

# Population Monitoring Programme For Archeys Frog (*Leiopelma Archeyi*): Pilot Studies, Monitoring Design

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## A Synthesis of Direct Evidence of Predation on Amphibians in New Zealand, in the Context of Global Invasion Biology

There are currently almost as many threatened amphibian species as there are threatened mammalian and avian species combined (Bishop et al. 2012; IUCN 2014). Although the decline of amphibians has been of international concern for more than two decades, the direct causes of these declines are often difficult to identify, or they are difficult to disentangle as they may be acting synergistically (Alford and Richards 1999; Alford et al. 2001; Stuart et al. 2004). Introduced fauna are ranked as the third most important detrimental factor affecting amphibians after habitat modification and pollution (Chanson et al. 2008). Amphibians that have little or no evolutionary history with introduced fauna can exhibit naive responses that are not well suited for survival (Diamond and Case 1986; Gillespie 2001; Kats and Ferrer 2003) and the effect of introduced predators is predicted to be most acute in island ecosystems (Schoener and Spiller 1996; Courchamp et al. 2003; Ahola et al. 2006), particularly on insular endemic species (Diamond and Veitch 1991).

New Zealand's biota evolved in the absence of terrestrial mammals (apart from bats; see Clout and Saunders 1995). The Pacific Rat (*Rattus exulans*) and Polynesian Dog (*Canis familiaris*) arrived in association with the first human settlers in the thirteenth century AD (Anderson and Clark 2001; Wilmshurst

and Higham 2004; Wilmshurst et al. 2008) and a range of mammalian species were later introduced by European settlers (from the eighteenth century AD onwards) with 31 introduced mammalian species now present in wild or feral populations (Parks and Murphy 2003; King 2005).

The native amphibian fauna of New Zealand consists of four extant endemic frog species: Archeys Frog (*Leiopelma archeyi*), Hochstetter's Frog (*Leiopelma hochstetteri*), Maud Island Frog (*Leiopelma pakeka*), and Hamilton's Frog (*Leiopelma hamiltoni*); as well as three species introduced from Australia: Brown Tree Frog (*Litoria ewingii*), Southern Bell Frog (*Litoria raniformis*), and Green and Golden Bell Frog (*Litoria aurea*) (Bell 1994; Newman 1996; Frost et al. 2006). All four native species are ranked within the top 60 most Evolutionarily Distinct and Globally Endangered amphibians in the world, with Archeys Frog topping that list (EDGE 2008). Additionally, the two introduced bell frog species are declining in their native ranges in Australia and are listed as "Endangered" and "Vulnerable" (IUCN 2014).

The current native frog recovery plan considers the primary threats to be predation by rats and other introduced mammals, habitat loss and modification, disease, toxins, herbicides, and climate change (Bishop et al. 2013). While all these threats undoubtedly had, and continue to have, a devastating impact on native frogs, the problem of introduced mammals appears to be one of the most clear cut to remedy, i.e., through the control of mammal populations. Mammal control demands a large amount of resources and is only a viable option if conservation targets, e.g., an increase in frog abundance, are likely to be met. The evidence to date of introduced fauna negatively impacting *Leiopelma*, although convincing, is largely circumstantial. Therefore, the main objective of our study was to re-examine

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