, permanent streams and seepages. Hochstetter's frogs lay small clutches of yolky eggs under stones or vegetation alongside creeks. After hatching, the larvae are quite active and can swim, but do not

feed until after metamorphosis (Bell 1985). Hochstetter's frogs have been recorded at densities of 65–140 per 100 m^2 in the Waitakere Ranges (Slaven 1992); 5–12 per 100 m^2 in the Hunua Ranges (Greene & Tessier 1990); and 18–21 per 100 m^2 at Golden Cross Mine in the Coromandel (Whitaker 1996; Whitaker & Alspach 1999).

Maud Island frog and **Hamilton's frog** are the largest living leiopelmatid frogs (SVL up to 51 mm). Both species are currently found amongst the boulders and moss-covered rocks in terrestrial areas of remnant and regenerating coastal forests. Like Archey's frog, they are terrestrial breeders. However, their breeding behaviour, egg laying and parental care have only been observed in captivity. Maud Island frogs are considered to be numerous on Maud Island, reaching densities of 70–230 per 100 m^2 (Bell 1997). Hamilton's frogs have been recorded at densities of 53–58 per 100 m^2 (Newman 1990; Thomson 1997), although, based on modelling, they were estimated to have increased dramatically to 220 per 100 m^2 in 2004 (Tocher et al. 2006).

3.1.3 Status and species recovery phases

In recovery planning for threatened species, the Department of Conservation (DOC) has adopted a model that identifies four phases of recovery action: 'Research' to identify causes and key agents of decline; 'Secure' the taxon from extinction; 'Recovery'; and 'Maintenance'. There remains some uncertainty about the causes and key agents of decline for native frogs and the threats to both Archey's and Hochstetter's frogs still need to be identified. Given this, the plan is largely focused on the first two phases of recovery—research and secure. Less focus is placed on Maud Island and Hamilton's frogs, as they are considered to be in the recovery and maintenance phases, as previous management has resulted in additional populations being established so that both species are now considered secure from extinction as long as the populations remain protected from agent(s) of decline. The national and international threat classifications, and the current phase of recovery for native frog species are listed in Table 1.

3.1.4 Past and present distribution

Subfossil remains indicate that *Leiopelma* species were once widely distributed throughout New Zealand. Subfossil frog bones have been dated at between 200 and 2000 years BP, and it is thought that the extinction of these frogs may be correlated with the arrival of the Pacific rat (kiore, *Rattus exulans*) in New Zealand (Worthy 1987a, b). Remains identified as Hamilton's and Hochstetter's frogs have been discovered on both the South and North Islands (Worthy 1987a, b); and Leiopelmatidae fossils and a second frog taxon that had not previously been recorded in New Zealand were recently discovered in Central Otago (Worthy et al. 2009).

All native frog species appear to have reduced distributions and exist in remnant populations (Fig. 1). Information on the past and present distribution of native frog species has been collated in DOC's Atlas of Amphibians and Reptiles of New Zealand (DOC 2009).

Table 1. Threat classification/status and phase of recovery for native frogs (*Leiopelma* spp.).

SPECIES NAME	NZ THREAT CLASSIFICATION (Newman et al. 2013)	IUCN STATUS (IUCN 2012; Version 2012.2)	PHASE(S) OF SPECIES RECOVERY (from DOC 2008)
Archey's frog	Nationally Vulnerable	Critically Endangered	Identify agent(s) of decline Secure the taxon
Hochstetter's frog	At risk—Declining	Vulnerable	Identify agent(s) of decline Secure the taxon
Maud Island frog	Nationally Vulnerable	Vulnerable	Secure the taxon
Hamilton's frog	Nationally Critical	Endangered	Secure the taxon

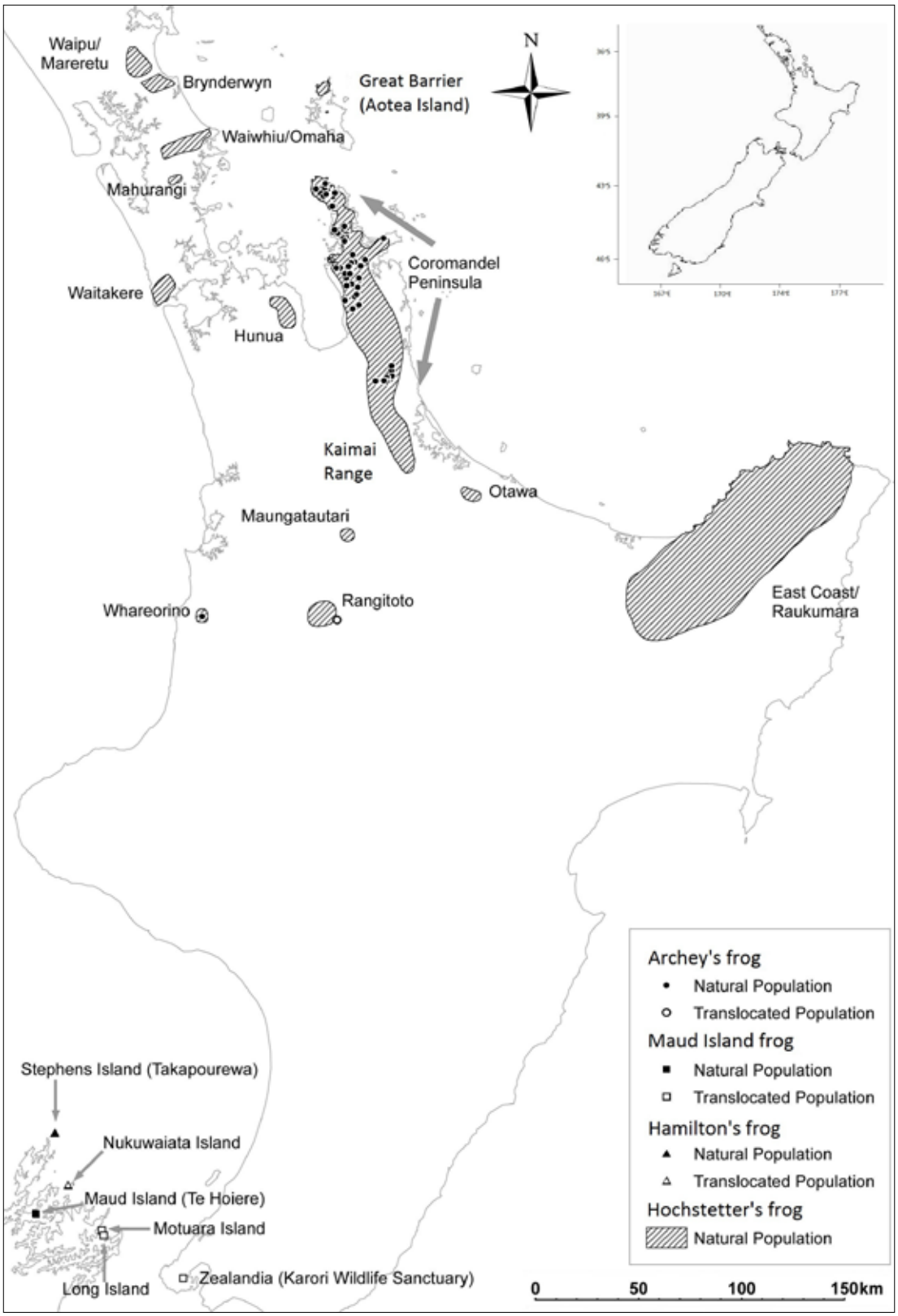

Figure 1. The present-day distribution of native frogs (*Leiopelma* spp.).

Archey's frog is currently restricted to two regions in the North Island: the Coromandel Peninsula and a 6-km^2 area of Whareorino Forest, west of Te Kuiti. In both of these areas, it occurs sympatrically with Hochstetter's frog. The total population size is estimated to be 5000–20 000 individuals. In 2006, 70 Archey's frogs were translocated from Whareorino Forest to Pureora Forest to establish an additional mainland population after the amphibian chytrid fungus was detected in the Whareorino population. However, although breeding has been observed each year, only a low number of the original individuals has been detected and it is still too early to determine whether the translocation was successful.

Hochstetter's frog currently has the most widespread distribution, being found in scattered populations over an extensive area of the North Island. Its distribution ranges over the Whangarei District and Great Barrier Island (Aotea Island), through the Waitakere and Hunua Ranges, down the Coromandel Peninsula and into the northern Kaimai Range, from Whareorino in the west, through isolated populations in the central North Island (Maungatautiri and Rangitoto), and throughout the Eastern Bay of Plenty and Raukumara Ranges. The total population size is estimated to be c. 100 000 individuals.

Maud Island frog is presently only found naturally on Maud Island, a small predator-free island in the Marlborough Sounds. The population is mainly restricted to 16 ha of native bush and has been estimated at 25 000–30 000 individuals (Le Roux & Bell 2007; Bell & Pledger 2010). The species has also been translocated to restored habitat at a second site on Maud Island (1984–1985), to predator-free Motuara Island (1997) (Tocher & Pledger 2005), to Long Island (2005) and to Zealandia (formerly named Karori Wildlife Sanctuary), a fenced mainland site (2006). However, although juvenile frogs have been found during post-release monitoring, translocation success is difficult to determine in the short term.

The only naturally occurring **Hamilton's frog** population presently consists of less than 300 adult frogs on Stephens Island in Cook Strait, where they are limited to a rock tumble (c. 600 m^2) on the island summit (Newman 1990; Tocher et al. 2006). Hamilton's frogs were translocated to an additional site on Stephens Island in 1992 (Brown 1994) and to a second island in the Marlborough Sounds (Nukuwaiata Island) in 2004 and 2006. However, as with the other native frog species, although there is evidence of breeding, judging whether the frogs have successfully established remains a challenge.

3.1.5 Agent(s) of decline and threats

Agents of decline for native frogs have not been conclusively demonstrated, particularly at the population level, and in some cases are speculative. Primary threats are considered to be predation by rats (*Rattus* spp.) (known predators of native frogs); habitat loss and modification; disease; toxins; herbicides; and climate change. Introduced frogs (*Litoria* spp.) are also known to prey on native frogs, and it has been suggested that other mammals such as mice (*Mus musculus*), stoats (*Mustela erminea*), hedgehogs (*Erinaceus europaeus*), possums (*Trichosurus vulpecula*) or pigs (*Sus scrofa*) may affect native frog populations; however, the significance of these species as predators and/or habitat modifiers has not yet been determined. Domestic cats (*Felis catus*), which are also known predators of frogs, are another potentially significant threat as subdivisions adjacent to, or within, native frog habitat increases (Bell 1994; Thurley & Bell 1994; Newman 1996; Bell et al. 2004a).

Predation by rats is suspected to be an important agent of decline and a primary threat for two main reasons. Firstly, dead Archey's frogs displaying bite marks characteristic of rat predation have been found in the wild (Thurley & Bell 1994). Secondly, two species of native frogs (Maud Island and Hamilton's) are restricted to rat-free islands, despite subfossil remains having been found on the mainland where rats are now present.

Habitat loss and modification is also considered to be an important threat and an agent of decline (Bell et al. 2004c). Although Hochstetter's frog has persisted in some landscapes modified by forestry, the long-term survival of these populations is uncertain.

In the last 15 years, chytridiomycosis, which is caused by the amphibian chytrid fungus, has emerged as a significant new threat to native frogs. This disease is present in introduced *Litoria* spp., and was detected in Archey's frog populations on the Coromandel Peninsula in 2001 and in Whareorino Forest in 2006 (Shaw et al. 2008). Chytridiomycosis is thought to be the most likely explanation for an 88% decline in monitored Archey's frog populations in Coromandel over the 1996 to 2001 period (Bell et al. 2004a); however, no decline has been observed in the Whareorino population. To date, chytridiomycosis has not been detected in the semi-aquatic Hochstetter's frog, despite extensive disease surveys (Thurley & Haigh 2008; Shaw et al. unpubl. data); and similarly, disease surveys for Hamilton's and Maud Island frog populations have also yielded negative results (Shaw et al. 2013). Recent research suggests that Archey's frogs, Maud Island frogs and Hochstetter's frogs have a natural ability to cure themselves within weeks when experimentally infected with the amphibian chytrid fungus under laboratory conditions (Shaw et al. 2010; Ohmer et al. 2013); and Archey's frogs that were naturally infected in the wild also showed the ability to self cure when held in captivity (Bishop et al. 2009). However, knowledge about the susceptibility of native frogs to the amphibian chytrid fungus in the wild and about population-wide effects of the disease is limited.

In addition to the amphibian chytrid fungus, new amphibian diseases would present a significant threat to native frogs should they reach New Zealand, as they have caused frog population declines and extinctions in other countries (Daszak et al. 1999; Kiesecker et al. 2004).

It is important to note that agents of decline are likely to be site-specific, and several may interact and occur at the same location. Therefore, robust experimental design will be important to identify which agent(s) are of most threat to the security and recovery of each species of native frog.

The main threats to native frog populations are unmanaged agents of decline, restricted distributions, small population size and disease. Risks to small populations include loss of genetic diversity and inbreeding; while small populations and restricted distributions increase vulnerability to stochastic events.

3.1.6 Past management and the species' responses

Past and current management actions of significance to the recovery of all native frog species include their classification as absolutely protected wildlife under the Wildlife Act 1953, statutory advocacy and legal protection of habitat. These are principally aimed at protecting native frog populations from adverse human impacts. Other management actions have included the implementation of rodent control; disease surveillance; strict hygiene management by field workers and researchers to reduce disease transmission between frog populations; closure of tracks in important frog habitat to reduce the transport of disease via contaminated soil on footwear; and an increase in public advocacy over the last 10 years.

Archey's frog

The initial management of Archey's frogs was focused on statutory advocacy and legal habitat protection. Long-term monitoring at one site in the Coromandel detected a major population decline between 1996 and 2001 (Bell et al. 2004a). This decline, coupled with the subsequent discovery of chytridiomycosis at the site, resulted in an increase in research and management efforts. Since 2001, management has focused on mitigating disease and predator threats to Archey's frog populations, developing non-invasive monitoring tools, carrying out surveys to improve understanding of the species' distribution, and establishing new wild and captive populations.

Data from a 'research-by-management' project investigating the impact of predator control have been analysed and indicate that rat control appears to be highly beneficial for Archey's frog populations in the Whareorino Forest (Pledger 2011). Intensive population monitoring has been

established as part of this project (Haigh et al. 2007) and has also been established at two new sites on the Coromandel Peninsula. The control of mammalian predators also occurs in Archey's frog habitat in the Coromandel Ranges, as part of other species or ecosystem restoration programmes.

Disease surveillance (since 2005), strict disease hygiene protocols and the establishment of a new wild population of chytrid-free frogs at Pureora Forest have been undertaken to mitigate the disease threat to this species. Archey's frogs were taken into captivity at the University of Canterbury between 2000 and 2006 (Shaw & Holzapfel 2008), and transferred to Auckland Zoo in 2005 and 2006 to develop captive husbandry techniques, establish captive breeding and form the nucleus of an *ex situ* insurance population. All current captive populations of Archey's frog are now free of amphibian chytrid fungus.

Hochstetter's frog

Past and current management of this species primarily consists of habitat protection and statutory advocacy. Recent surveys have extended the known range of Hochstetter's frog and genetic research has identified significant genetic variation within this species, challenging the management of this species as a single ESU.

Low-intensity monitoring of Hochstetter's frogs has occurred in a few populations in the past; however, a variety of techniques was used, limiting the potential for comparative analyses. Therefore, a new robust technique—site occupancy modelling (McKenzie et al. 2002)—is now planned to be established in Hochstetter's frog populations at Great Barrier Island (Aotea Island), Waitakere Ranges, Hunua Ranges and Otawa. A 2006 study using this technique in the Hunua Ranges indicated that Hochstetter's frogs may benefit from mammalian pest control for ecosystem management (M. Crossland & T. Wilson, Department of Conservation, unpubl. data).

Predator control programmes targeting other species or ecosystem outcomes have occurred or are continuing in portions of the Raukumara, Whareorino, North Pureora, Coromandel, Waitakere, Hunua and Warkworth populations; and the population discovered at Maungatautari in 2004 has been enclosed by a predator-exclusion fence.

Hochstetter's frogs were taken into captivity at the University of Canterbury between 2000 and 2004 (Shaw & Holzapfel 2008), and moved to an outdoor captive breeding facility at Hamilton Zoo in 2006 to develop captive husbandry techniques and maintain a potential *ex situ* insurance population.

An amphibian chytrid fungus survey that included populations from Northland through to North Pureora Forest Park was completed in 2008. All frogs tested negative for amphibian chytrid fungus (Thurley & Haigh 2008).

Maud Island frog

Early management actions extended the range of this species on Maud Island by translocating frogs from a 16-ha forest remnant to a second location on the island (Bell et al. 2004b) and facilitating habitat restoration. Population monitoring since 1976 indicates a fluctuating population at two monitoring plots in the forest remnant and a steady increase in the rate of recruitment in the translocated population on the island (Newman 1990; Bell et al. 2004b; Pledger & Bell 2008, 2009).

In 1997, frogs were translocated to predator-free Motuara Island and rigorous monitoring continued until 2003, when results indicated that the population was self-sustaining (Tocher & Pledger 2005). As part of a study to assess post-release dispersal, a third wild population of 100 frogs was translocated from Maud Island to Long Island (also rodent free) in 2006. However, intensive post-release monitoring indicated that this translocation was unsuccessful, potentially as a result of little spotted kiwi (*Apteryx owenii*) predation—although the exact causes of the failure remain unknown (Germano et al. unpubl. data 2010).

Also in 2006, 60 Maud Island frogs were translocated to mouse-proof pens inside the predator-excluded, fenced Zealandia in Wellington. Thirty of these frogs were sourced from Maud Island and 30 came from the University of Canterbury, where they had been held since 2004 for a laboratory-based study. In 2007, half of the remaining frogs were removed from the pens to investigate whether they could establish in the presence of mice, which remain in Zealandia (Lukis & Bell 2007). Recent monitoring of these two established populations found that survival within the mouse-proof enclosure was high (Lukis 2009; T. Karst, Victoria University of Wellington, unpubl. data) and that several individual frogs had survived outside the mouse-proof enclosure (Lukis 2009).

A separate small population of Maud Island frogs is currently held at the University of Otago for developing captive husbandry techniques and for research purposes.

All amphibian chytrid fungus testing of Maud Island frogs since 2006 (including frogs transferred to Zealandia) has returned negative results.

Hamilton's frog

Early management of Hamilton's frog included revegetation of the site on Stephens Island and fencing the core population to protect against a natural predator (tuatara *Sphenodon punctatus*) (Brown 2000). In 1992, 12 frogs were transferred to a newly created habitat approximately 60 m away (Brown 1994), but several subsequently returned to the original site (Tocher & Brown 2004), demonstrating homing behaviour. A tuatara-proof fence established a corridor connecting the two sites in 2004, extending the tuatara-free habitat that was available to Hamilton's frogs on Stephens Island. The first frogs were observed using this new habitat during a routine frog monitoring trip in April 2013.

Monitoring techniques to assess the status of this population have been refined and implemented. The viability of this small population to sustain a harvest of frogs for establishing a new population on a second predator-free island was assessed in 2004 (Tocher et al. 2006), following which 71 frogs were relocated to Nukuwaiata Island in 2004 and 2006; however, although breeding was observed in 2008, intensive monitoring will need to continue to determine whether these translocations have been successful (Germano & Bishop 2008; Bell et al. 2010).

A survey for amphibian chytrid fungus on Stephens Island was conducted in 2009 and all frogs returned negative results. All visitors to Stephens and Nukuwaiata Islands are subject to strict hygiene protocols to reduce the risk of introducing amphibian diseases.

3.1.7 Options for recovery and preferred option

There are four options for the recovery of native frogs:

1. **Do nothing**. This is likely to result in the decline and extinction of mainland populations of native frogs. Island populations of native frogs may persist for longer, but their decline and extinction could also eventually occur.
2. **Protect native frogs *ex situ* in captivity only**. In the wild, this will lead to the same result as doing nothing. In addition, captive management techniques are not sufficiently developed to ensure that survival and breeding will occur, so this may result in decline and extinction.
3. **Establish additional populations in the wild**. This could increase the range of native frog species and may provide security against stochastic events. However, this would not prevent further declines in existing populations.
4. **Protect existing native frog populations** from suspected agents of decline **and identify key agents of decline** in order to focus protection efforts. The protection of existing populations would result in their continued survival, while the identification of key agents of decline and threats would lead to the survival and recovery of all native frog populations.

Options 1 and 2 are inappropriate for the recovery of native frogs as they will lead to the eventual decline and extinction of existing wild populations. Therefore, the preferred option for the recovery of native frogs is a combination of options 3 and 4. This would allow the continued survival of all native frog populations by identifying and managing threats and agents of decline, while increasing security for all populations by extending their range.

3.2 Strategic directives

3.2.1 New Zealand Biodiversity Strategy

This recovery plan supports Goals 1 to 3 of the New Zealand Biodiversity Strategy (DOC & MfE 2000):

Goal 1: Community and individual action, responsibility and benefits

Enhance community and individual understanding about biodiversity, and inform, motivate and support widespread and coordinated community action to conserve and sustainably use biodiversity; and

Enable communities and individuals to equitably share responsibility for, and benefits from, conserving and sustainably using New Zealand's biodiversity, including the benefits from the use of indigenous genetic resources

Goal 2: Treaty of Waitangi

Actively protect iwi and hapu interests in indigenous biodiversity, and build and strengthen partnerships between government agencies and iwi and hapu in conserving and sustainably using indigenous biodiversity

Goal 3: Halt the decline in New Zealand's indigenous biodiversity

Maintain and restore viable populations of all indigenous species and subspecies across their natural range and maintain their genetic diversity.

3.2.2 Department of Conservation Statement of Intent

This recovery plan supports two of the five intermediate outcomes in DOC's Statement of Intent 2013–2017 (DOC 2013), which are identified as steps required to achieve DOC's vision and outcome.

Specifically, this plan supports four of the six objectives required to achieve Intermediate Outcome 1—'The diversity of our natural heritage is maintained and restored':

Objective 1: A full range of New Zealand's ecosystems is conserved to a healthy functioning state.

Objective 2: Nationally threatened species are conserved to ensure persistence.

Objective 4: Nationally iconic species are managed to ensure their populations are maintained or restored.

Objective 5: Locally treasured natural heritage is maintained or restored through partnerships.

It also supports all four objectives required to achieve Intermediate Outcome 4—'More people engage with conservation and value its benefits':

Objective 1: Communications and public engagement programmes lead to conservation being seen as part of New Zealanders' identity, values and thinking.

Objective 2: Partnerships, volunteer opportunities, training and on-the-ground support enable more people to participate in conservation activities (led by both DOC and others).

Objective 3: DOC and others influence decisions to reflect conservation as an essential investment in New Zealanders' wellbeing and prosperity.

Objective 4: Engagement with iwi, hapū and whānau to enable more conservation on and off Māori land.

3.3 Cultural importance

The Māori names for frog are pepeketua, pepeke and peketua, and they are sometimes referred to as 'Little People of the Forest'. Native frogs are important taonga to iwi and frogs have featured in Māori folklore. The relationship that tangata whenua have with taonga species has been recognised through Section 4 requirements of the Conservation Act 1987.

Many other groups (e.g. local communities, scientists, environmental organisations) also hold native frogs in high regard and support their conservation. Recognition of the importance of native frogs as part of a healthy ecosystem is growing, and increasing concern has, in some cases, resulted in further action for native frog protection and research.

3.4 Public awareness

Historically, public awareness of native frogs has been relatively low, and this has not been assisted by their secretive habits, cryptic colouration, scarcity and limited distribution. Native frogs are gradually receiving increased media attention, however, reflecting both a growing local profile and worldwide interest in amphibians as indicators of ecosystem health. Advocacy as a result of the 2008 Year of the Frog Campaign, National Frog Week, displays at captive institutions, a national frog roadshow and increased presence on the internet (e.g. doc.govt.nz; teara.govt.nz/en/frogs/1; nzfrogs.org; sciencelearn.org) is intended to improve public awareness about the challenges facing native frog recovery.

4. Goals

4.1 Long-term recovery goal

The long-term goal is to secure and recover all *Leiopelma* taxa so that they are no longer threatened and are integral components of healthy New Zealand ecosystems by 2050.

4.2 Recovery plan-period goals

4.2.1 Management

Goal 1.1: A new population of Archey's frog is established on a predator-free island or site by 2018.

Goal 1.2: Regular monitoring of selected native frog populations representing each species to determine their status and trends is in place by 2017.

Goal 1.3: The viability of translocated populations is assessed by 2015, and new translocations and supplementations are undertaken by 2018, as required.

Goal 1.4: At least one population from every native frog ESU is managed to protect it from identified agents of decline by 2018.

4.2.2 Community relations

Goal 2.1: Public support and community awareness of native frog conservation is increased throughout the term of this plan.

Goal 2.2: Tangata whenua involvement in native frog conservation is increased.

4.2.3 Research

Goal 3.1: The key agent(s) of decline and current threats for all native frog species are identified by 2017, and their impacts are better understood.

Goal 3.2: Evolutionary significant units (ESUs) are defined for all native frog species using genetic analysis by 2015.

Goal 3.3: Native frog ecology and behaviour are further investigated to inform and support conservation management through the life of this plan.

Goal 3.4: Captive management techniques are developed to ensure the survival and breeding of native frogs held in captivity by 2018.

5. Implementation

This section provides short-term advice for DOC managers and community groups involved in native frog recovery by identifying desired actions for achieving the 34 objectives specified in this plan.

The plan is grouped into three themes that are common to species recovery programmes (management, community relations and research). Under each theme are topics with background, issues, objectives and actions to resolve the issues. Each topic identifies an issue and objective for the recovery of native frogs, and generates actions to address each issue and objective.

It must be noted throughout the implementation section that Conservation Services Managers at each location will endeavour to meet these objectives. However, they will have to weigh up competing priorities according to DOC's annual business planning process.

It must also be noted that the recommended objectives and actions in this plan are subject to normal business planning processes for resource allocation within DOC. In some cases, external funding will be sought where departmental resources are insufficient.

All actions in this plan have been placed in one of three priority classes ('essential', 'high' or 'medium'). These indicate the relative importance of each action in terms of its contribution towards achieving the recovery objectives and goals. This is recommended advice identified in the development of this plan:

E—Essential: Recommended as essential for the recovery of native frogs. These actions should be carried out in the timeframe specified and in the 5-year term of this plan, subject to resources being available and existing decision-making processes.

H—High: Recommended as necessary for achieving the long-term goals for native frog recovery. These actions should be carried out during the 5-year term of this plan, subject to resources being available and existing decision-making processes.

M—Medium: Recommended to support the recovery of native frogs. Some progress should be made towards these actions during the 5-year term of this plan, subject to resources being available and existing decision-making processes.

A timeline for recovery actions is provided in Appendix 1.

5.1 Management

5.1.1 Topic 1—Distribution

Owing to the cryptic, nocturnal nature of native frogs and the likelihood of frog populations occurring in low densities, our knowledge of the present-day distribution of native frog species may be incomplete. The discovery of native frog populations on Maungatautari in 2004 (Baber et al. 2006) and in Titirangi in 2010 (T. Wilson, pers. comm.) indicates that as-yet undiscovered native frog populations could still exist elsewhere. Although historical surveys have been conducted, these used a variety of techniques and results were not always reported where no frogs were located, suggesting that the currently documented distribution of *Leiopelma* species may not reflect their true distribution. Therefore, targeted and standardised survey methods should be used when searching for native frogs to provide confidence in the results. Search effort should be focused on sites suitable for native frogs and results must be reported so that an accurate map of native frog distribution can be built. Standardised methods that could be used by external parties surveying native frog habitat or known areas of low-density frog populations would also be valuable.

Issues

Issue 1.1: Variable survey methods for native frogs have been used in the past, yielding incomparable results, and the reporting of results has not always occurred.

Issue 1.2: Many areas of New Zealand have not been specifically surveyed for native frogs, yet appear to contain suitable habitat, including areas where subfossil frog remains have been found.

Objectives and actions

Objective 1.1: To better understand the current distribution of native frogs.

Objective 1.2: To make information on the past and present distribution of native frogs available to aid native frog recovery throughout the term of this plan.

ACTION	ACCOUNTABILITY	PRIORITY
1.1 Prepare distribution survey best practice guidelines for all users, detailing survey techniques, and reporting and data management requirements by 2015, and apply throughout the term of this plan.	Recovery Group Science and Capability Group Relevant Conservation Services Group staff	Essential
1.2 Identify priority sites for native frog surveys by 2015 and undertake surveys by 2018.	Recovery Group Science and Capability Group	High

5.1.2 Topic 2—Monitoring

Monitoring of native frogs is necessary if we wish to understand population trends, identify sudden unexpected declines and measure the response of frog populations to management actions such as pest control or translocation. The success of any monitoring programme is dependent on the quality of data collected. However, unfortunately, historical monitoring has not always been sufficient to determine population trends due to the low detectability, variable emergence patterns and long life-span of native frogs. Therefore, future monitoring needs to be robust and carried out at regular intervals in order to detect population trends and drive appropriate management.

Robust long-term monitoring is already established at several key sites for Archey's frog and on Maud Island for Maud Island frog. However, monitoring at other sites for Archey's, Maud Island and Hamilton's frogs is more sporadic, and there is presently no robust long-term monitoring for Hochstetter's frog. Monitoring for Maud Island, Hamilton's and Hochstetter's frogs can be hampered by the absence of a non-invasive technique for identifying individual frogs (see Issue 17.2). Although a robust monitoring technique that does not require individual identification is now available for monitoring Hochstetter's frog (Crossland et al. 2005), this is labour intensive and has not yet been implemented for the purpose of long-term monitoring. Furthermore, a robust and cost-effective method for monitoring low-density populations of all native frog species also needs to be developed.

Issues

Issue 2.1: Regular, robust monitoring of native frog populations is resource- and labour-intensive.

Issue 2.2: Best practice guidelines to inform the monitoring of native frogs have not been developed.

Objectives and actions

Objective 2.1: To regularly assess frog population trends using robust monitoring techniques.

ACTION	ACCOUNTABILITY	PRIORITY
2.1 Develop best practice monitoring guidelines, including for low-density populations, by 2014.	Recovery Group Relevant Conservation Services Group staff	Essential
2.2 Develop protocols regarding how and where to monitor priority populations of each native frog species by 2015, and reassess on completion of the *Leiopelma* taxonomic review (see Action 15.1).	Recovery Group	Essential
2.3 Conduct robust long-term monitoring in selected priority frog populations (as identified in Action 1.2) throughout the term of this plan.	Recovery Group Relevant Conservation Services Group staff	Essential
2.4 Establish robust long-term monitoring to determine the success and long-term viability of new populations created through translocation by 2015.	Relevant Conservation Services Group staff	High
2.5 Annually report on the status of, and trends in, monitored populations to the Recovery Group throughout the term of this plan.	Recovery Group Relevant Conservation Services Group staff	High

5.1.3 Topic 3—Management of threats

The key agent(s) of decline for native frogs are not well understood, so recovery actions need to focus on managing those threats that are considered most likely to impact on or limit native frog populations. Predation by introduced rodents and disease are currently considered to be the most likely agents of decline; however, this may change over the course of this plan as understanding of threats and agents of decline is increased. Threats to native frogs can be site-specific and multiple threats (e.g. rats and disease) might operate at each site, particularly in mainland populations. Furthermore, island frog populations are particularly vulnerable to stochastic perturbations such as fire or disease, despite being relatively protected from other threats, such as introduced predators.

The amphibian chytrid fungus is being monitored in several Archey's frog populations in the North Island, increasing our knowledge about baseline levels and the significance of chytrid fungus in these populations. However, novel amphibian diseases could still be introduced to New Zealand (Bell et al. 2004a). Amphibian diseases (both known and novel) are considered to be a serious ongoing threat to native frogs. Other potential threats and agents of decline include introduced mammalian predators, impacts of site management occurring in frog habitat, toxins and habitat modification. All of these threats are discussed under Topic 14 of this plan.

Issues

Issue 3.1: Few sites with native frog populations receive targeted control of suspected predators of native frogs.

Issue 3.2: Small, isolated or translocated populations of native frogs are vulnerable to stochastic events.

Issue 3.3: Amphibian diseases are an ongoing threat to native frog populations.

Objectives and actions

Objective 3.1: To control suspected predators of native frogs at selected mainland sites.

Objective 3.2: To protect island frog populations from pest incursions.

Objective 3.3: To implement current hygiene protocols for field staff working in native frog habitat to minimise the risk of amphibian disease transmission.

ACTION	ACCOUNTABILITY	PRIORITY
3.1 Select two sites for each species of native frog where control of their predators should be undertaken by 2014.	Recovery Group Science and Capability Group Relevant Conservation Services Group staff	Essential
3.2 Initiate or continue control of predators of native frogs at the sites selected in Action 3.1 by 2015.	Relevant Conservation Services Group staff	High
3.3 Maintain island biosecurity throughout the term of this plan.	Relevant Conservation Services Group staff	Essential
3.4 Ensure that all people working in frog habitat follow national hygiene protocols to minimise the spread of amphibian diseases throughout the term of this plan.	Recovery Group Relevant Conservation Services Group staff	Essential
3.5 Conduct regular monitoring of amphibian chytrid fungus at selected population monitoring sites throughout the term of this plan.	Recovery Group Relevant Conservation Services Group staff	Medium

5.1.4 Topic 4—Translocation

The establishment of new populations of native frogs through translocation to new sites has been, and will continue to be, an important tool to increase their security. The intent of these translocations is to establish self-sustaining populations across a number of diverse sites, thereby minimising the risk of species extinctions. At all sites selected for translocation, it is important that the key agents of decline (see Topic 14) are eradicated or managed to a level that allows the translocation to have the greatest chance of success. In addition, translocation sites for native frog populations should be spatially diverse to minimise the risk of major threats affecting all populations.

Translocations of Maud Island frogs were first conducted in 1984 (Bell et al. 2004b). Since then, there have been additional translocations of Maud Island frog, Archey's frog and Hamilton's frog. However, some of these more recent translocations may require supplementation to become self-sustaining. It is considered the highest priority to establish a new wild Archey's frog population at a protected site with high biosecurity control, due to recent population declines, slow population recovery and limited captive breeding success for this species to date. The establishment of additional secure wild populations of Maud Island frog and Hamilton's frog are also needed to expand the range of these species, and Maud Island frogs should be translocated to a predator-managed site on the mainland to determine whether they can coexist with a reduced suite of predators.

Post-release monitoring has occurred for all previous native frog translocations to determine their success and guide future management (Bell et al. 2004b; Tocher & Pledger 2005; Germano & Bishop 2009). However, even with intensive monitoring, it can be difficult to ascertain the exact reasons for the success or failure of a translocation, as seen following the Long Island translocation in 2005 (Germano et al. unpubl. data 2010). Furthermore, long-term monitoring is required to determine the success of frog translocations, which may require decades rather than years to ascertain in long-lived species such as *Leiopelma* spp. (Germano & Bishop 2009).

Issues

Issue 4.1: Native frogs are long-lived, making monitoring to determine the success of translocations both cost- and labour-intensive.

Issue 4.2: Hamilton's frog is highly vulnerable to extinction through stochastic events because there is only one self-sustaining population.

Issue 4.3: The data that are required to build population models and provide guidance for frog translocations are lacking (see Issue 16.1).

Issue 4.4: Historical translocations may require supplementation to be successful.

Objectives and actions

Objective 4.1: To establish or maintain at least one additional self-sustaining population of each native frog species at a site that is being managed for known key agents of decline and threats.

Objective 4.2: To assess the viability of frog populations that were created by previous translocations and conduct supplementations or rescues where necessary.

Objective 4.3: To use population modelling prior to translocations to assess the possible impacts on the source population (see Objective 16.1).

ACTION	ACCOUNTABILITY	PRIORITY
4.1 Review the outcomes of all native frog translocations and make recommendations on whether supplementation or rescue is required by 2015.	Recovery Group Relevant Conservation Services Group staff	Essential
4.2 Supplement or rescue translocated populations as required according to the results of the review in Action 4.1 by 2015.	Relevant Conservation Services Group staff	Essential
4.3 Monitor translocations over an appropriate timeframe to measure their success throughout and beyond the term of this plan.	Relevant Conservation Services Group staff	Essential
4.4 Select suitable sites for the potential establishment of new native frog populations through translocation for each species by 2017.	Recovery Group	Essential
4.5 Establish a predator-free island or site for establishing a new Archey's frog population by 2016; plan the translocation and implement by 2018.	Recovery Group Relevant Conservation Services Group staff	Essential
4.6 Identify a predator-managed site for establishing a new Maud Island frog population by 2016; plan the translocation and implement by 2018.	Recovery Group Relevant Conservation Services Group staff	High

5.1.5 Topic 5—Captive management

The maintenance and establishment of healthy *ex situ* populations can play an important role in the long-term conservation of native frogs. Although the ultimate aim of this plan is to recover native frog populations in the wild, captive management could provide insurance populations in case of catastrophic declines in the wild, and captive rearing programmes could provide stock for re-introductions and/or translocations. Therefore, e*x situ* conservation action should be considered as a management tool for all native frog species, as recommended by The Global Amphibian Assessment (IUCN et al. 2006).

During the term of this plan, *ex situ* and captive management will be used to:

- Develop and refine captive husbandry techniques
- Help secure from extinction the most threatened taxa and ESUs
- Advocate for all native frog species and their conservation

Captive management currently occurs for both Archey's frog (Auckland Zoo) and Hochstetter's frog (Hamilton Zoo), and is planned for Maud Island frog (Orana Wildlife Park). This management is coordinated through the Recovery Group via captive institutions and is supported by the professional association of captive institutions (the Zoo and Aquarium Association). Small populations of Hochstetter's frog and Maud Island frog are also held at the Department of Zoology, University of Otago.

Many issues are relevant to the captive management of native frogs, including diverse specialist topics (e.g. disease management, husbandry techniques, small population management) that are best managed through close collaboration with captive holders and universities. The strategic direction for the captive management of native frogs as part of the wider native frog recovery effort needs to be more strongly developed and promoted by publishing a native frog captive management plan. This plan should not only address future directions, but also assess past learning, including the development of understanding around metabolic bone disease (MBD), which had detrimental effects on many of our native frogs due to misunderstandings regarding the amount of light that was required by individuals in captivity. The sharing of this knowledge and consistent management of captive populations at a national level is essential for native frog recovery. Publication of the native frog captive management plan will comply with the requirements of DOC's Captive Management Standard Operating Procedure (McInnes, 2008).

Issues

Issue 5.1: There is currently insufficient information available on successful captive husbandry techniques for *Leiopelma* species.

Issue 5.2: High mortality has occurred in the existing captive populations of Archey's and Hochstetter's frogs (see Issue 18.1).

Issue 5.3: There is no clear strategic direction for the captive management of native frogs.

Objectives and actions

Objective 5.1: To provide a clear strategic direction for the captive management of native frogs.

Objective 5.2: To ensure that native frog captive management is achieving *ex situ* objectives and is integrated well with *in situ* management throughout the term of this plan.

Objective 5.3: To ensure that best practice techniques for captive husbandry, including minimum standards, are collated, communicated efficiently and implemented.

Objective 5.4: To identify native frog species and/or ESUs that require captive management for recovery.

Objective 5.5: To define the conditions under which captive programmes will be deemed successful and/or terminated for all relevant native frog species and/or ESUs.

ACTION	ACCOUNTABILITY	PRIORITY
5.1 Review and, where required, refine husbandry techniques to reduce health issues and mortality in the existing captive populations of Archey's and Hochstetter's frogs throughout the term of this plan.	Captive institutions Recovery Group	Essential
5.2 Prepare operative native frog captive management plans (covering all necessary species and ESUs) in alignment with the goals and objectives of this plan by 2014, and prior to Action 5.3 being undertaken.	Recovery Group Conservation Services Group staff responsible for management of Maud Island	Essential
5.3 Determine the conditions under which it would be appropriate to end captive management for selected species, as required and defined in the plans prepared under Action 5.2.	Captive institutions Recovery Group	Essential
5.4 Review the native frog captive management plans every 2 years and circulate recommended changes.	Captive institutions Recovery Group	Essential
5.5 Prepare a proposal and undertake a translocation to establish a captive breeding population of Maud Island frog, and refine husbandry techniques for this species by 2015; maintain throughout the term of this plan.	Recovery Group Captive institutions	High
5.6 Amend the native frog captive husbandry manual to include Maud Island frog and Hamilton's frog by 2015, and update as new information becomes available.	Recovery Group Captive institutions	Essential
5.7 Identify any new priority populations/ESUs for captive management by 2017 (in conjunction with Action 15.2).	Captive institutions Recovery Group	High

5.1.6 Topic 6—Habitat restoration

Native frogs were once widely distributed throughout New Zealand (Worthy 1987b). However, all surviving native frog species now have significantly reduced distributions. While the agents of decline for native frogs are not yet fully understood and historical declines may have been caused by a combination of factors, it is likely that habitat loss contributed to past population declines and extinctions. Frogs have specific temperature and humidity requirements, and rely upon suitable damp refuges (such as those present in forest habitats) to survive. Deforestation or severe habitat modification can alter the temperature and humidity in frog habitats, rendering them unsuitable. Unless there is suitable habitat for native frogs, remnant populations cannot expand and may eventually become extinct.

Evidence of the effects of deforestation on native frogs can be seen in Maud Island frog and Hamilton's frog. By 1911, Maud Island had been cleared of forest and converted to grazing, with only one catchment retained in forest cover (Sherwood 1912, cited in Bell 1995). Maud Island frogs survived only within the forested catchment, becoming extinct over the rest of the island. Similarly, Stephens Island (where Hamilton's frog is found) was entirely cleared of native vegetation, so that the frogs only survived in very low numbers in a boulder bank, in which there were sufficient damp refuge sites under the rocks. Mainland frog populations are also currently restricted to areas of remnant native forest or to specific habitat in modified forest (e.g. Hochstetter's frog can survive on stream edges in forestry plantations).

Issues

Issue 6.1: Land use activities have reduced and modified native frog habitat.

Objective and actions

Objective 6.1: To protect selected frog populations through habitat restoration at targeted sites.

ACTION	ACCOUNTABILITY	PRIORITY
6.1 Identify sites where habitat restoration is necessary to ensure the survival of a native frog species or ESU by 2015.	Recovery Group Relevant Conservation Services Group staff	Essential
6.2 Initiate restoration at the sites identified in Action 6.1 by 2017.	Recovery Group Relevant Conservation Services Group staff	High
6.3 Identify sites where habitat restoration will be necessary for frog population expansion by 2018.	Science and Capability Group Recovery Group	Medium

5.1.7 Topic 7—Capability

The management and monitoring of native frogs requires specific research and technical skills. To carry out techniques such as photographic monitoring, toe-tip clipping or site occupancy monitoring, individuals need to be able to detect cryptic species, and must have frog handling skills in the manipulation of body posture and toes. Specific expertise is also required for the captive management of native frogs. However, staff turnover in the past has led to a lack of continuity in native frog projects and the loss of specific skills.

Issues

Issue 7.1: Staff turnover can lead to a lack of continuity in frog monitoring or management projects.

Issue 7.2: Specific research and technical skills are required to guide and inform frog recovery.

Objectives and actions

Objective 7.1: To ensure continuity in frog monitoring and management projects through the provision of appropriate technical skills.

ACTION	ACCOUNTABILITY	PRIORITY
7.1 Provide appropriate training and support for key staff and stakeholders before they begin working with native frogs.	Relevant Conservation Services Group staff Science and Capability Group Recovery Group Captive institutions	High
7.2 Develop resources that clearly explain the methods for key monitoring and management techniques by 2014.	Relevant Conservation Services Group staff Science and Capability Group Recovery Group Captive institutions	High

5.1.8 Topic 8—Planning / legal protection

Not all native frogs occur on land that is legally protected and/or administered by DOC; for example, some frog populations are present on land that is used for production forestry or human habitation. While the impacts of these land uses on native frogs are not fully understood, it is likely that some land use changes will adversely affect native frogs as habitats are modified and/or lost (e.g. through increased stream sedimentation or forest felling). These potential negative effects could be avoided or mitigated through legal protection, land acquisition, appropriate legislation, regulations, consent processes and relevant policies.

Issues

Issue 8.1: Some native frog populations occur on land that is not legally protected.

Issue 8.2: The impacts of land uses on native frog habitats and populations are not well understood (also see Issue 14.8).

Objectives and actions

Objective 8.1: To avoid or mitigate the adverse impacts of land use activities on native frog populations via legal and planning mechanisms.

ACTION	ACCOUNTABILITY	PRIORITY
8.1 Continue to mitigate the potential adverse impacts of land use activities (on native frog populations occurring on land that is not legally protected) using statutory protection throughout the term of this plan.	Relevant Conservation Services Group and Conservation Partnerships Group staff Policy and Regulatory Services Group	Essential
8.2 Survey priority sites on private land (as identified in Action 1.2) for the presence of native frogs by 2018.	Relevant Conservation Services Group and Conservation Partnerships Group staff Recovery Group	High
8.3 Determine the impacts of land use activities (specifically production forestry) using targeted research throughout the term of this plan (see Action 14.9).	Relevant Conservation Services Group staff Science and Capability Group Recovery Group	High
8.4 Ensure that local and regional authorities are aware of their statutory obligations under the Resource Management Act 1991 through the circulation of a memo detailing native frog conservation issues by 2015.	Relevant Conservation Services Group and Conservation Partnerships Group staff Policy and Regulatory Services Group	Medium

5.1.9 Topic 9—Recovery planning

Since there is uncertainty about the causes and key agents of decline for native frogs, recovery planning for these species is still strongly focused on the research phase and the security from extinction phase. This means that the Recovery Group has a pivotal role in providing recommendations, ongoing technical advice and support for research into and the recovery of native frogs. Consequently, an appropriate mix of experts (from both research and management backgrounds) on the Recovery Group is critical to ensure that frog recovery is strategic and benefits from the best knowledge available. Research findings throughout the term of this plan will inform and guide the management of native frogs.

The previous native frog recovery plan (Newman 1996) was well utilised, but has been out of date for some time. The native frog recovery plan is an essential document for any parties interested in the conservation of native frogs, including members of the public, researchers and DOC staff. It provides a summary of past work and known information, as well as guidance for future work, and provides strategic direction for people working with native frogs.

Issues

Issue 9.1: Native frog recovery has lacked clear direction in recent years due to the 1996 native frog recovery plan being outdated.

Issue 9.2: Stakeholders working with native frogs (e.g. captive institutions, research institutions) require clear strategic direction.

Objectives and actions

Objective 9.1: To provide a clear and effective recovery plan, and to review the plan before it expires.

ACTION	ACCOUNTABILITY	PRIORITY
9.1 Review this recovery plan by 2017 and draft a new recovery plan (if required) by 2018.	Recovery Group	Essential
9.2 Review Recovery Group membership biennially to ensure that it contains appropriate representation and expertise.	Recovery Group	Essential

5.2 Community relations

5.2.1 Topic 10—Tangata whenua

Native frogs are taonga species, and often have strong spiritual and cultural value to tangata whenua (iwi or hapū that have customary authority in a place). Specific names can vary between iwi, but frogs in New Zealand are broadly referred to as pepeketua, pepeke or peketua. Although pepeketua are not formally listed as a taonga species, they are mentioned in Treaty Settlement documents for Ngāti Koata, who manage the native frogs in the Marlborough Sounds in consultation with Ngāti Kuia. The wider distributions of Archey's frog and Hochstetter's frog encompass many rohe. The relationship of tangata whenua with native species has been recognised in Section 4 of the Conservation Act 1987 (to give effect to the Principles of the Treaty of Waitangi) and DOC is committed to engaging with tangata whenua over native frog recovery, as can be seen in the consultation process that is undertaken in relation to native frog research and management.

While iwi are consulted when significant frog research or management is planned, differing perspectives between researchers or managers and tangata whenua can lead to tension in relationships. For example, many iwi are strongly opposed to the removal of tissue from live animals (toe clipping), while researchers may feel that this is necessary for effective study or management. The retention of deceased specimens for research purposes is also a matter where opposing views have arisen. Resolving such issues requires clear communication pathways and discussion of viewpoints between research institutions, DOC and the relevant iwi. The recent offer to return a selection of deceased pepeketua for burial has highlighted the success of such active discussions.

Tangata whenua have not historically been involved in native frog management. Providing opportunities for tangata whenua to work with frogs in the role of kaitiaki (guardians) could strengthen relationships that are essential for frog recovery. Tangata whenua may also possess mātauranga Māori (traditional knowledge) that could aid native frog recovery.

Issues

Issue 10.1: There has not always been sufficient two-way communication with tangata whenua over native frog recovery actions.

Issue 10.2: Tangata whenua do not always have opportunities to be involved in native frog recovery.

Objective and actions

Objective 10.1: To improve communication between frog researchers and managers and tangata whenua.

Objective 10.2: To provide more opportunities for tangata whenua to be involved in native frog recovery.

ACTION		ACCOUNTABILITY	PRIORITY
10.1	Develop communication guidelines in conjunction with iwi for the discussion of native frog conservation with tangata whenua by 2015.	Recovery Group Relevant Kahui Kaupapa Atawhai staff	Essential
10.2	Identify opportunities for tangata whenua to be involved in native frog recovery and share these with relevant iwi throughout the term of this plan.	Recovery Group Relevant Conservation Services Group and Conservation Partnerships Group staff Relevant Kahui Kaupapa Atawhai staff	High
10.3	Seek out and record mātauranga Māori related to native frogs by 2015.	Recovery Group Relevant Kahui Kaupapa Atawhai staff	High
10.4	Facilitate opportunities for mātauranga Māori to be incorporated into native frog recovery efforts (where appropriate) throughout the term of this plan.	Recovery Group Relevant Conservation Services Group and Conservation Partnerships Group staff Relevant Kahui Kaupapa Atawhai staff	High

5.2.2 Topic 11—Community-led conservation initiatives

Owing to their cryptic nature and restricted distribution, native frogs have not historically had a high profile with the New Zealand public and have never been the focus of community-led conservation initiatives. However, as the number of community conservation projects increases, a small number of community-led projects are now operating in areas where native frogs are present (e.g. Maungatautiri Ecological Island Trust). While these initiatives are not tailored for native frog recovery, management actions undertaken for other species projects can lead to benefits for frogs (M. Crossland, unpubl. data). Keeping community-led conservation projects well informed about native frogs could provide even stronger benefits for frog recovery efforts.

Issues

Issue 11.1: Community-led conservation initiatives have not always been aware of the native frog populations that are present in their management areas, which has led to a lack of focused management for native frogs.

Issue 11.2: Community-led initiatives may not have adequate information to protect native frogs.

Objective and actions

Objective 11.1: To increase community involvement in native frog recovery by providing support, information and advice to community-led conservation initiatives.

ACTION		ACCOUNTABILITY	PRIORITY
11.1	Promote and support the inclusion of frog recovery actions in community-led initiatives occurring in native frog habitat throughout the term of this plan.	Recovery Group Relevant Conservation Services Group and Conservation Partnerships Group staff	Essential
11.2	Provide the technical advice and information that is necessary for native frog recovery to community groups operating in frog habitat throughout the term of this plan.	Recovery Group Relevant Conservation Services Group and Conservation Partnerships Group staff	Essential
11.3	Develop and distribute best practice guidelines for frog recovery (i.e. monitoring and pest control standards) using available knowledge throughout the term of this plan.	Recovery Group	High
11.4	Establish a communication network for community-led conservation projects involved with native frog recovery throughout the term of this plan.	Recovery Group	Medium

5.2.3 Topic 12—Public awareness

Public awareness is an important component of native frog recovery, as it helps to ensure wider public acceptance, and provides external support and resources. It includes sharing information, promoting specific issues and solutions, and generally raising the profile of native frogs and their protection. Many members of the general public do not know the difference between introduced frog species (e.g. the brown tree frog, sometimes referred to as the whistling frog, *Litoria ewingii*, green and golden bell frog *Litoria aurea*) and native frog species. An aware and supportive New Zealand public is central to native frog conservation and this recovery programme.

Issues

Issue 12.1: Public awareness of native frogs has been quite low in the past, which has hindered efforts to gain external funding and public support for conservation initiatives.

Issue 12.2: Introduced frogs and other exotic amphibians that are sold in local pet shops and transported around the country may be hosts to diseases, which can be transmitted to native frogs.

Objective and actions

Objective 12.1: Increase public awareness of native frogs, their recovery and reasons for their decline throughout the term of this plan.

ACTION		ACCOUNTABILITY	PRIORITY
12.1	Produce a native frog public advocacy plan or advocacy guidelines (and associated resources) by 2015, and implement throughout the term of this plan.	Recovery Group Relevant Conservation Services Group and Conservation Partnerships Group staff Captive institutions	Essential
12.2	Ensure that all conservation delivery centres and captive management facilities that are responsible for native frog populations hold National Frog Week events and activities annually throughout the term of this plan.	Recovery Group Relevant Conservation Services Group and Conservation Partnerships Group staff National Community Engagement Unit Captive institutions	Essential
12.3	Raise awareness of the risks of spreading amphibian disease through the amphibian pet trade by producing and distributing advocacy material to pet shops and suppliers by 2015.	Recovery Group Relevant Conservation Services Group and Conservation Partnerships Group staff	High
12.4	Produce specific advocacy material detailing how backcountry users of native frog habitat can minimise their impact on frog populations by 2015.	Recovery Group Relevant Conservation Services Group and Conservation Partnerships Group staff	Medium

5.2.4 Topic 13—External funding and collaboration

Native frog recovery is still in the research and secure from extinction phases, and much research and management is required to safeguard these species. Implementation of the research and management actions that are outlined in this plan as being necessary for the recovery of native frogs will be costly. While other institutions such as universities and captive facilities contribute significantly to research and captive management, *in situ* management of native frog populations is currently funded largely by DOC. Since DOC has to prioritise resource allocation across the full range of threatened species it is responsible for managing, this may lead to insufficient resources being available for the completion of all essential actions in this plan.

Issue

Issue 13.1: Additional resources will be required to fulfil all the recovery goals of this plan.

Objective and actions

Objective 13.1: To increase support for frog recovery through external sponsorship or research and management collaborations.

ACTION		ACCOUNTABILITY	PRIORITY
13.1	Prepare a strategic document outlining sponsorship opportunities (i.e. management or research goals) and benefits arising from a sponsorship relationship for both native frogs and the sponsoring party by 2015.	Recovery Group Relevant Conservation Services Group and Conservation Partnerships Group staff	Essential
13.2	Circulate the document created in Action 13.1 to potential external funding sources until a sponsorship relationship is established.	Recovery Group	High
13.3	Maintain existing collaborative relationships with research organisations throughout the term of this plan.	Recovery Group Relevant Conservation Services Group and Conservation Partnerships Group staff	Essential

5.3 Research

5.3.1 Topic 14—Threats and agents of decline

Research is urgently needed to determine the past and present agents of decline for all *Leiopelma* species, as our current understanding, and therefore management, of these threats is insufficient to ensure the long-term security of native frogs. Dramatic population declines have been observed at long-term monitoring sites (Bell et al. 2004a), but the cause of these declines is uncertain. Although disease and predation by rats have been implicated as likely causes of decline, other possible causes include habitat loss, habitat fragmentation or degradation, other introduced mammalian predators, and toxins used in frog habitat.

More frequent management for the control of both pests and weeds (for frog or other species benefits) is occurring in native frog habitat. Such site management may affect frogs directly or indirectly. However, the impacts may be positive or negative (e.g. increased frog survival due to decreased predator numbers, impact of toxins on native frogs) and are not always measured. In the past, it has been found that there was no correlation between toxin use and Archey's frog declines (Perfect & Bell 2005; Crossland 2006). However, more research is required to confirm that toxins are not a threat to native frog populations.

Native frogs are extremely sensitive to environmental health and changes, so also face potentially serious threats from climate change and increased environmental pollution. However, these longer term threats are not within the scope of this 5-year plan.

Issues

Issue 14.1: The historical agents of decline of native frogs in New Zealand largely remain unidentified.

Issue 14.2: Further information on baseline levels of disease in native frogs is needed to understand the role of disease in frog populations.

Issue 14.3: Information on the distribution and transmissibility of amphibian chytrid fungus in New Zealand, and its past or future impact on native frog populations is limited.

Issue 14.4: The impacts of introduced mammals, either as predators or as habitat modifiers (e.g. pigs), on mainland frog populations are unconfirmed or unknown.

Issue 14.5: It is unknown whether Maud Island frogs can coexist with a limited suite of predators (e.g. mice).

Issue 14.6: Certain native species (e.g. kiwi) may prey on frogs, but their impact on frog populations is unknown. These potential interactions have largely not been taken into account during previous translocations of frogs or potential native predators.

Issue 14.7: The impacts of other species management programmes and ecosystem programmes (e.g. predator and weed control) that occur in frog habitat on native frog populations are not well understood.

Issue 14.8: The impacts of land use activities (e.g. production forestry, agriculture, recreation, mining, roading, subdivisions) on native frog populations are not well understood.

Objectives and actions

Objective 14.1: To identify the key agents of decline for native frogs in New Zealand.

Objective 14.2: To investigate the impact of habitat and pest management (e.g. use of toxins, modification of habitat, ecosystem restoration) on native frogs.

ACTION		ACCOUNTABILITY	PRIORITY
14.1	Determine the impacts of rats, mice and pigs on native frog populations by 2017.	Recovery Group Science and Capability Group Relevant Conservation Services Group staff	Essential
14.2	Complete the investigation into the effect of targeted rat control on the Archey's frog population in Whareorino Forest, and analyse, interpret and distribute and/or publish the results by 2015.	Recovery Group Science and Capability Group Relevant Conservation Services Group staff responsible for management of Whareorino Forest	Essential
14.3	Test the susceptibility of all native frog species to infection by amphibian chytrid fungus by 2014.	Recovery Group	Essential
14.4	Assess the impact of kiwi on frog populations using experimental trials combined with a modelling approach by 2016.	Recovery Group Kiwi Recovery Group Relevant Conservation Services Group staff responsible for management of the Marlborough Sounds islands	Essential
14.5	Determine baseline disease profiles for two populations of each species by 2016.	Recovery Group Relevant Conservation Services Group staff Wildlife Health Coordinator	High
14.6	Enter all records of dead frogs into the Huia database as they occur, throughout the term of this plan.	Recovery Group Wildlife Health Coordinator Relevant Conservation Services Group staff	High
14.7	Determine the effects of selected ecosystem restoration projects (e.g. predator exclusion and predator control) on native frogs using population monitoring by 2018.	Recovery Group Relevant Conservation Services Group staff	High
14.8	Assess the threat to frogs of toxins that are commonly used for pest and weed control in native frog habitat through post-mortem analyses and experimental trials by 2017.	Recovery Group Science and Capability Group	High
14.9	Assess the effects of land use activities (e.g. roading, subdivision, production forestry and mining) in native frog habitat on frog populations by 2018.	Recovery Group Relevant Conservation Services Group staff Science and Capability Group	High
14.10	Develop best practice guidelines for the use of toxins in native frog habitat by 2018.	Recovery Group	Medium

5.3.2 Topic 15—Genetics and taxonomy

The distribution of native frogs in New Zealand has been greatly reduced through historical declines (Worthy 1987a). These declines have resulted in small populations of each species that have experienced a long period of isolation—conditions that can lead to diversification and speciation. Genetic techniques provide the tools that are necessary to clarify the taxonomic relationships between isolated frog populations, and are best applied with concurrent morphological studies.

Previous genetic work with native frogs led to the separation of Hamilton's frog (*L. hamiltoni*) into two distinct species: Maud Island frog (*L. pakeka*) and Hamilton's frog (Bell et al. 1998a). This separation has since been questioned (Holyoake et al. 2001), however, and so the taxonomy needs to be resolved. Morphological and biochemical analyses have been conducted with Archey's frog (*L. archeyi*) to determine the relationship between the Whareorino and Coromandel populations (Bell et al. 1998b), and recent work on Hochstetter's frog (*L. hochstetteri*) suggests that this species may comprise a complex of ESUs or even cryptic species (Gemmell et al. 2003; Fouquet et al. 2010b).

A clear understanding of the identity of native frog species or taxonomic units (such as ESUs) is essential for frog recovery. Knowledge of taxonomy is necessary to assign threat classifications, define priority populations for protection and guide management actions. It is also important to investigate the genetic fitness of captive, translocated or wild populations that are descended from a few founders.

Issues

Issue 15.1: Frog taxonomy is not resolved, leading to uncertainties about the taxonomic status and the associated importance of distinct populations.

Issue 15.2: The genetic diversity of small, isolated or translocated frog populations is unknown, as are the effects of reduced diversity on population viability.

Objectives and actions

Objective 15.1: To resolve the taxonomy within genus *Leiopelma* and identify priority populations for management.

Objective 15.2: To determine the genetic viability of small, isolated or translocated populations of native frogs.

ACTION		ACCOUNTABILITY	PRIORITY
15.1	Complete the taxonomy of the entire *Leiopelma* genus, including extinct species, and formally publish the findings by 2018.	Recovery Group Science and Capability Group	Essential
15.2	Identify priority frog populations for management by 2018.	Recovery Group	Essential
15.3	Determine the long-term genetic viability of small, isolated or translocated populations using genetic analyses by 2015.	Science and Capability Group Relevant Chief Rangers and Senior Rangers	High

5.3.3 Topic 16—Species ecology and population modelling

An understanding of the interactions between a species and its living and non-living environment is critical for managing species recovery. Knowledge of the biological requirements, life-history parameters, population dynamics and behaviour of native frogs is essential for the assessment of habitat suitability and the identification of factors restricting population growth. This information is also integral to developing realistic population models to assess the outcomes of various management scenarios.

Current knowledge of the biological requirements (including habitat requirements) of native frogs is lacking. The main stronghold populations of native frogs are found in unmodified forest habitats and this was thought to reflect their habitat requirements. However, native frogs can also persist in some highly modified environments (Brown 2000; Bell et al. 2004c), which suggests that the current distribution of native frogs may not reflect the full range, or even optimal, native frog habitat.

It is of increasing importance that we understand the habitat requirements and life-history parameters of native frogs, as translocation is becoming a key tool for the management of these species. A good understanding of their habitat requirements is essential for assessing the suitability of new sites for translocation, while knowledge of life-history parameters is required to assess the viability of new or small populations.

Issues

Issue 16.1: Many of the life-history characteristics of native frogs that are necessary for developing population models (e.g. frequency of breeding, age-specific fecundity) are unknown.

Issue 16.2: Key information about native frog behaviour and microhabitat requirements (e.g. egg-laying sites, seasonal refuges, juvenile habitat requirements, UV exposure, environmental cues) is not available. Therefore, microhabitat suitability at existing sites, or for the establishment of new sites, can not be accurately determined.

Objectives and actions

Objective 16.1: To ensure that the information that is required to construct robust population models is available and that population modelling is undertaken for all taxa.

Objective 16.2: To increase our understanding of the suitability of microhabitats for the establishment and maintenance of native frog populations.

ACTION		ACCOUNTABILITY	PRIORITY
16.1	Facilitate research into the biology and ecology (e.g. breeding biology, communication, growth rate, mortality rate) of native frogs throughout the term of this plan.	Science and Capability Group Relevant Chief Rangers and Senior Rangers	Essential
16.2	Develop population models using knowledge of the biology and ecology of species to determine the long-term viability of small, isolated or translocated frog populations by 2018.	Science and Capability Group Recovery Group Captive institutions	Essential

5.3.4 Topic 17—Survey and monitoring

Native frogs are difficult to detect and monitor accurately because they are silent, nocturnal, very cryptic, and often occur in small populations and/or at low densities. In addition, leiopelmatid frogs are very long-lived, which means that any population monitoring must occur over an appropriately long time scale to detect change. The development of additional tools for the detection of frog populations and of less-intensive monitoring methods could reduce the cost of population monitoring and distribution surveys.

To date, native frog monitoring has mostly been conducted using photographic identification techniques (Bradfield 2004) and toe clipping (Bell & Pledger 2005, 2010). However, photographic techniques require that each individual has distinctive natural markings, and so have only been successful in population monitoring programmes for Archey's frog and Hamilton's frog (Newman 1990; Smale et al. 2005; T. Beauchamp, pers. comm.; P. Gaze, pers. comm.). Furthermore, the impacts of photographic identification or marking methods, such as the use of Passive Integrated Transponder (PIT) tags, have not been assessed for native frogs—although toe tip clipping was found to have minimal impact on survival and return rates in Maud Island frog (Bell & Pledger 2005, 2010; Pledger & Bell 2008) and the use of alphanumeric tags was shown to have little influence on survival or growth in introduced frogs (Clemas et al. 2009).

A monitoring method that does not require identification of individuals—site occupancy monitoring—has also been applied to native frogs. However, this has only been used for Hochstetter's frog to date.

Issues

Issue 17.1: Detailed population monitoring is cost- and labour-intensive.

Issue 17.2: A non-invasive technique for identifying individual Hochstetter's, Hamilton's and Maud Island frogs is not yet available.

Issue 17.3: Our knowledge of frog distribution is limited by our ability to detect new populations in the field.

Objectives and actions

Objective 17.1: To develop more cost-effective methods for monitoring native frogs.

Objective 17.2: To clearly understand the impact of monitoring techniques on monitored individuals and populations.

Objective 17.3: To develop new techniques and protocols for surveying and detecting native frogs.

ACTION		ACCOUNTABILITY	PRIORITY
17.1	Assess the impact of individual identification methods (invasive and non-invasive) on frog health, behaviour, survival and return rates; and develop best practice guidelines by 2017.	Recovery Group Science and Capability Group	Essential
17.2	Develop non-invasive identification techniques (e.g. the use of eye venation and other individual pattern markings) and publish/distribute the results by 2016.	Recovery Group Science and Capability Group	Essential
17.3	Research robust low-intensity monitoring methods for native frogs throughout the term of this plan.	Recovery Group Science and Capability Group	High
17.4	Assess new techniques for locating native frogs in the wild (e.g. frog detecting dog, drift fences, pitfall trapping) by 2016.	Recovery Group Science and Capability Group	Medium

5.3.5 Topic 18—*Ex situ* conservation techniques

Three species of native frogs (Archey's, Hochstetter's and Maud Island) have been held in captivity since 2000 as part of a captive management research programme. However, the mortality rate of these frogs has been high. This was thought to be caused by a combination of factors relating to husbandry, particularly the control of MBD (see Shaw & Holzapfel 2008). Although several egg clusters have been produced by Archey's frogs and Hochstetter's frogs in captivity (Auckland Zoo, Hamilton Zoo, University of Canterbury), none have survived past the froglet stage.

An additional barrier to captive breeding is the inability to physically identify male and female frogs. Although non-invasive sex identification techniques using hormone assays have recently been developed for native frogs (Germano et al. 2012), assisted reproductive technologies have not yet been used to increase the reproductive success and output of captive breeding populations. The development of artificial insemination and in vitro fertilisation are additional *ex situ* tools that could help to secure native frogs.

To date, cryopreservation techniques for the storage of sperm and eggs/embryos have only been developed successfully for a few amphibian species worldwide. Such development is considered beyond the scope of this 5-year plan, but may become an important focus in the future.

Issues

Issue 18.1: Mortality rates in captive frog populations that have been established for breeding are very high.

Issue 18.2: Captive frog populations that have been established for breeding have had very limited success.

Objectives and actions

Objective 18.1: To reduce mortality rates in captivity to natural levels (as identified in Action 16.1).

Objective 18.2: To increase the reproductive success and offspring survival rates in captive breeding populations.

ACTION		ACCOUNTABILITY	PRIORITY
18.1	Review and, where required, refine husbandry techniques to reduce mortality in captivity for the duration of this plan.	Recovery Group Captive institutions	Essential
18.2	Review the diet (mineral and nutritional content) of captive frogs by analysing the stomach contents and faecal samples of wild frogs by 2015.	Recovery Group Captive institutions	Essential
18.3	Identify and provide an appropriate microhabitat in captive environments to maximise the success of captive breeding and juvenile survival by 2018.	Recovery Group Captive institutions	Essential

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Appendix 1

Timeline for recovery actions for native frogs (*Leiopelma* spp.)

All actions in this plan have been placed in one of three priority classes ('essential', 'high' or 'medium'). These indicate the relative importance of each action in terms of its contribution towards achieving the recovery objectives and goal. This is recommended advice identified in the development of this plan:

E—Essential: Recommended as essential for the recovery of native frogs. These actions should be carried out in the timeframe specified and in the 5-year term of this plan, subject to resources being available and existing decision-making processes.

H—High: Recommended as necessary for achieving the long-term goal for native frog recovery. These actions should be carried out during the 5-year term of this plan, subject to resources being available and existing decision-making processes.

M—Medium: Recommended to support the recovery of native frogs. Some progress should be made towards these actions during the 5-year term of this plan, subject to resources being available and existing decision-making processes.

Actions have been abridged to include key points; see section 5 for full details. Shaded areas indicate the timing for the actions.

ACTION NUMBER	ACTION	PRIORITY	2013	2014	2015	2016	2017	2018
Topic 1—Distribution								
1.1	Prepare distribution survey best practice guidelines	E	■	■	■			
1.2	Identify priority sites for survey and undertake surveys	H	■	■	■	■	■	■
Topic 2—Monitoring								
2.1	Develop best practice monitoring guidelines	E	■	■				
2.2	Develop protocol for monitoring priority populations	E	■	■	■			
2.3	Conduct robust long-term monitoring in priority populations	E	■	■	■	■	■	■
2.4	Establish monitoring in populations created through translocation	H	■	■	■			
2.5	Report on status of monitored populations to Recovery Group	H	■	■	■	■	■	■
Topic 3—Management of threats								
3.1	Select two sites for each frog species where predator control will occur	E	■	■				
3.2	Initiate or continue control of predators of native frogs at selected sites	H	■	■	■			
3.3	Maintain island biosecurity	E	■	■	■	■	■	■
3.4	Ensure frog hygiene protocols are followed	E	■	■	■	■	■	■
3.5	Conduct regular monitoring of chytrid fungus at selected sites	M	■	■	■	■	■	■
Topic 4—Translocation								
4.1	Review success of prior translocations and make recommendations	E	■	■	■			
4.2	Supplement or rescue translocated populations as required by 4.1	E	■	■	■			
4.3	Monitor translocations over an appropriate timeframe	E	■	■	■	■	■	■
4.4	Select suitable sites for establishing new frog populations	E	■	■	■	■	■	
4.5	Identify and implement a new site for an Archey's frog translocation	E	■	■	■	■	■	■
4.6	Identify and implement a new site for a Maud Island frog translocation	H	■	■	■	■	■	■
Topic 5—Captive management								
5.1	Refine husbandry techniques for Archey's and Hochstetter's frogs	E	■	■	■	■	■	■
5.2	Prepare operative native frog captive management plans	E	■	■				
5.3	Define conditions where appropriate to end captive management for each species	E	■	■				
5.4	Review captive management plans every 2 years and circulate changes	E	■	■	■	■	■	■
5.5	Establish a captive population of Maud Island frog and refine husbandry techniques	H	■	■	■			
5.6	Amend the captive husbandry manual to include new species	E	■	■	■			
5.7	Identify any priority populations/ESUs for captive management	H	■	■	■	■	■	
Topic 6—Habitat restoration								
6.1	Identify sites where habitat restoration is essential to species/ESU survival	E	■	■	■			
6.2	Initiate restoration at sites essential for species/ESU survival	H	■	■	■	■	■	
6.3	Identify sites where restoration is necessary for population expansion	M	■	■	■	■	■	■
Topic 7—Capability								
7.1	Provide training and support for key staff and stakeholders	H	■	■	■	■	■	■
7.2	Develop resources for monitoring and management techniques	H	■	■				
Topic 8—Planning/legal protection								
8.1	Mitigate potential adverse land use impacts using statutory protection	E	■	■	■	■	■	■
8.2	Survey priority sites on private land for native frog presence	H	■	■	■	■	■	■
8.3	Determine impacts of land use activities using research	H	■	■	■	■	■	■
8.4	Ensure local/regional authorities are aware of statutory obligations	M	■	■	■			
Topic 9—Recovery planning								
9.1	Review this recovery plan and draft a new version if required	E					■	■
9.2	Review Recovery Group membership biennially	E	■	■	■	■	■	■

Continued on next page

Appendix 1—continued

ACTION NUMBER	ACTION	PRIORITY	2013	2014	2015	2016	2017	2018
Topic 10—Tangata whenua								
10.1	Develop communication guidelines for discussion with tangata whenua	E	■	■	■			
10.2	Identify opportunities for tangata whenua to be involved in frog recovery	H	■	■	■	■	■	■
10.3	Seek out and record mātauranga Māori related to native frogs	H	■	■	■			
10.4	Facilitate opportunities for mātauranga Māori to be incorporated in frog recovery	H	■	■	■	■	■	■
Topic 11—Community-led conservation initiatives								
11.1	Promote inclusion of frog recovery actions in community-led initiatives	E	■	■	■	■	■	■
11.2	Provide technical advice to community groups	E	■	■	■	■	■	■
11.3	Develop best practice guidelines for frog recovery	H	■	■	■	■	■	■
11.4	Establish a communication network for community initiatives with frogs	M	■	■	■	■	■	■
Topic 12—Public awareness								
12.1	Produce and implement a frog advocacy plan or guidelines	E	■	■	■	■	■	■
12.2	Ensure that DOC regions with native frogs hold frog week events annually	E	■	■	■	■	■	■
12.3	Raise awareness of disease risks with the amphibian pet trade	H	■	■	■			
12.4	Produce advocacy material for backcountry users	M	■	■	■			
Topic 13—External funding and collaboration								
13.1	Prepare a strategic document regarding sponsorship relationships	E	■	■	■			
13.2	Circulate the strategic sponsorship document until a sponsor is found	H	■	■	■	■	■	■
13.3	Maintain collaborative relationships with research organisations	E	■	■	■	■	■	■
Topic 14—Threats and agents of decline								
14.1	Determine the impacts of rats and mice on native frogs	E	■	■	■	■	■	
14.2	Review and publish results of Whareorino Forest rat control	E	■	■	■			
14.3	Test susceptibility of native frogs to amphibian chytrid fungus	E	■	■				
14.4	Assess impact of kiwi on native frogs	E	■	■	■	■		
14.5	Determine baseline disease profiles for each native frog species	H	■	■	■	■		
14.6	Enter all records of dead frogs into the Huia database as they occur	H	■	■	■	■	■	■
14.7	Determine the effect of selected ecosystem restoration projects	H	■	■	■	■	■	■
14.8	Assess the threat of toxins to native frogs	H	■	■	■	■	■	
14.9	Assess the effect of land use activities on native frogs	H	■	■	■	■	■	■
14.10	Develop best practice guidelines for use of toxins in frog habitat	M	■	■	■	■	■	■
Topic 15—Genetics and taxonomy								
15.1	Complete taxonomy of entire *Leiopelma* genus	E	■	■	■	■	■	■
15.2	Identify priority frog populations for management	E	■	■	■	■	■	■
15.3	Determine genetic viability of small, isolated or translocated populations	H	■	■	■			
Topic 16—Species ecology and population modelling								
16.1	Facilitate research into biology and ecology of native frogs	E	■	■	■	■	■	■
16.2	Develop population models to determine frog population viability	E	■	■	■	■	■	■
Topic 17—Survey and monitoring								
17.1	Assess the impact of individual frog identification methods	E	■	■	■	■	■	
17.2	Develop non-invasive identification techniques	E	■	■	■	■		
17.3	Research low-intensity frog monitoring methods	H	■	■	■	■	■	■
17.4	Assess new techniques to locate native frogs	M	■	■	■	■		
Topic 18—*Ex situ* conservation techniques								
18.1	Review and refine husbandry techniques	E	■	■	■	■	■	■
18.2	Review the diet of captive frogs	E	■	■	■			
18.3	Provide the appropriate microhabitat for breeding and juvenile survival	E	■	■	■	■	■	■