Re-establishing North Island kākā

(*Nestor meridionalis septentrionalis*)

in New Zealand

A thesis presented in fulfilment of the requirements for the degree of

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For Orlando, Aurora and Nayeli

"I don't want my children to follow in my footsteps,

I want them to take the path next to me and

go further than I could have ever dreamt possible"

Anonymous

Abstract

Recently there has been a global increase in concern over the unprecedented loss of biodiversity and how the sixth mass extinction event is mainly due to human activities. Countries such as New Zealand have unique ecosystems which led to the evolution of many endemic species. One such New Zealand species is the kākā (*Nestor meridionalis*). Historically, kākā abundance has been affected by human activities (kākā were an important food source for Māori and Europeans). Today, introduced mammalian predators are one of the main threats to wild kākā populations. Although widespread and common throughout New Zealand until the 1800's, kākā populations on the mainland now heavily rely on active conservation management. The main methods of kākā management include pest control and re-establishments.

This thesis evaluated current and past commitments to New Zealand species restoration, as well as an analysis of global Psittacine re-establishment efforts. First, I surveyed individuals involved in ecological restoration projects at multiple North Island locations, to establish their past and future commitments to the re-establishment of New Zealand native species. Secondly, another survey was distributed amongst several experts in the field of kākā re-establishment in New Zealand. Lastly, a systematic literature review was completed to establish which psittacine species have been part of re-establishment projects and the methods that were applied to these projects.

The outcomes of the surveys and literature review contributed to the development of a draft recovery plan for North Island kākā. This 10-year plan is a guide for the Department of Conservation (DOC) and interest groups involved in conserving North Island kākā.

Keywords: North Island kākā, *Nestor meridionalis septentrionalis*, threatened species recovery, recovery plan, conservation, stakeholder survey, expert survey, systematic review, Delphi technique, New Zealand

Preface

Thesis outline

The overall aim of this thesis was to develop a detailed recovery plan for North Island kākā (*Nestor meridionalis septentrionalis*) in the North Island of New Zealand. The four key concepts were identified as follows: 1) to investigate the success of re-establishment programmes globally with particular reference to species similar in biology and behaviour to North Island kākā; 2) to research and capture current knowledge amongst experts on North Island kākā distribution, reintroductions and translocations; 3) to establish a long-term goal for North Island kākā re-establishment into the entire North Island of New Zealand and 4) to investigate and capture the current commitments and future expectations of release sites, governmental organisations and community groups. The purpose of the research is to develop a recovery plan, which will include methods to develop a self-sustaining population of North Island kākā widely distributed across the North Island. This plan in turn could become an example for other species recovery plans.

The methods that have been used to meet the key concepts include a stakeholder contribution survey, a survey of kākā experts and a systematic literature review.

Thesis structure

The thesis is comprised of an introduction chapter (chapter one), three research chapters (chapters two to four) and a concluding chapter (six) which provides general conclusions and recommendations. Additionally, chapter five is the proposed recovery plan which has been reviewed by experts in the field of kākā conservation. Their feedback has been included in this final version. The contents of each chapter are as follows:

Chapter one: Introduces the background of the evolution of psittacines and the extinction of New Zealand species. Furthermore, it discusses the concept of re-establishment and New Zealand's unique position regarding the recovery of species.

Chapter two: This chapter provides the outcomes of a survey conducted with individuals involved in New Zealand restoration projects. The survey was approved to be 'low risk' in agreeance with Massey University's Human Ethics Committee (Ethics notification number 4000016051). The survey was designed by me and reviewed by Denise Fastier (Department of Conservation) prior to circulation amongst restoration experts. The survey questionnaire is attached at Appendix III.

Chapter three: This chapter provides the outcomes of a three-staged survey, in line with the Delphi technique to attempt to reach a consensus on the factors that determine successful kākā re-establishment. The participants selected for this survey were kākā experts both past and current. The survey was approved to be 'low risk' in agreeance with Massey University's Human Ethics Committee (Ethics notification number 4000016298). The survey was designed by me and reviewed by Professor Dianne H. Brunton and Dr Aaron Harmer. The three survey questionnaires are attached at Appendix IV.

Chapter four: This chapter presents a systematic literature review on global psittacine re-establishments. The data extraction form was designed by me and reviewed by Professor Dianne H. Brunton and Dr Aaron Harmer. The data extraction form is attached at Appendix V.

Chapter five: This chapter is the final version of the recovery plan for North Island kākā. The plan was written by me and reviewed by experts in the field of kākā conservation and ecological restoration projects.

Chapter six: This final chapter presents the overall conclusions and recommendations for a successful re-establishment programme for North Island kākā in New Zealand.

Acknowledgements

First, my supervisor Professor Dianne Brunton, whose extreme patience has been greatly appreciated. For correcting me when I was heading into the wrong direction and for giving me the space to make this truly my own.

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All those who contributed to the different aspects of my thesis, especially those who took the time to participate in surveys, providing me with useful information, reviewing the recovery plan and/ or proof reading parts of my thesis.

My family, especially my children, Orlando, Aurora and Nayeli, my little eco-warriors in the making, even though you made the whole process harder at times (sleep is so over-rated), I ultimately completed this for you, to demonstrate that even when you think you have too much on your plate, you can always add more… continue to make me proud!

Ultimately, to everyone who gave me support even in the smallest of ways, without you I could not have finished this enormous task.

Glossary and Acronyms

CBD	Convention on Biological Diversity. International multilateral treaty with the main objective to develop national strategies for the conservation and sustainable use of biological diversity. Entered into force on 29 December 1993.
DOC	Department of Conservation. New Zealand's principal conservation agency.
IUCN	International Union for Conservation of Nature. Global authority on the status of the natural world and the measures needed to safeguard it.
NGO	Non-Governmental Organisations. Non-profit organisation that is independent of governments and has no political affiliations.
RSG	Reintroduction Specialist Group. Part of the IUCN's SSC. Its primary objective is promoting the reintroduction of viable populations of animals and plants back to their natural ecosystems.
RTCI	Residual Trap Catch Index. A standard method for estimating relative densities of pests.
SSC	Species Survival Commission. A special commission operated by the IUCN, made up of a global network of scientists and conservation managers.
UNEP	United Nations Environment Programme. An agency of the United Nations and coordinates its environmental activities, assisting developing countries in implementing environmentally sound policies and practices.

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Chapter 1 General introduction

1.1 Introduction

There is a global increase in concern over the unprecedented loss of biodiversity and how the current mass extinction is mainly attributed to human activities. To try and halt the increasing trend of biodiversity loss, the United Nations Environment Programme (UNEP) developed the Convention on Biological Diversity (CBD) at the Earth Summit in Rio de Janeiro, Brazil, in 1992. This convention came into force in December 1993 with its main objectives being (Ministry for the Environment, 2000): 1) the conservation of biological diversity; 2) the sustainable use of its components; and 3) the fair and equitable sharing of the benefits arising out of the utilisation of genetic resources.

The New Zealand government is a signatory to the CBD, and thereby notes the fundamental importance of in-situ conservation of ecosystems and natural habitats for the maintenance and recovery of viable populations of indigenous species. This ecosystem-focused approach is mirrored in the government's non-statutory initiatives such as the New Zealand Biodiversity Strategy. Documents such as this emphasise the importance of in-situ conservation of indigenous plants and animals (Saunders & Norton, 2001).

The fact that most of New Zealand's biodiversity is endemic and highly unique, makes it even more crucial for New Zealanders to stand behind government initiatives that support our indigenous biodiversity (Ministry for the Environment, 2000). New Zealand aspires to be seen internationally as "being clean and green", and a responsible steward of its environment and biodiversity. In 1998 the Government adopted "halting the decline of indigenous biodiversity" as one of its ten Strategic Principles (Ministry for the Environment, 2000). They pride themselves on being at the forefront of nature conservation. In 2017, the New Zealand government announced they are aspiring to make New Zealand predator free by 2050. This ambitious project aims to remove three mammalian predators (possums, rats and stoats) from the country, allowing its native species to flourish once again.

Now is a good time to continue the push for threatened species management. The purpose of this thesis is to initiate some of the work that can be done for one of New Zealand's forests' indicator species, the North Island kākā (*Nestor meridionalis septentrionalis*). Where indicator species can flourish in an ecosystem, it demonstrates the health of the entire ecosystem (Recio, *et al*., 2016). Not only are kākā a good indicator species for the quality of the New Zealand's forests, they are also able to fulfil the role of being a flagship species to attract public support (Recio, *et al*., 2016; Leech, *et al*., 2008; O'Donnell & Hoare, 2012).

This thesis introduces a background to global psittacine re-establishments and re-establishment efforts in New Zealand. The accumulated data have assisted in the development of the recovery plan for North Island kākā.

1.2 History of New Zealand

More than five hundred million years ago, during the late Ediacaran Period, the continents of Antarctica, South America, Africa, India and Australia were joined together as a single supercontinent known as Gondwana, or Gondwanaland. New Zealand formed beneath the sea level on the eastern edge of this continent, between southeast Australia and west Antarctica. About 85 million years ago, this part of Gondwanaland broke off and moved into the Pacific Ocean, creating the Tasman Sea. Most of this landmass (known as Zealandia) is still under the sea. Over the last 25 million years, movements between the Pacific and Australian plates have shaped New Zealand into its current biophysical form and geographic location (Department of Conservation, 2006; McSaveney & Nathan, 2017; Dussex, *et al.*, 2015).

New Zealand was the last major land mass on the planet, apart from Antarctica, to be permanently colonised by humans. Unfortunately, the impacts of its settlement have been catastrophic on New Zealand's indigenous biota. New Zealand has one of the world's poorest record of indigenous biodiversity survival. While biodiversity variations occur naturally, nothing since the extinction of the dinosaurs (65 million years ago) compares with the decline of New Zealand's indigenous biodiversity over the last century (Ministry for the Environment, 2000; Saunders & Norton, 2001).

1.3 North Island forest (past and present)

Once New Zealand became cut off from Gondwana much of its flora evolved in isolation for millions of years. Tree species such as kauri (*Agathis australis*) and podocarps (Podocarpaceae spp) link back to the ancestral forests of Gondwana, whereas other species' arrivals are more recent and originate from Australia and the tropical Pacific (Walrond, 2005).

Since the arrival of humans in New Zealand approximately 700 years ago, more than 75% of New Zealand's forests have been reduced by human exploitation (Walrond, 2005). By about 1600, around a third of the original forests had been replaced by grasslands. An additional wave of forest destruction followed from around 1850, since then another third of the original forests have been converted into farmland. Today, less than a quarter of the New Zealand land mass remains covered in original forests (Walrond, 2005; Recio, *et al.*, 2016; Ministry for the Environment, 2000; Saunders & Norton, 2001; Department of Conservation, 2017).

The North Island forests are made up of conifer-broadleaf forests which include species such as rimu (*Dacrydium cupressinum*), mataī (*Prumnopitys taxifolia*), miro (*Prumnopitys ferruginea*), kāmahi (*Weinmannia racemosa*) and tawa (*Beilschmiedia tawa*). In the North Island, beech forests also contain species such as red beech (*Fuscospora fusca*), hard beech (*Fuscospora truncata*), mountain beech (*Fuscospora cliffortioides*), black beech (*Fuscospora solandri*) and silver beech (*Lophozonia menziesii*). A typical North Island forest has five layers: the canopy, smaller trees, emergent trees, shrubs and ground plants (such as ferns). Where forests were once a continuous range of unique ecosystems, they are now isolated fragments scattered around the island (Walrond, 2005; Ministry for the Environment, 2000; Department of Conservation, 2017).

As a result of legal protection measures, some 30% of New Zealand's land mass is now formally reserved. Lowland forests however, have generally been under-represented in reserves, thereby providing insufficient protection for sustainability of the species found in these forests (Saunders & Norton, 2001; Leech, *et al.*, 2008).

1.4 New Zealand birds

The breakup of Gondwana and the subsequent isolation of New Zealand did not only lead to the unique ecosystems we see today, it also led to the evolution of New Zealand's fauna into many endemic species. It is believed that some species may have evolved from species living on Gondwana, although for many species there is little or no fossil evidence to support this

(McGlone, 2007). Most species arrived more recently and evolved their unique characteristics to match the uniqueness of the New Zealand environment. With a limited number of ground-dwelling predators, many bird species did not need an ability to fly, therefore several species evolved to become flightless (e.g. kākāpō (*Strigops habroptilus*), kiwi (*Apteryx* spp) and takahē (*Porphyrio* spp)). Additionally, adaptation to differing habitats or ecosystems resulted in large numbers of subspecies (e.g. wētā (Anostostomatidae and Rhaphidophoridae spp)) (McGlone, 2007; Department of Conservation, 2017).

1.5 Extinction rates New Zealand species

Populations can decline, potentially to extinction, when the number of individuals lost through death or emigration is greater than the number recruited through birth or immigration (Innes, *et al.*, 2010). New Zealand has experienced many extinctions following human arrival (refer Table 1.1), where most of the pre-settlement avifauna is now already extinct (Sekercioglu, *et al.*, 2004). The extinctions in the New Zealand avifauna have resulted in a greater loss of biodiversity than expected by chance alone. This occurred because highly specialized and evolutionarily unique species are more likely to go extinct (Duncan & Blackburn, 2004; Sekercioglu, *et al.*, 2004).

Innes *et al.* (2010) found that nearly a third of bird species breeding in pre-human times in the New Zealand region (including oceanic islands) became locally or globally extinct after human arrival, including 41% of endemic birds. Extinction rates have been even higher on the New Zealand mainland (52% of North Island birds and 47% of South Island birds) where larger suites of mammalian predators and competitors were introduced (Innes, et al., 2010).

The Ministry for the Environment notes that about 1 000 of New Zealand's known animal, plant and fungi species are now considered threatened (Saunders & Norton, 2001). The continuously diminishing local populations will inevitably lead to further extinctions. Globally, 78% of threatened bird species experience this ongoing loss of local populations (Sekercioglu, *et al.*, 2004).

Sekercioglu *et al.* (2004) forecasted that by the year 2100 forest, marine, and wetland habitats, as well as regions with large numbers of island birds, will experience the highest proportion of real and functional extinctions. New Zealand has been forecasted to lose the greatest percentage (48%) of its species compared to other countries or regions (Oceanic region: 39% and Malagasy 30%) (Sekercioglu, et al., 2004). This is likely because New Zealand has many endemic bird species that either belong to monospecific genera or to families of few species, therefore making them more susceptible to extinction.

Table 1.1 Summary of the status of New Zealand's vertebrate species. 1 Conservation Status of New Zealand Birds, 2016 (Robertson, et al., 2017); 2 Conservation Status of New Zealand Reptiles, 2015 (Hitchmough, et al., 2016); 3 Conservation Status of New Zealand Marine Mammals, 2013 (Baker, et al., 2016); 4 Conservation Status of New Zealand Bats, 2012 (O'Donnell, et al., 2013); 5 Conservation Status of New Zealand Frogs, 2013 (Newman, et al., 2013); 6 Conservation Status of New Zealand Freshwater fish, 2013 (Goodman, et al., 2014).

Category	**Birds 1**	**Reptiles 2**	**Marine Mammals 3**	**Bats 4**	**Frogs 5**	**Freshwater Fish 6**
Extinct	59	2	0	0	3	1
Data deficient	2	7	12	1	1	1
Threatened- Nationally Critical	23	8	5	1	2	5
Threatened- Nationally Endangered	15	8	2	2	0	6
Threatened- Nationally Vulnerable	33	21	1	1	2	10
At Risk- Declining	22	27	0	1	10	14
At Risk- Recovering	23	4	0	0	0	0
At Risk- Relict	15	11	0	0	0	0
At Risk- Naturally uncommon	47	10	0	0	0	5
Non-resident- Coloniser	8	N/A	0	0	0	3
Non-resident- Migrant	24	2	7	0	0	0
Non-resident- Vagrant	141	6	19	1	0	0
Not threatened	38	10	11	0	0	12
Introduced and Naturalised	37	1	0	0	3	20
TOTAL	**487**	**117**	**57**	**7**	**21**	**77**

1.6 Island endemism

Species endemism is an ecological state where a species occurs naturally in one geographical area, without the influence of people. The species can only be found in that particular area and nowhere else in the world (Primack, 2012). Island floras and faunas usually maintain a high degree of endemism because of their geographic isolation and the limited interchange with neighbouring mainland or island biota (Kier, *et al.*, 2009). Kier *et al.* (2009) also found that some ancient continental fragments like New Zealand, New Caledonia, Madagascar and the Seychelles harbour very distinct paleoendemic lineages.

New Zealand has a very high percentage of endemism as a result of its isolation and the diversity of its land and seascapes. Within New Zealand all the species of bats, frogs and reptiles, as well as about 80% of vascular plants, 25% of all bird species, 90% of insects and 90% of marine molluscs are endemic. Approximately 30 000 indigenous species have been described in New Zealand so far. There are still many species that are yet to be described or are data deficient, but it is estimated that New Zealand may have as many as 80 000 indigenous species. This estimate of endemism is remarkable internationally (Ministry for the Environment, 2000).

Duncan and Blackburn (2004) identified three features that are associated with endemic island birds that might explain their extinction vulnerability: their restricted distribution, flightlessness, and traits associated with large body mass. All three of these features tend to characterize the endemic birds in New Zealand.

New Zealand forest birds have much in common with those of other isolated islands, such as Hawaii, Mauritius and Madagascar. All four avifaunas evolved on an isolated land mass that lacked predatory mammals and each had a unique history of environmental change resulting from human colonisation in the last 800- 1 000 years (Innes, *et al.*, 2010). Unfortunately, threatened isolated endemic populations generally have lower genetic variation than threatened species from mainland areas (Jamieson, 2009) making them more vulnerable to extinction risk. Their risk for extinction is further increased by the fact that island endemic birds often have reduced predator escape responses, making them more vulnerable to predation when they encounter unfamiliar species (Duncan & Blackburn, 2004).

1.7 Evolution of psittacines

All birds fall under the class Aves, which is made up of two clades known as Paleoagnathae (which covers the ratites and tinamous) and the Neoagnathae (which covers all the other bird species). Within the Neoagnathae there are two superorders called the Galloanserae (which consists of waterfowl and land fowl) and the Neoaves (which contains all other birds and some 95% of avian diversity) (Thoft & Wright, 2015).

Within the Neoaves there are 34 orders. The order Psittaciformes or “parrots” is made up of 92 genera and are found in most of the tropical or subtropical regions around the world. The order is subdivided in three super-families: Cacatuidae or “cockatoos” (21 species), Psittacidae or “true parrots” (389 species) and the Strigopidae or “New Zealand parrots” (4 species) (IUCN, 2017). The closest relatives of the Psittaciformes are the Passeridae (songbirds) and the Falconidae (falcons) (Thoft & Wright, 2015).

Parrots have a unique set of morphological features which sets them well apart from other groups of birds. These features include a humerus bone in the wings, the presence of a fleshy cere over a curved bill, powder down, large heads, short necks and legs, and zygodactyl feet. They have a short tibia which is either feathered or bare (Thoft & Wright, 2015; Robaldo Guedes, *et al.*, 2001).

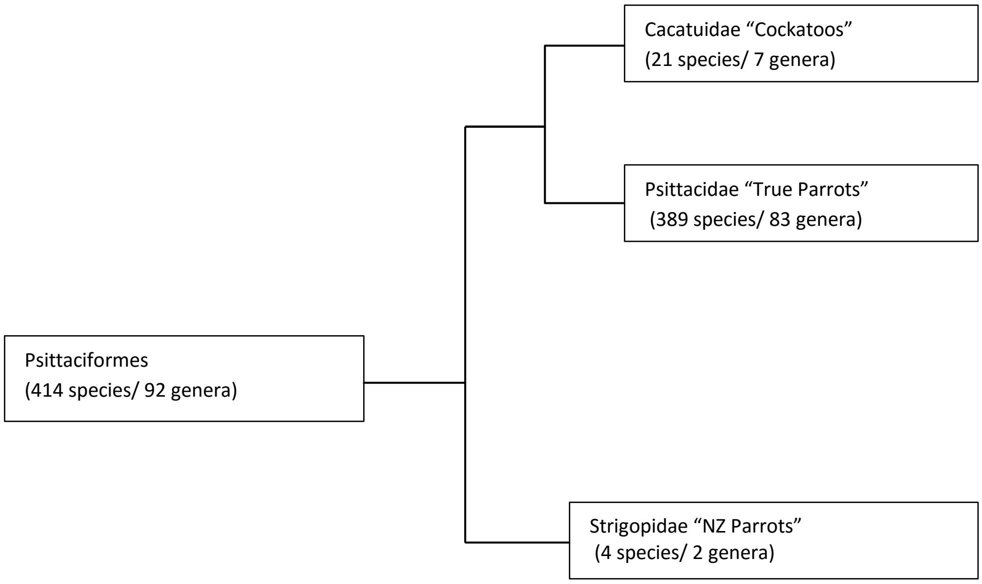

Figure 1.1 Phylogenetic tree illustrating the relationship of Psittaciformes and the number of genera and species that fall under the super-families.

1.8 Evolution of North Island kākā

With the break-up of Gondwana circa 85 million-years-ago an ancient New Zealand lineage diverged from all other parrots. This lineage is now called the Strigopidae or “New Zealand parrots” and includes the kākāpō, kākā and kea (*Nestor notabilis*). These parrots are globally significant because they form a superfamily that sits separated from all other parrots. Within the Strigopidae, molecular research indicates that the kākāpō and *Nestor* lineages separated 23-

29 million-years-ago. Additionally, this research dated the separation of the kākā and kea lineages to 2.3- 4.4 million-years-ago (Tennyson, *et al.*, 2014; Powlesland, *et al.*, 2009).

Kākā are believed to have evolved into four distinctive taxa within the New Zealand archipelago: 1) Norfolk Island kākā (*Nestor productus*[1]); 2) Chatham Island kākā (*Nestor* n.sp.[2]); 3) North Island kākā and 4) South Island kākā (*Nestor meridionalis meridionalis*) (Tennyson, *et al.*, 2014; Wood, *et al.*, 2014). The current distinction between the North Island and South Island subspecies appears to be based on their size and colour of plumage and its accuracy has been up for debate as it is questionable whether the Cook Strait should be considered a geographic barrier for kākā. Additionally, there is no genetic or consistent morphological difference in their skeletal structure (Moorhouse & Greene, 1998; Dussex, *et al.*, 2015; Powlesland, *et al.*, 2009; Sainsbury, *et al.*, 2006). Dussex *et al.* (2015) showed that most of the genetic variation in kākā was shared among populations (80%), a smaller proportion within populations (17%) and a nonsignificant proportion (3%) between the putative North and South Island subspecies. The lack of deep genetic divergence between northern and southern genetic lineages does not support the hypothesis of two subspecies of kākā diverging due to geographical isolation (Dussex, *et al.*, 2015).

Overall, there is much evidence based on microsatellite DNA data that there is a New Zealand wide metapopulation of kākā rather than two distinct subspecies. The phenotypic differentiation between the subspecies is likely the result of local adaptation and is consistent with natural selection for larger size of individuals when living in higher altitudes (as is the case with many taxa) (Dussex, *et al.*, 2015). Further research is recommended to determine whether the two recognised subspecies should be merged into a single species or not.

1.9 Threats to psittacines worldwide

The order Psittaciformes comprises around 414 species worldwide, of which approximately 16 are recorded ‘extinct’, 57 are ‘endangered’ with an additional 115 ‘vulnerable’ or ‘near

[1] Extinct 1851 (IUCN, 2017)
[2] Extinct between 13th and 16th centuries AD (Wood, *et al.*, 2014)

threatened' (refer Table 1.2). This makes this order one of the most endangered avian groups in the world (White Jr., *et al.*, 2012; Munn, 2006; IUCN, 2017; Collar, 2000).

Collar (2000) found that ninety (26%) of the world's parrot species are threatened with extinction. He notes that this figure varies with deteriorating circumstances, taxonomic insight and assessment of new evidence, however the great majority (approximately 93%) of threatened parrots are forest species. Most of the forest species (n =75 or 83%) have populations estimated at less than 10 000 mature individuals, and many (n =37 or 41%) have ranges smaller than 20 000km^2. The most notable threats to psittacines around the world include habitat destruction, poaching for the illegal pet trade and introduced species (Collar, 2000; Moorhouse, *et al.*, 2003; White Jr., *et al.*, 2012).

The introduction of mammalian predators to oceanic islands has resulted in declines and extinctions of numerous endemic species on these islands. Therefore, the control or eradication of introduced predators has become a major conservation priority in these areas (O'Donnell & Hoare, 2012). Furthermore, it is now generally accepted that the factors that cause populations to decline (e.g. habitat loss, over-exploitation and introduced predators) and the processes that become amplified in small populations (e.g. demographic and environmental variation, catastrophic events, genetic drift and inbreeding) play a combined role in increasing the risk of extinction of threatened species (Jamieson, 2009).

Table 1.2 Redlist categories Psittaciformes (IUCN, 2017).

	Strigopidae	**Cacatuidae**	**Psittacidae**	**All Psittaciformes**
Genera	2	7	83	**92**
Species	4	21	389	**414**
Redlist Category				
Extinct (EX)	1[3]	0	15	**16**
Critically Endangered (CR)	1	2	15	**18**
Endangered (EN)	1	3	35	**39**
Vulnerable (VU)	1	2	51	**54**
Near Threatened (NT)	0	1	60	**61**
Least Concern (LC)	0	13	213	**226**
TOTAL	**4**	**21**	**389**	**414**
Population trends				**%**
Increasing	1	5	31	**9.0**
Stable	0	4	133	**33.0**
Decreasing	2	12	205	**53.0**
Unknown	0	0	5	**1.0**
Extinct	1	0	15	**4.0**

[3] The Chatham Island kākā is not listed in the IUCN Red List and therefore not included in this table.

1.10 Kākā threats

Historically, kākā were an important food source for the Māori population of New Zealand (Riley, 2001). Additionally, feathers were used for traditional cloaks (O'Donnell & Rasch, 1991). According to Buller (1877), kākā were killed in their thousands when flocking onto flowering rata (*Metrosideros robusta)*. Since European settlement a further decline in their numbers followed when Europeans also started hunting kākā extensively for food and pet collection (Wilson, *et al.*, 1998; Powlesland, *et al.*, 2009; Buller, 1873; O'Donnell & Rasch, 1991). Besides hunting pressures, kākā numbers continued to decline due to deforestation and forest fragmentation (Jamieson, 2009; Saunders & Norton, 2001; Berry, 1998; Moorhouse & Greene, 1998; Sainsbury, *et al.*, 2006).

Today, one of the main threats to kākā populations is introduced mammalian predators, which have caused a dramatic decline in kākā populations. Stoat (*Mustela erminea*), common brushtail possum (*Trichosurus vulpecula*) and rats (*Rattus* spp) have proven to be the main predators of kākā. The largest threat to mainland populations is the stoat, which can kill nesting female kākā, fledglings, chicks and eggs (Saunders & Norton, 2001; Berry, 1998; Moorhouse & Greene, 1998; Recio, *et al.*, 2016; Greene & Jones, 2003).

Besides predators, competition from introduced mammals (i.e. goat (*Capra hircus*), deer (*Cervus* spp, *Dama dama* and *Odocoileus virginianus*) and brushtail possum) and wasps (*Vespula* spp) is also a notable threat to kākā (Berry, 1998; Moorhouse & Greene, 1998; Recio, *et al.*, 2016; Leech, *et al.*, 2008; Moorhouse, *et al.*, 2003). The browsing behaviours of the mammals cause significant changes in the structure and composition of the forest, making the habitat less suitable for kākā (Saunders & Norton, 2001). Furthermore, kākā productivity is generally low with nesting only occurring in years when food supply is abundant (Berry, 1998), therefore competitors can greatly impact breeding success in kākā.

When populations fall below a critical level, they become vulnerable to stochastic events (i.e. disease and weather) which can lead to local extinctions. This critical level varies between species and is determined by life history characteristics (e.g. reproduction and survivorship). Even if predator control restores the number of birds without management of the population (i.e. by translocation), the genetic diversity that has been lost in the first instance will not recover without dispersal between populations. Hence populations that experience a genetic bottleneck and suffer severe loss of genetic diversity, can have lower productivity and fitness (e.g. reduced reproductive success and survivorship) (refer Figure 1.2) (Innes, et al., 2010; Jamieson, 2009). According to Dussex *et al.* (2015) the kākā's genetic diversity is much higher than that of the closely related kea and kākāpō. Given the documented population decline in kākā, it is possible that the species' historical genetic diversity may have been much higher than the contemporary data indicates.

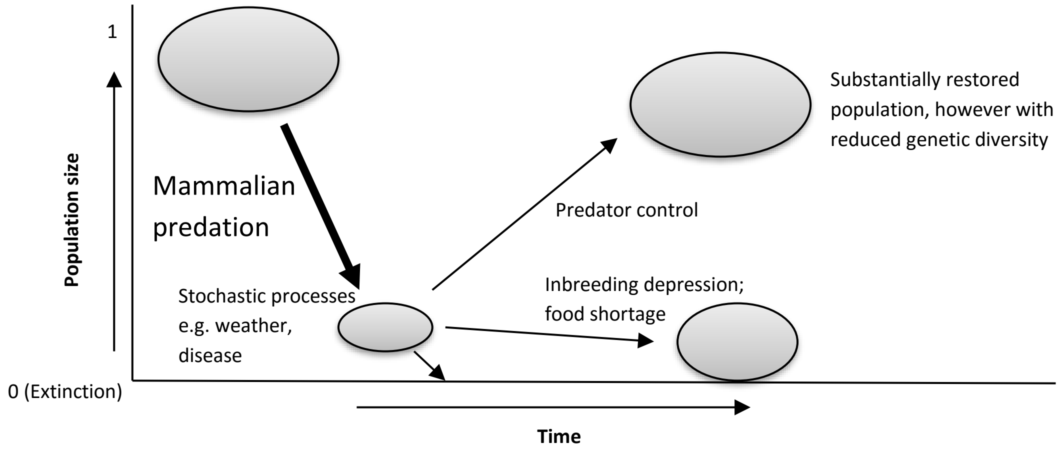

Figure 1.2 Schematic model of relationships between factors currently limiting New Zealand forest birds. Introduced pest mammals primarily drive population declines by predation of eggs, chicks and adults. Small populations are then vulnerable to disease, extreme weather and other stochastic processes, and may become extinct. Predator control may substantially restore population size but cannot recover lost genetic diversity, although translocation or mutation may do so in short and long terms respectively. Both inbreeding depression and food shortage may slow recovery rates, and food limitation and other kinds of competition may reduce population size (carrying capacity) (Innes, *et al.*, 2010).

Where kākā are still relatively common on the mainland, they often exhibit a significant sex ratio bias towards male birds. This is particularly the case for unmanaged populations where predators have a large impact on incubating females (Powlesland, *et al.*, 2009; Greene, *et al.*, 2004; Leech, *et al.*, 2008; Collen, 2010). On the other hand, managed and offshore island populations have balanced sex ratios close to 1:1 (Collen, 2010; Ministry for the Environment, 2007; Charles & Linklater, 2013; Powlesland, *et al.*, 2009; Moorhouse & Greene, 1998).

Threat classification

Under the New Zealand Threat Classification System, kākā are classified as 'nationally vulnerable' (Robertson, et al., 2017). They are an endemic species that is listed by the International Union for Conservation of Nature and Natural Resources (IUCN) as 'endangered'. The listing was upgraded to 'endangered' in 2005, previous to that it was listed as 'vulnerable'.

The re-classification to 'endangered' was because the kākā population has declined by ≥ 50% over the last three generations, and a further population decline of the same magnitude is predicted to continue over the next three generations (Powlesland, *et al.*, 2009; IUCN, 2017).

Both subspecies of kākā are classified as 'nationally vulnerable' with an estimated total population of 1 000- 5 000 mature individuals. In the last 100 years there has been a decline of ≥ 60% in the total kākā population and habitat area due to existing threats (Powlesland, *et al.*, 2009; Robertson, *et al.*, 2013).

1.11 Distribution of North Island kākā

Although once widespread and common throughout New Zealand in the 1800's, they began to decline between 1885 and 1900. By 1930 their distribution had become localised (Wakelin, 1991; Powlesland, *et al.*, 2009; St. Paul, 1977). In areas such as Northland, populations started to decline as late as the 1960's (O'Donnell & Rasch, 1991). Three generations ago, over 90% of the kākā population would have been found on the main islands (Hirschfeld, *et al.*, 2013).

Today, kākā are uncommon and are continuing to decline throughout their historical range (they now populate less than 20% of their historical range (Ministry for the Environment, 2007)). North Island kākā are now rare in most districts, with population strongholds restricted to a few larger remnant tracts of virgin podocarp/ hardwood forest (Pureora and Whirinaki) in the central North Island and a few pest-free offshore islands, in particular Kapiti, Great and Little Barrier Islands (refer Table 1.3) (Greene & Fraser, 1998; Leech, *et al.*, 2008; Sainsbury, *et al.*, 2006; Moorhouse, 1997; O'Donnell & Rasch, 1991; Ministry for the Environment, 2007; Berry, 1998; Wilson, *et al.*, 1998; Scofield & Stephenson, 2013; Hirschfeld, *et al.*, 2013).

Table 1.3 Overview of the status of North Island kākā populations (O'Donnell & Rasch, 1991), updated by author with additional sources. It is noticeable that there is little to no change in the status of North Island kākā populations since the workshop notes from O'Donnell & Rasch in 1991.

DOC Conservancy	Areas	Status	Original Source	Updated Source
Northland	All mainland forests	Very rare/ absent	Ogle (1982); S. King pers. comm.	(Pierce, *et al.*, 1993)
	Hen and Chickens Islands	Common	G. Taylor pers. comm.	(Pierce, *et al.*, 1993)
	Whangarei	Rare vagrants	-	(Wakelin, 1991)
Auckland	Mainland forests	Very rare/ vagrants, probably juveniles from the islands	Workshop participants	
	Great Barrier Island	Common	Ogle (1980)	(Powlesland, *et al.*, 2009)
	Little Barrier Island	Common	Workshop participants	(Scofield & Stephenson, 2013; Pierce, *et al.*, 1993; Powlesland, *et al.*, 2009; Sainsbury, *et al.*, 2006)
Waikato	Coromandel	Rare vagrants	Workshop participants	(Wakelin, 1991)
	Mercury Islands	Regular in very low numbers	A. Tennyson pers. comm.	(Blackburn, 1967)
	Western forests	Almost gone	O'Donnell (1983); Moynihan (1986)	(Wakelin, 1991)
	Pureora/ Waihaha	Still moderate numbers/ highest numbers on NI Mainland	Imboden (1978); S. King pers. comm.	(Greene & Fraser, 1998; Berry, 1998; Wakelin, 1991; Sainsbury, *et al.*, 2006; Powlesland, *et al.*, 2009)
Bay of Plenty	Mamaku Plateau	Very rare/ declining	Saunders (1983)	
	Mayor Island	Present/ may be breeding	Workshop participants	
	Whirinaki	Moderate numbers/ second NI stronghold	Moynihan *et al.* (1979);	(Greene & Fraser, 1998; Berry, 1998; Sainsbury, *et al.*, 2006)
East Coast	Urewera	Scattered/ some local concentrations/ declining recently	Workshop participants; Saunders (1983)	(Wakelin, 1991)
	Raukumara	Low numbers but could be isolated populations	S. Moore pers. comm.	(Wakelin, 1991)
Tongariro/ Taupo	All forests	Very few/ no viable populations	Workshop participants	(Wakelin, 1991)
Wanganui	All forests	Very rare/ virtually gone	O'Donnell (1983); Workshop participants	(Sainsbury, *et al.*, 2006)
Hawkes Bay	All forests	Very rare/ virtually gone	Workshop participants	(Wakelin, 1991)
Wellington	Mainland forests	Very low numbers only in Tararuas	Workshop participants	(Wakelin, 1991; Miskelly, *et al.*, 2005)
	Urban areas	Common	-	(Miskelly, *et al.*, 2005)
	Kapiti Island	Common	R. Moorhouse pers. comm.	(Scofield & Stephenson, 2013; Miskelly, *et al.*, 2005; Van Horik, 2011; Powlesland, *et al.*, 2009; Sainsbury, *et al.*, 2006)

1.12 Global re-establishments

Within re-establishment programmes there is a differentiation between four types of relocations: 1) “introductions”, where a species is established outside its known range; 2) “reintroductions”, where a species is established in an area which was once part of its historical range; 3) “translocations”, the deliberate transfer of wild individuals from one part of their range to another and 4) “supplementations”, where individuals are added to an existing population. (Fischer & Lindenmayer, 2000; White Jr., *et al.*, 2012; Collar, 2006; Berry, 1998).

Re-establishment techniques have become more important since the twentieth century, before this they were mainly used in game management. The first programmes to use these techniques for conservation purposes were for the European bison (*Bison bonasus*), the Hawaiian goose (*Branta sandvicensis*) and the Arabian oryx (*Oryx leucoryx*) (Collar, 2006). Today however, reintroductions, translocations and supplementation are proven to assist in the conservation of species around the world (Collar, 2006; Seddon, 2015; Wolf, *et al.*, 1996), assist in re-establishment of gene flow between populations and to prevent species extinctions (Dussex, *et al.*, 2015; Jamieson, 2009).

Human-assisted translocations can substitute for natural migration, which aids the population’s ability to maintain genetic variation as it increases the effective population size by connecting sub-populations. This can assist in dispersal of rare or ‘new’ alleles throughout the population, increasing the population’s genetic diversity. As a rule-of-thumb it has been suggested that one reproducing migrant is required to significantly increase genetic diversity of a population (Jamieson, 2009).

Reviews of surveys completed between 1973 to 1986 demonstrated that of the nearly 700 intentional translocations of native birds and mammals to the wild in Australia, Canada, Hawaii, New Zealand and the United States, 90% of the translocations focussed on native game species, with an 86% success rate. In comparison only 7% of the translocations focussed on threatened, endangered, or sensitive species and only 46% of these were successful (Griffith, *et al.*, 1989).

To support the increasing interest in re-establishments, the IUCN’s Species Survival Commission (SSC) has published a main guiding document for reintroductions worldwide. These guidelines emphasize the need to ensure that the ‘habitat and landscape requirements of the species are satisfied and likely to be sustained for the foreseeable future’ (Osborne & Seddon, 2011).

Re-establishment practitioners may increase their success by consideration of the following techniques:

1) the species has a polygynous mating system;

2) there are multiple release events;

3) the founder population is genetically diverse enough to establish a self-sustaining population;

4) species are released in the core of their historical range;

5) habitat has been restored to sufficient quality by identifying and removing agents of decline;

6) competitors have been eliminated;

7) the species has large clutch sizes; and

8) the individuals used for release are exclusively wild-caught.

(Griffith, *et al.*, 1989; Dussex, *et al.*, 2015; Jamieson, 2009; Osborne & Seddon, 2011; Berry, 1998; Robert, *et al.*, 2015).

Measuring success

According to data published by the IUCN (Soorae, 2008; Soorae, 2010; Soorae, 2011; Soorae, 2013; Soorae, 2016), there are 293 recorded reintroduction programmes, which are mostly active in North America and the Caribbean (n =62), West Europe (n =61) and Oceania (n =59) (refer Figure 1.3).

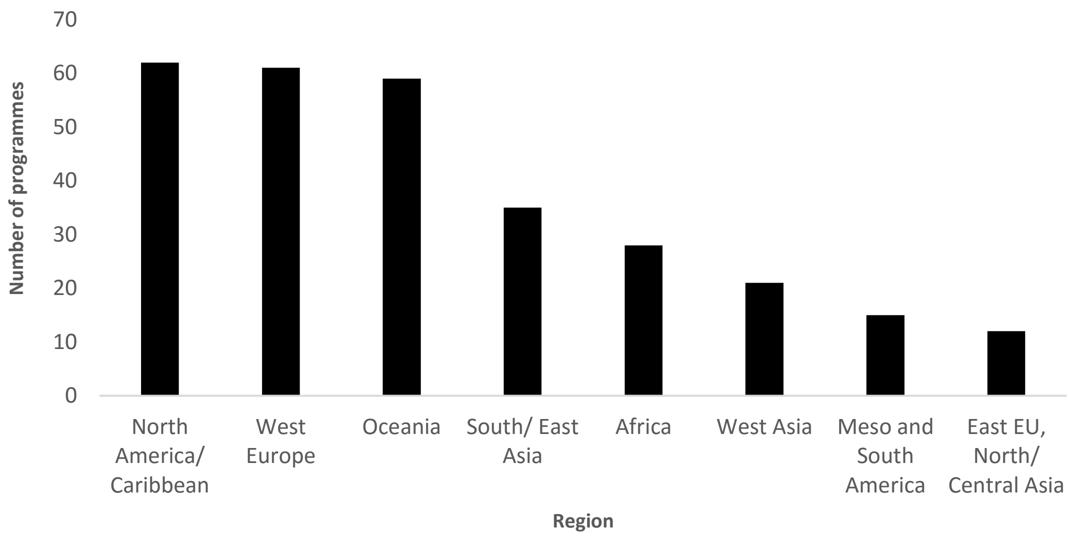

Figure 1.3 Overview of the number of reintroduction programmes per region (n =293). Data summarised from the IUCN's Global Reintroduction Perspectives series (Soorae, 2008; Soorae, 2010; Soorae, 2011; Soorae, 2013; Soorae, 2016).

The focus of the 293 reintroduction programmes on a global scale are mainly on mammals (n =85), birds (n =58) and plants (n =48) (refer Figure 1.4).

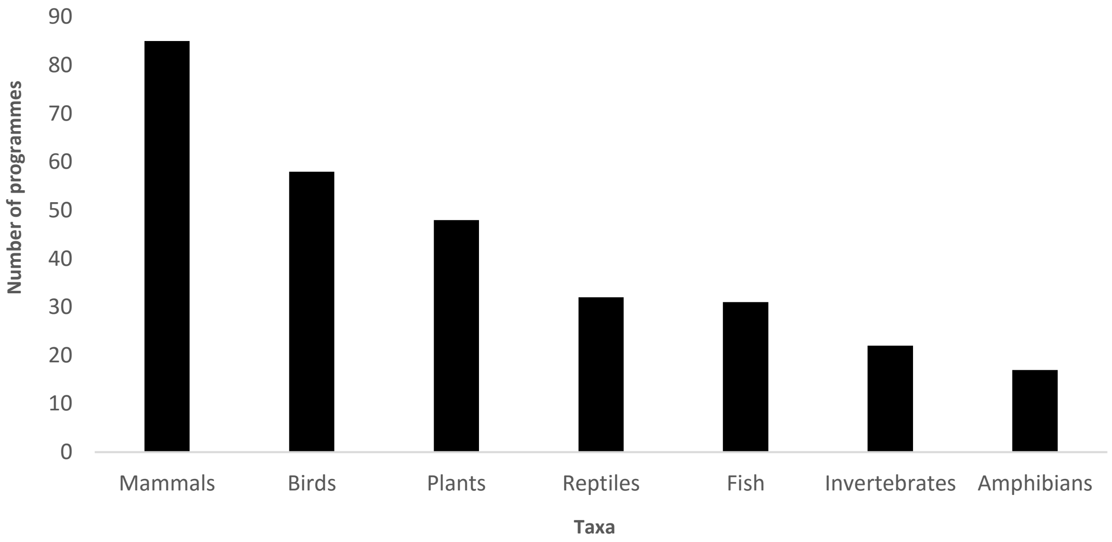

Figure 1.4 Overview of the taxa focus for global reintroduction programmes (n =293). Data summarised from the IUCN's Global Reintroduction Perspectives series (Soorae, 2008; Soorae, 2010; Soorae, 2011; Soorae, 2013; Soorae, 2016).

Despite the large number of projects, the success of projects is quite varied, with only 60 out of 319 projects (this number varies from above as some projects include reintroductions at multiple sites and success has therefore been measured at multiple sites) identified as 'highly successful' (refer Figure 1.5). In general, there should be a clear standard on how to record success of reintroduction projects. Where one author cites their project as 'highly successful' due to some successful breeding taking place, another author may be more inclined to rate theirs 'successful' if they haven't determined the ability of the population to sustain itself long-term.

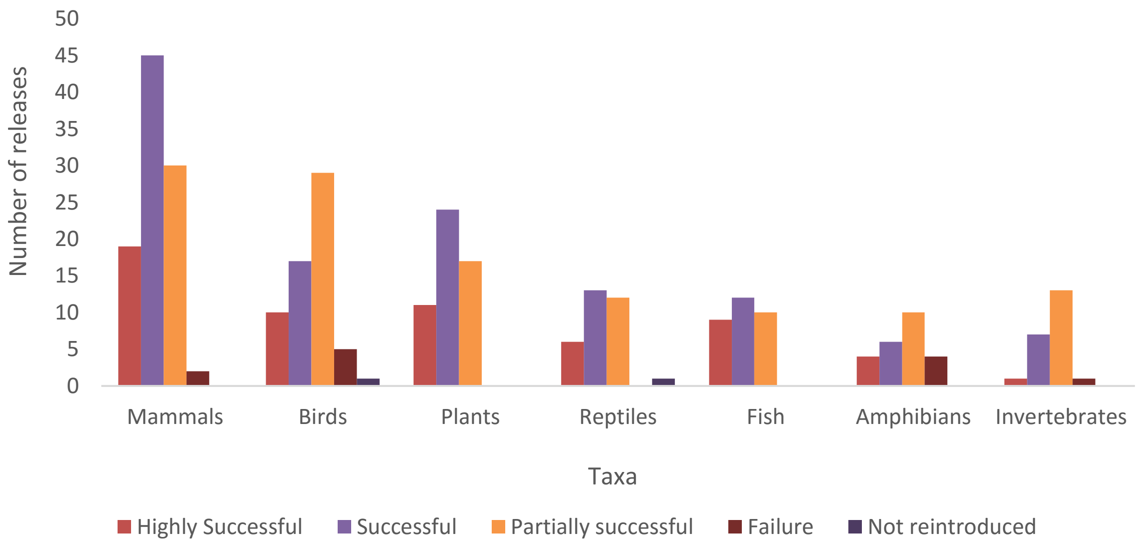

Figure 1.5 Overview of global reintroduction success by taxa focus (n =319). Data summarised from the IUCN's Global Reintroduction Perspectives series (Soorae, 2008; Soorae, 2010; Soorae, 2011; Soorae, 2013; Soorae, 2016).

When measuring the success of these projects the most successful are the fish and plants where there have been no failures recorded (Soorae, 2008; 2010; 2011; 2013 and 2016). Additionally, fish have the highest success rates with 29% classified as ‘highly successful’ followed by plants (21.2%). Within the category of ‘successful’ mammals (46.9%) and plants (46.2%) rate highest.

Where some success has been measured the category ‘partially successful’ invertebrates rate the highest with 59.1%, this is followed by birds (46.8%) (Soorae, 2008; 2010; 2011; 2013 and 2016). The differences in measurement of partial success is most obvious here, where every author identifies different aspects that makes them feel their project has some form of success, e.g. for one it could be the fact that birds survived for a week, where for others it could be that animals were successfully prepared for release. For the other taxa, the invertebrates rate highest with 59.1%.

Some of the projects were classified as ‘failure’, again there is a large difference within the opinions of the authors about whether a project has failed. Some might say a project has failed if no self-sustaining population has been achieved, whereas for others a failed project might not warrant a description in the literature. The highest rates of failure were for amphibians (16.7%) and birds (8.1%). There were no failures recorded for fish, reptiles or plants.

Furthermore, there were two taxa (reptiles 3.1% and birds 1.6%) that also had projects that were classified as ‘not reintroduced’, these projects were still active and a measurement could not be given at the stage of thesis completion.

1.13 Global psittacine re-establishments

The only places where governments protect wild parrot populations in the wild are Australia, New Zealand, Gabon, and parts of Costa Rica, Peru, Ecuador, and Brazil. In the first three countries, cultural norms prohibit parrot trapping, while in the latter four cases, parrot ecotourism has become significant eco-business and has therefore created a local conservation culture that diverges from the national norm (Munn, 2006).

According to White Jr. *et al.* (2012) numerous conservation efforts on behalf of psittacines (over 47 since 1987) have been initiated. Data on these however is scarce, with the abovementioned

IUCN global reintroduction perspectives only reporting on five members of the order Psittaciformes. Again, the reasoning for this could be that many are considered failed attempts and therefore the incentive to share was small (Collar, 2006), or there is a lack of resources for personnel to measure and share the success (or failure) of the projects. Some of the psittacine species that have been part of re-establishment programmes are included in Appendix I.

In general, re-establishment of psittacine populations relies on techniques such as reintroduction, supplementation and translocations. Collar (2006) developed guidelines for parrot reintroductions which can assist with increasing the success of these projects (a summary of which can be found in Appendix II).

1.14 New Zealand re-establishments

Richard Henry's employment as caretaker of Resolution Island, Fiordland, is arguably New Zealand's first concerted effort to conserve native species for their intrinsic value. During 1895 to 1907 hundreds of kākāpō, little spotted kiwi (*Apteryx owenii*) and South Island brown kiwi (*Apteryx australis*) were translocated in the Fiordland sounds. Unfortunately, much of his work proved futile once stoats invaded many of the islands around 1900. Despite this, his work was the start of conservation efforts as we know them today (Miskelly & Powlesland, 2013; Berry, 1998; Saunders & Norton, 2001; Taylor, 2007).

The New Zealand Wildlife Service developed translocation techniques for forest birds, and initiated the eradication of cats from offshore islands. The 1930's were the start of pest-control efforts to attempt to restore habitats to pre-predator invasions (Saunders & Norton, 2001; Powlesland, *et al.*, 2009). From 1964, the number of translocations increased dramatically, with many successes. This rapid increase in conservation activity was in part motivated by the rapid loss of three endemic species (Bush wren (*Xenicus longipes*), South Island snipe (*Coenocorypha iredalei*) and the greater short-tailed bat (*Mystacina robusta*)) and the near extinction of the South Island saddleback (*Philesturnus carunculatus*) on Big South Cape (Taukihepa) Island in 1964 following the arrival of ship rats. The increases in effort and success were facilitated by improved techniques, especially the use of newly-developed mist nets, and developments in island pest eradications (Miskelly & Powlesland, 2013).

The Department of Conservation (DOC) came into force with the passing of the Conservation Act 1987. The Act included a merger between several governmental agencies such as the New Zealand Wildlife Service, the Department of Land and Surveys, the New Zealand Forest Service and the National Parks Authority. During this time, methods to eradicate rats from offshore islands were developed (Miskelly, 2009). Today, pest control operations in New Zealand include one-off pest specific operations (e.g. Tiritiri Matangi Island) as well as longer term continuous trapping or pulsed poison operations (e.g. Ark in the Park) (O'Donnell & Hoare, 2012).

The Department of Conservation administers approximately 80 000km^2 of publicly owned land in New Zealand in the form of national parks, conservation parks and reserves. In addition to the public land managed by the Department of Conservation there is an increasing number of sites that are managed by community conservation groups (Miskelly, 2009). Some of the public and private sites have predator proof fencing and are focussed on ecosystem restoration rather than single species re-establishments (Leech, *et al.*, 2008; Miskelly & Powlesland, 2013).

Major success stories for New Zealand re-establishments include the Malherbe's parakeet (*Cyanoramphus malherbi*) to Maud Island, Red-fronted parakeet (*Cyanoramphus novaezelandiae*) to Tiritiri Matangi Island (Soorae, 2010) and North Island kākā to Zealandia in Wellington. One of the internationally renowned conservation stories is how the Chatham Island black robin (*Petroica traversi*) was saved from the brink of extinction when only five birds (one female and 4 males) remained in 1980. Today around 250 birds make up the black robin population, all descendants from the one female. This population continues to struggle; however, this is mainly due to their poor genetic diversity (Department of Conservation, 2017).

Genetic diversity allows a population to adapt to a changing environment or to be buffered against stochastic events such as harsh weather or disease outbreaks. Genetic diversity has been an important consideration in the development of management strategies for threatened populations around the world. In New Zealand, however, species recovery programmes have tended to focus on increasing population size at the expense of decreasing genetic diversity (e.g. by using over-represented founders) (Jamieson, 2009). To ensure that re-establishments can lead to self-sustainable populations it is crucial to incorporate sound population management as part of all restoration projects in New Zealand.

1.14.1 Island re-establishments

The potential of New Zealand's offshore islands as conservation management sites has been recognised for over 100 years. Despite the inability to protect the birds on Resolution Island, the process of translocating birds to this offshore island proved that 'securing' vulnerable species on predator-free islands was a key to averting further extinctions (Saunders & Norton, 2001).

With the increased ability to remove pests from offshore islands (especially those up to 2 000ha in size), came the opportunity to translocate vulnerable species to these islands to establish new populations (Saunders & Norton, 2001). Species such as takahē are managed on a large number of islands, to continue to grow their population while maintaining proper genetic management.

Department of Conservation records show that 17 species of vertebrates (15 mammals and two bird species) have been successfully eradicated from 140 islands around the New Zealand coast (Saunders & Norton, 2001). The following nine islands are now considered to be free of all species of introduced mammals: 1) Little Barrier Island; 2) Raoul Island; 3) Kermadec Islands; 4) Kapiti Island; 5) Whale Island; 6) Codfish Island; 7) Breaksea Island; 8) Mana Island and 9) Campbell Island. These islands are internationally important sites for biodiversity conservation and restoration (Miskelly, 2009).

Again, it is important to consider the fact that population genetics is also very important for island populations where reduced genetic diversity can occur due to limitation of immigration. The North Island kākā population on Kapiti Island is suffering from reduced genetic diversity because of a recent bottleneck (Sainsbury, et al., 2006). When the island was almost completely deforested in the 1840s, the carrying capacity for kākā was severely reduced. The subsequent invasion of the introduced brushtail possum from the 1890s, until their eradication in the 1980s, kept the kākā population size low over a prolonged period (Beggs & Wilson, 1991). Low genetic variation is linked to a reduction in reproductive fitness and hatching success (Moorhouse, 1997; Sainsbury, *et al.*, 2006).

1.14.2 Mainland Islands

The term 'mainland island' was coined to describe mainland sites that are managed as if they are islands. Some of these "islands" are forest islands in a "sea" of farmland, but others are embedded within large expanses of contiguous forest. The island metaphor refers to traps, toxins, and/or pest-proof fencing creating a barrier to pest re-invasion analogous to the protection provided by the sea around a true island (Miskelly, 2009). The first predator-proof fence around a mainland sanctuary was completed in 1999 at a 252ha site called Karori Sanctuary (now Zealandia) in Wellington (Innes, *et al.*, 2010). Mainland island pest control regimes are more intensive and have been maintained for longer periods than has normally been the case previously in New Zealand (Saunders & Norton, 2001).

During 1995 and 1996 the Department of Conservation initiated six mainland island projects. Three of these (Trounson Kauri Park, Boundary Stream Reserve and Paengaroa Reserve) are 'habitat islands' involving isolated forest remnants in essentially modified landscapes dominated by farmland. The other three (Northern Te Urewera National Park, Rotoiti Nature Recovery Project and Hurunui River) are 'habitat complexes' featuring core management areas within a larger complex of similar habitats. These mainland island projects have ecosystem-focused restoration goals. Management objectives include rehabilitating habitats, enhancing particular plant and animal populations, and informing stakeholders of activities and progress. The development of sustainable management regimes by which critical pests can be effectively controlled and their re-invasion limited to acceptable levels is a priority activity at these sites (Saunders & Norton, 2001; Adams, *et al.*, 2008).

Besides the six mainland "islands" managed by the Department of Conservation, there are an increasing number of community projects (over 8 000ha) which follow similar restoration goals (Berry, 1998; NatureSpace, 2016; Innes, *et al.*, 2010). Mainland island projects are relatively expensive and it may take many years before restoration goals can be assessed (Saunders & Norton, 2001). Despite this, the number of successful reintroductions of forest bird species (including North Island kākā) suggest that mainland sites can provide a suitable habitat for species, and in some cases become fully self-sustainable populations.

1.15 Chapter contents of thesis

The overall aim of this thesis is to develop a comprehensive recovery plan (refer Chapter five) for North Island kākā which can be adopted by the Department of Conservation and restoration organisations that are involved with North Island kākā re-establishment. As part of compiling this plan, a wider investigation of past and current psittacine recovery programmes and a review on New Zealand restoration programmes were conducted, and input from experts on kākā recovery obtained. The recovery plan includes both long-term and short-term goals, implementation methods giving short term direction for those involved with kākā recovery and management methods including issues and objectives that have been identified. Research findings are covered in chapters two, three and four, with concluding comments and suggestions for further research in chapter six.

Chapter 2 Stakeholder contribution survey

2.1 Introduction

A survey was conducted of several release sites, in the North Island of New Zealand, that are or have been involved in ecological restoration projects. The main aim was to establish their past and future commitments to re-establishment of New Zealand native species, and to see how these commitments could integrate in a draft recovery plan (hereafter "the plan") for North Island kākā (*Nestor meridionalis septentrionalis*). Public interest and involvement in conservation management projects appears to be growing (Saunders & Norton, 2001), which is demonstrated by the New Zealand government's initiative to become predator free by 2050 (Department of Conservation, 2016). Restoration projects in New Zealand currently include sites from Cape Reinga to Bluff, and vary in size from 40 hectare off-shore islands to national parks covering up to 1.2million hectares (Fiordland National Park) (Department of Conservation, 2017). A large proportion of restoration projects is completed by the Department of Conservation, however recently there has been an increase in community groups and organisations that contribute to restoration projects (Department of Conservation, 1998; Department of Conservation, 2016; Forest Lifeforce Restoration Trust, 2017; Blackie, 2015; Karori Sanctuary Trust, 2016; Lowe Corporation Limited, 2016; Maungatautari Ecological Island Trust, 2015; Miskelly, 2009; Miskelly & Powlesland, 2013; NatureSpace, 2017).

In general, restoration projects may plan to have a suite of species re-established in their management areas, however, usually the participation in programmes is determined by the availability of animals, resources and financial commitments (Joustra, 2016). Differences in approach among project managers are the product of differences of circumstances for each release site and are often *ad hoc*. The success of their participation depends on a variety of factors such as the available knowledge of the project team, financial and human resources, biological factors, conservation status of the species, source of the birds to be used, nature of the threats, and the kinds of options available to them (Collar, 2006; Wolf, *et al.*, 1996; Fischer & Lindenmayer, 2000). A comparison of the types of release sites that are currently available (though not specifically aimed at North Island kākā), would therefore be a helpful tool in the development of the plan. Where some sites may currently be focussing on just one species, it is possible that due to their contributions, the site could be suitable for other species (with minimal additional contribution) as well. The overall aim of this chapter is to assess whether there are more release sites suitable for North Island kākā releases and if they are willing to participate in the plan.

2.2 Research objectives

This research had two principle objectives:

1) To capture past and current commitments and perspectives regarding re-establishments from release sites, governmental organisations and community groups (from here on referred to as "stakeholders") in the North Island of New Zealand.
2) To investigate future expectations of these stakeholders regarding re-establishments, with the aim to see if these stakeholders can be included in the draft recovery plan for North Island kākā.

The main purpose of this survey was to gather information about what kind of contributions release sites are currently making to restoration of native species, what they have done in the past or what their focus is for the future. Contributions can range from the types and frequency of predator control they conduct, to their restoration methods, their target species and how successful their projects have been to date. Additionally, the stakeholders were also questioned about their willingness to participate in North Island kākā re-establishment.

2.3 Methods

This research was conducted using SurveyMonkey®. SurveyMonkey® is an online survey development company that uses cloud-based software (SurveyMonkey, 2016). The decision was made to only email a link to the survey (rather than sending out hard copies of the survey by standard mail) since email responses would allow for easier administration (e.g. sending reminders) (Cook, *et al.*, 2000). Considering the quick turnaround with email responses and the limited amount of time available for the survey, it was decided this was the most appropriate method.

To address the correct respondents directly, an internet search was started on the 1st March 2016. Stakeholders were found through extensive searches on websites (such as Sanctuaries of New Zealand and individual community pages) and the Department of Conservation Translocation register, which was kindly shared by Department of Conservation personnel.

In total 124 community groups/ organisations/ sanctuaries/ individuals directly involved in re-establishments were identified. These stakeholders were divided in North and South Island, 86 and 38 respectively, and email addresses were collected for the North Island stakeholders (refer Table 2.1).

From the 86 stakeholders in the North Island email addresses were identified for 68 (79%). To attempt to contact the remaining 18 stakeholders (or additional stakeholders that were not located in the initial searches) a link to the survey was also emailed to 139 members of the SanctuariesNZ discussion forum (most of these were already covered in the 124 identified earlier).

The survey was emailed to the remaining 68 stakeholders on the 31st May 2016. Reminders were emailed to the stakeholders on the 14th, 22nd and 28th June 2016. This is in line with research produced by Cook *et al.* (2000) where response rates had the highest average after three contacts, however more frequent contact achieved diminished returns (Cook, *et al.*, 2000).

Table 2.1 North Island stakeholders. Data from internet and Department of Conservation translocation register (Department of Conservation, 2016). * A number of these members were doubled up in the original list of stakeholders.

Email outcomes	Number
North Island stakeholders	86
South Island stakeholders	38
Total number of stakeholders in New Zealand	124
Members on SanctuariesNZ list serve	139*

The survey (refer Appendix III) contained five sections. Section one asked about a description of the management area (the term “Management Area” was defined as: land managed for conservation), this included information such as the location of the area, the tree species identified in the area and aviary designs. Section two asked about pest control activities, frequencies of pest control and who completes control in the management area. Section three dealt with animal release information such as which species have been released and success rating, the sources of the forest birds used for release, frequency of releases and number of individuals per release event. Section four asked about release methods adopted, including the type of release, details on supplementary feeding, disease screening and monitoring. The final section asked about North Island kākā participation and potential suitability of the management area for future kākā releases.

2.3.1 Ethics

The survey itself was evaluated by peer review and judged to be low-risk. This meant that it did not need to be reviewed by the University's Human Ethics Committee. However, respondents were advised that any concerns could be raised via email to humanethics@massey.ac.nz.

2.3.2 Survey design

A draft version of the survey was created in Microsoft Word and reviewed by an experienced re-establishment expert. Once the feedback was incorporated the survey was set up in SurveyMonkey®.

The survey consisted of 75 questions and skip-logic was applied to this survey (refer Appendix III). Skip-logic directs respondents through different paths in a survey based on one or multiple conditions (SurveyMonkey, 2016), this means that not all questions would need to be answered by every respondent. The number of questions each respondent would receive was dependent on their previous answers (e.g. if the respondent selected that they currently do not have any aviaries on site, none of the questions relating to aviary design would be asked).

2.3.3 Sample Size

The survey was emailed to 68 stakeholders (refer Table 2.2). Following the email to the 68 stakeholders, 3 returned with an invalid email addresses and 1 returned with a long-term absence (beyond the 30th June 2016). According to Kittleson (1997), electronic surveys can expect a response rate of between 25% - 30% (Cook, *et al.*, 2000), which would mean a minimum of 17 stakeholders would need to reply to meet this target. However, due to the objectives of the survey the research expectation was that cooperation would be much higher.

Table 2.2 North Island stakeholder email contact outcomes (n =68).

Email outcomes	%
No email address identified	21.0
Email invalid	4.0
Long-term out of office received (e.g. retirement, parental leave)	1.0
Successful email contact made	74.0

2.4 Results

2.4.1 Response rate

The survey ran from the 1st June 2016 to the 30th June 2016, with 42 respondents having started the survey (refer Table 2.3). Once reviewed there were 14 incomplete responses which were therefore excluded from further analysis, resulting in a response rate of 44%.

Table 2.3 Summary of stakeholder participation. * Accumulation via internet searches and the Department of Conservation translocation database.

Type of response	Number of experts/ specialists
Final included in survey	64
Received before 1st reminder	19
Received before 2nd reminder	8
Received before 3rd reminder	10
Received after 3rd reminder	5
Total responses received	42

Baruch and Holton (2009) already demonstrated that response rates for surveys have decreased since 1975. The response rate from the stakeholder survey fell below the average response rate for paper surveys (55.6%), however, it fell above the generally accepted mean response rate for electronic surveys (34.66%) (Baruch, 1999; Cook, *et al.*, 2000).

2.4.2 Management Areas

Respondents were asked to select which type of area best described their management area. Mainland areas (being either mainland, mainland islands or peninsulas) represented 89.3% of the answers. For the purposes of the re-establishment plan the contribution of a large percentage of mainland sites is a great result as kākā numbers have continued to decline on the mainland (Moorhouse, *et al.*, 2003; Powlesland, *et al.*, 2009) and the purpose of the plan is to establish how to re-establish the species on the New Zealand mainland.

2.4.3 Flora

Respondents were asked which tree species could be identified in their management areas, to determine whether the area could be suitable for North Island kākā. In addition to the species, the height of the trees is important in determining the availability of nest spaces. A study by Powlesland *et al.* (2009) shows the mean kākā nest tree height is 28.8 and 39.4m and the nest entrance height is 11.7 and 13.4m (Powlesland, *et al.*, 2009). Many of the sites are in areas with trees reaching more than 11m (71.4%), with 39.3% having the height required to be considered suitable nesting trees (refer Table 2.4).

2.4.4 Aviaries

Historically many bird species (including kākā) have been released after a period of adjustment/ acclimatisation at the release site (referred to as "soft-release"). Respondents were asked if they have aviaries on-site to allow for soft-release. Only 28.6% currently have aviaries on-site, and a further 17.9% are planning to build or start utilising aviaries to enable soft-release of birds (refer Table 2.4).

2.4.5 Boundaries

The respondents were asked what form of predator proof boundaries their management area has. Fifty percent advised they have no predator proof boundary (refer Table 2.4). From the 28.6% that have artificial boundaries, 50% use Xcluder® fences (Xcluder Pest Proof Fencing Limited, n.d.).

2.4.6 Pest Control

When asked about pest control, 96.4% of the respondents currently completed pest control in their management area (refer Table 2.4). The frequency of pest control varied, but the majority (66.7%) performs some form of continuous pest control.

Next, the respondents were asked who managed the pest control in their management areas. Most sites use volunteer personnel to manage pest control (70.4%), followed by contractors (40.7%) and their own paid personnel (37%). Department of Conservation personnel were used in 33.3% of the sites (refer Figure 2.1).

Table 2.4 Description of management areas (n =42). The data in this table assists in determining the suitability of release sites to participate in North Island kākā re-establishment.

Types of management area	**%**
Mainland	53.6
Off-shore Island	10.7
Peninsula	10.7
Mainland Island	10.7
Other	14.3
Average height of trees in management areas	**%**
< 5m	17.9
5m – 10m	10.7
11m – 20m	32.1
21m – 30m	28.6
> 30m	10.7
Soft-release aviaries present to allow for soft-release	**%**
Yes	28.6
No	53.6
Not yet (planned for future)	17.9
Type of predator proof boundary	%
Natural boundaries (e.g. rivers)	21.4
Artificial boundaries (e.g. fencing)	28.6
None	50.0
Frequency of pest control activities in management areas	**%**
Continuous	66.7
Pulsed	22.2
Other (e.g. none)	11.1

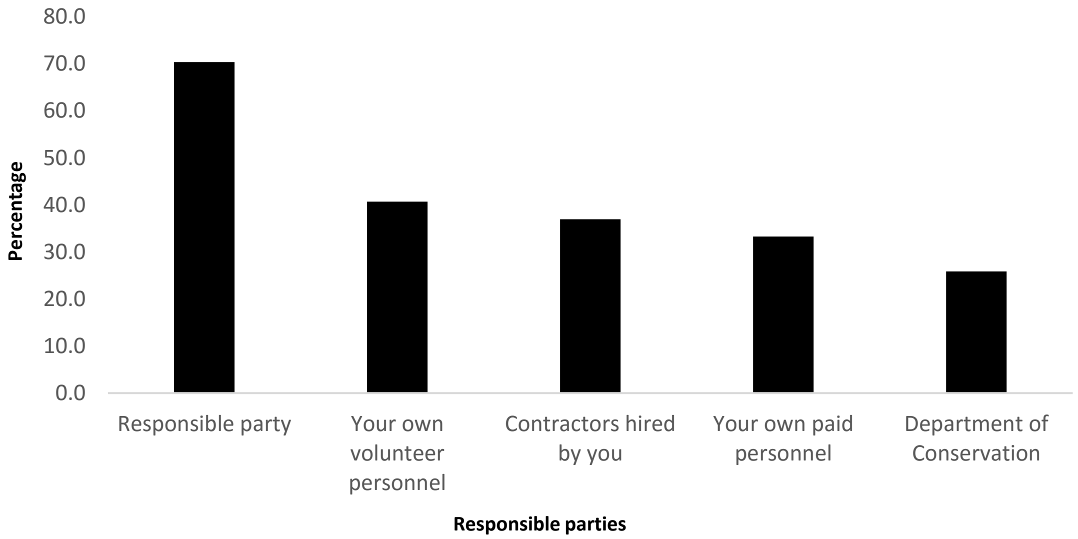

Figure 2.1 Parties responsible for pest control in the management areas (note: multiple parties can be utilised to complete past control in one management area).

From the types of ground control that are utilised in the different management areas, 88.9% use trapping (of which 48.1% use kākā proof traps, with a further 37% being unsure about whether traps are kākā proof) and 77.8% use bait stations (of which 30.8% use kākā proof bait stations and a further 50% are unsure if their stations are kākā proof) (refer Figure 2.2).

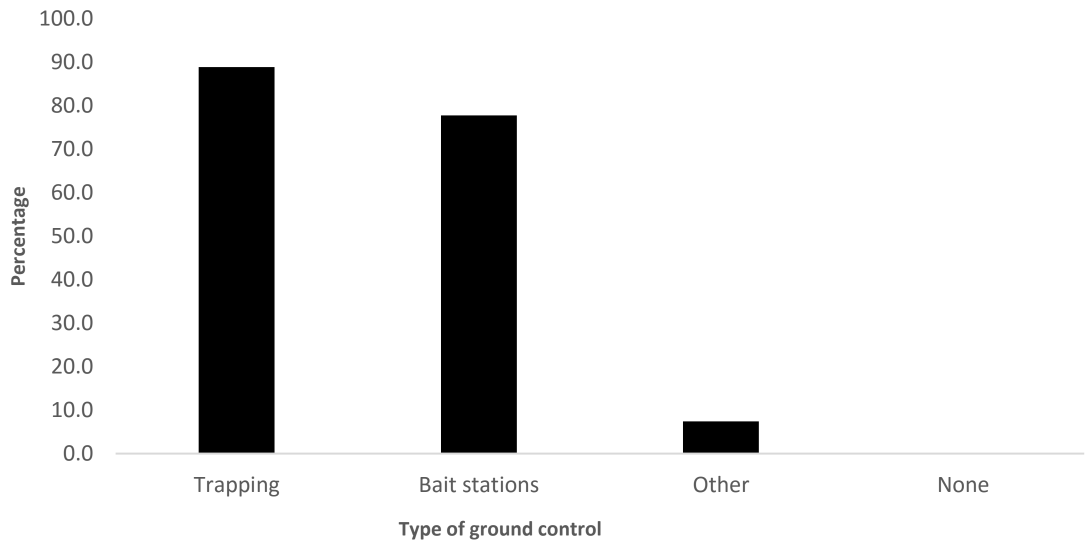

Figure 2.2 Ground pest control techniques adopted in the management areas.

The top five target species of pest control were rats (*Rattus* spp) (100%), stoat (*Mustela erminea*) (81.5%), weasel (*Mustela nivalis*) (77.8%), possum (*Trichosurus vulpecula*) (74.1%) and ferret (*Mustela putorius furo*) (63%) (refer Figure 2.3). As rats, mustelid and possum are the main predators of kākā females and nests (Innes, *et al.*, 2010; Greene, *et al.*, 2004) this would be beneficial to creating suitable kākā breeding habitat.

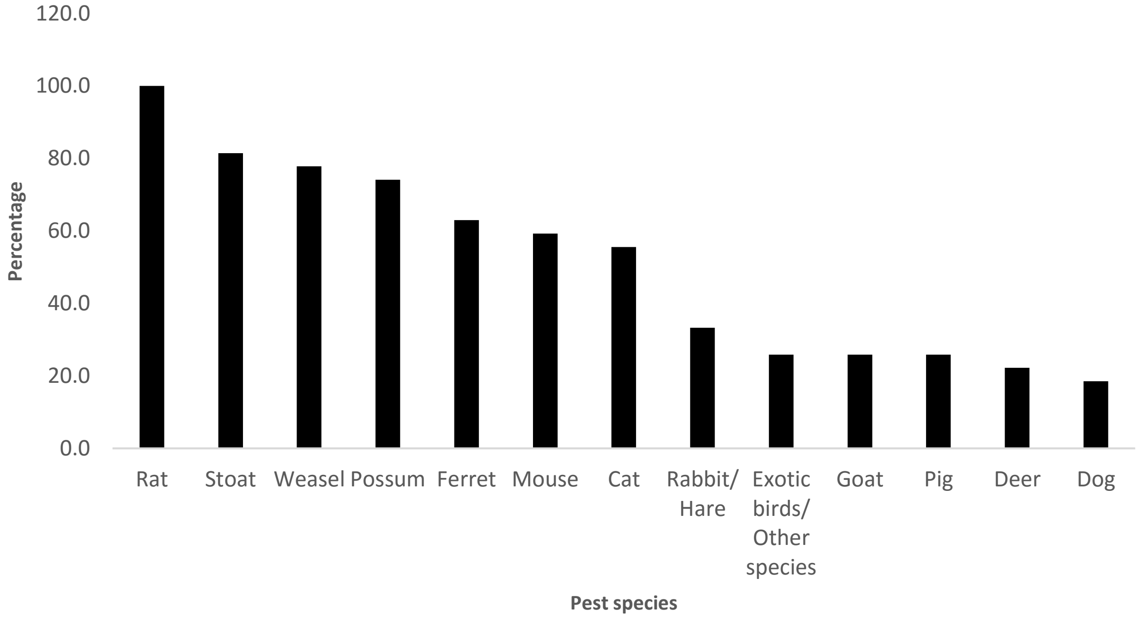

Figure 2.3 Targeted pest species for pest control in management areas (note: areas may control more than one species).

2.4.7 Success rating

There are no general guidelines regarding the rating of success for re-establishment programmes, this needs to be addressed within the restoration community (refer Chapter 6). However, respondents were asked to rate the success of the reintroductions of the species they have been working with so far. A five-tiered rating scale was drafted as part of the survey, to provide guidance to the stakeholders in determining the level of reintroduction success for their programmes. The following descriptions were utilised: 1) “excellent”: where the newly established population is considered to be self-sustaining; 2) “above average”: where breeding has been observed in the newly established population; 3) “average”: where the majority of the released individuals are still living; 4) “below average”: where a large percentage of the released individuals have died; and 5) “poor”: where there has been no survival of the released individuals.

Respondents participated in 78 release projects. When asked to rate the success of each of these projects: 21.8% were rated as "excellent", 43.6% was rated "above average" and 17.9% as "average". Only 16.7% was rated below "average" (9.0% below and 7.7% poor) (refer Figure 2.4). Considering translocations have taken place in New Zealand for more than 125 years (Saunders & Norton, 2001), it is encouraging to see that the release projects seem to be meeting long-term goals of creating sustainable populations.

Griffith *et al.* (1989) found that from a comparison of global translocation projects, 90% of translocations were of game species. Whereas threatened, endangered, or sensitive species accounted for only 7% of translocations. It is important to note that all projects mentioned in this research are for the purposes of conservation of threatened or endangered species.

When asked to rate the success of the projects involving forest birds, the proportion of "excellent" and "above average" (18.8% and 37.5% respectively) ratings was similar to overall success rates (i.e. across taxa) (refer Figure 2.4). However, the category "average" was significantly higher for forest birds than all species' releases (31.3% and 17.9% respectively). None of the forest bird projects were rated as "poor".

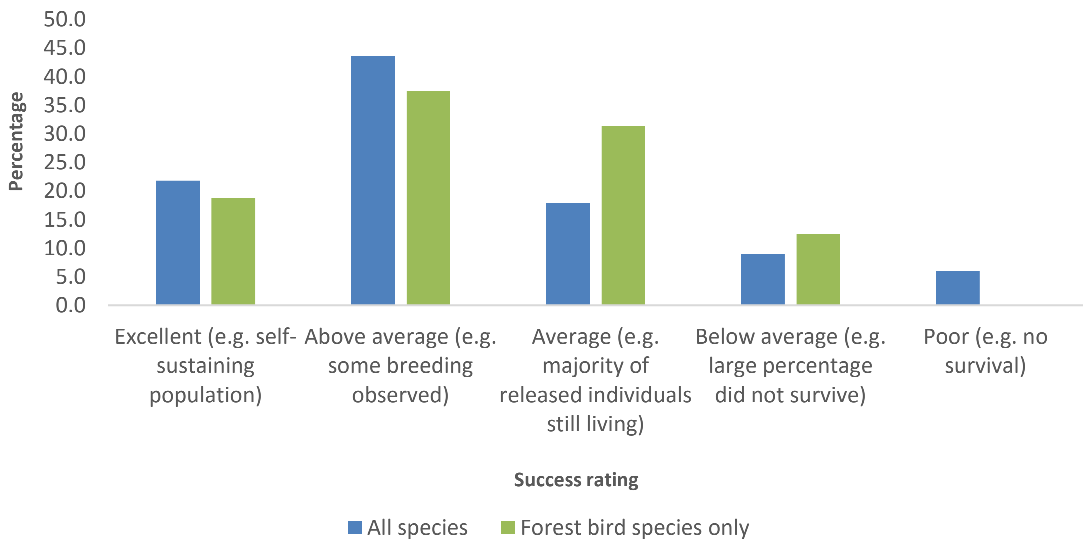

Figure 2.4 Success ratings of release projects in New Zealand for all native species and native forest bird species only.

2.4.8 Source of birds

To determine which birds would be most suitable for successful release programmes, respondents were asked about the source of the birds they have released. Most of the sites used translocated adult birds for release (93.8%), whereas only 31.3% have used captive sourced birds. No wild sourced rescue/ rehabilitation birds were used for translocations. The category “other” included birds used for the Operation Nest Egg (ONE) programme and made up 12.5% of releases (refer Figure 2.5).

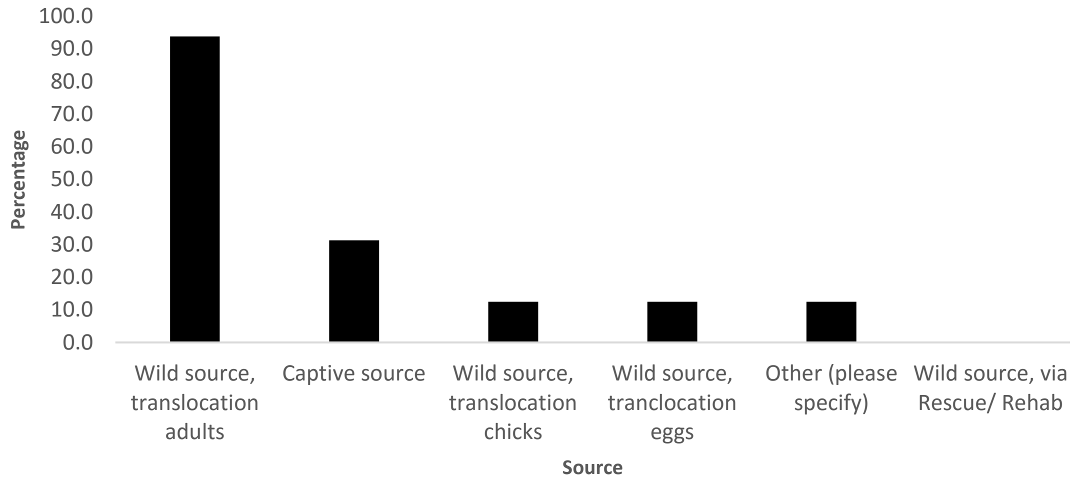

Figure 2.5 Source of forest birds for release in New Zealand restoration programmes.

2.4.9 Involvement reasons

When asked why they selected the species that were released, most of the sites released for the purpose of re-establishment (87.5%) followed by supplementation (18.8%) (refer Figure 2.6). Other purposes included ease of acquisition of animals, trialling for a more endangered species and having previously been involved with the species at other locations (12.5%, 6.3% and 6.3% respectively).

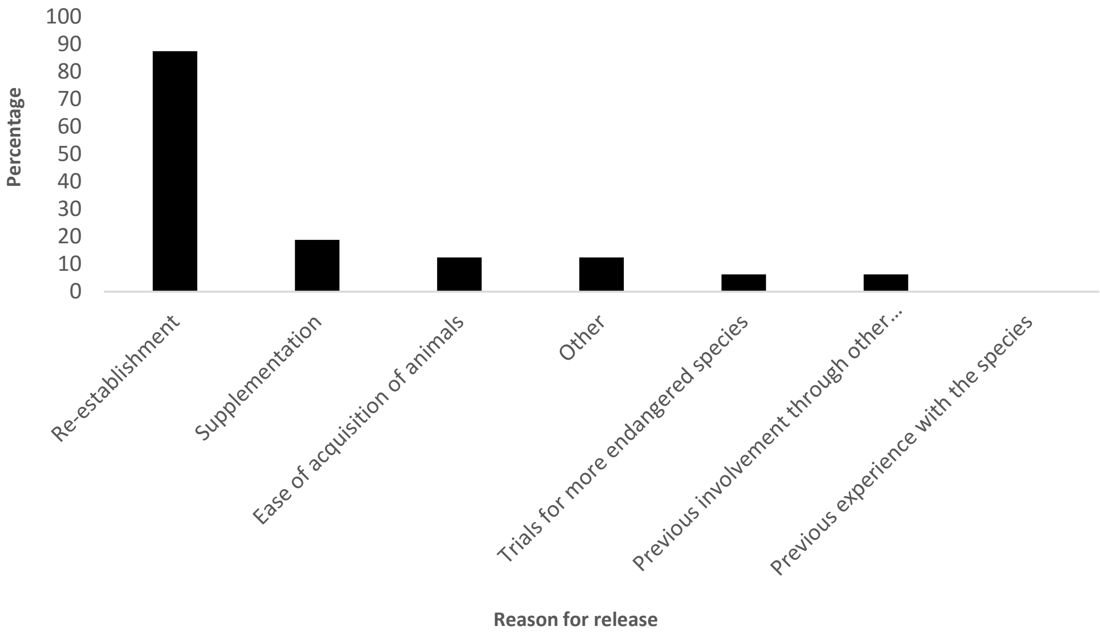

Figure 2.6 Reasons given for species selection for release projects in New Zealand. More than one reason could be selected.

2.4.10 Release events

Respondents were asked how many specimens they would normally release per species (refer Table 2.5). Most sites would release more than ten specimens (70.8%) per release event. Most sites would use single release events (54.1%) rather than multiple release events (45.8%).

Table 2.5 Number of specimens per release event. Question 33: stakeholder contribution survey.

Specimens and frequency per release event	%	N
Single release of < 10 specimens	20.8	5
Single release of > 10 specimens	37.5	9
Multiple releases of < 10 specimens	8.3	2
Multiple releases of > 10 specimens	33.3	8

2.4.11 Release methods

There appears to be a divide when asked whether sites used hard-release or soft-release methods. Generally, the sites used hard-release with only one respondent specifying that they use hard-release for all species except for when releasing captive kākā.

Respondents were also asked whether they instigated supplementary feeding after release (refer Table 2.6). The majority currently provide supplementary food (45.8%), with a further

12.5% planning to do so in the future. The duration of the supplementary feeding for most sites is longer than 12 months (80%) with only 10% less than 1 month and 10% between 1 and 2 months.

Table 2.6 Use of supplementary feeding post release in the management areas.

Supplementary feeding utilised in management area	%	N
Yes	45.8	11
No	41.7	10
Not at this stage (planned for the future)	12.5	3

The frequency of supplementary feeding varies greatly for the sites. With 30% feeding daily, 10% on a weekly basis and the remainder feeding at irregular intervals (mainly when birds are seen).

Respondents were asked which food items they use for supplementary feeding (refer Figure 2.7). Most sites provided sugar water (70%). Fruits and nuts were both fed at 40% of the sites and vegetables and bird pellets were both used at 30% of the sites. "Other" food items included mealworms, peanuts and seeds.

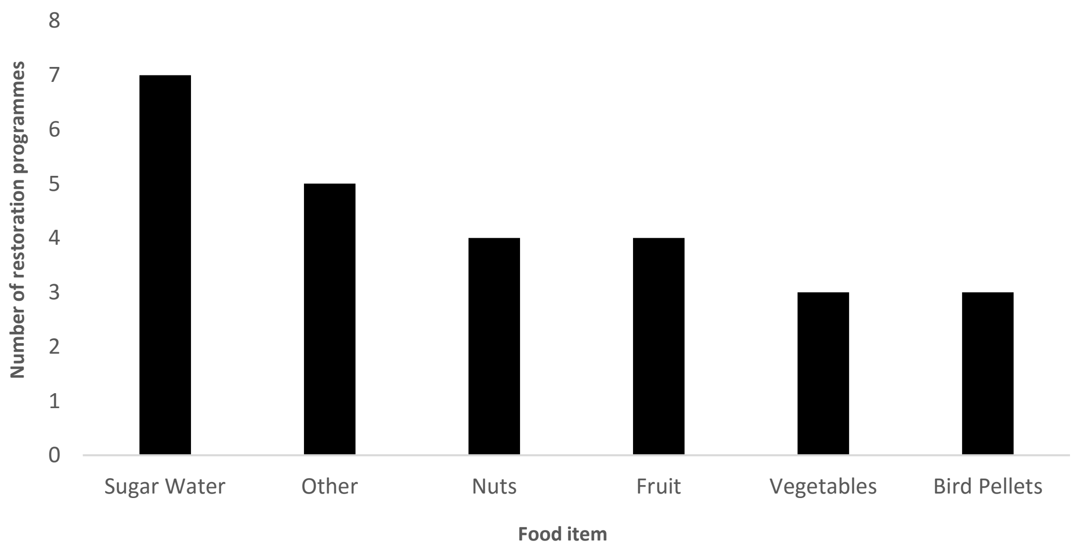

Figure 2.7 Food items used for supplementary feeding as part of New Zealand restoration programmes (n =10).

2.4.12 Monitoring

The respondents were asked whether they monitor any of the species that have been released in their management areas (refer Table 2.7). A clear majority (81.8%) has some form of monitoring in place, with a further 13.6% planning to do monitoring in the future.

Table 2.7 Existence of monitoring in the management areas

Use of monitoring in management area	%	N
Yes	81.8	18
No	4.5	1
Not at this stage (planned for the future)	13.6	3

The main methods of post-release monitoring (refer Figure 2.8) used are visual counts (77.8%) and banding (72.2%). Transmitters are used in 33.3% of the sites and "other" types include call counts and nest checks (27.8%). Only 5.6% of the sites used transponders in their birds.

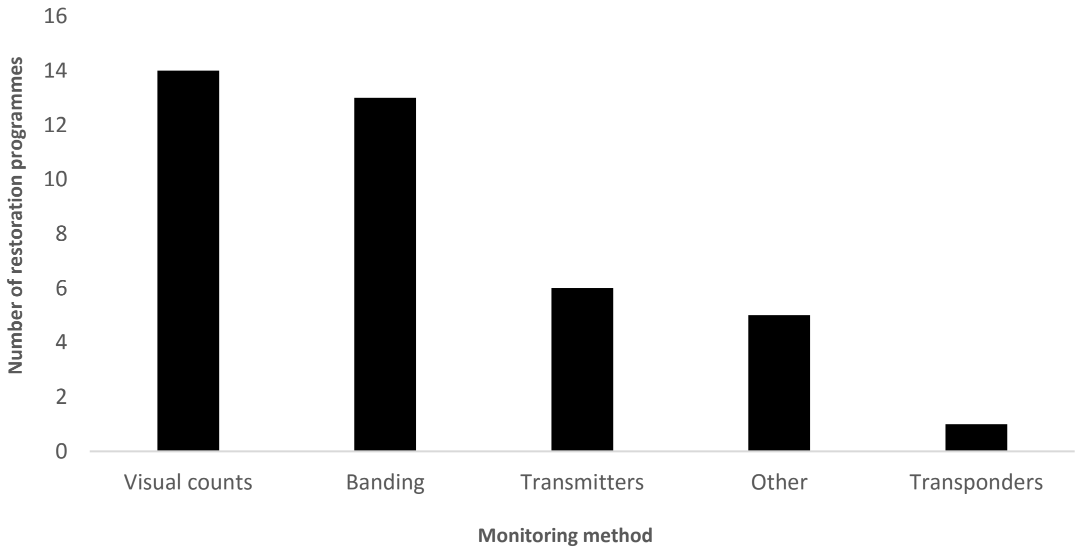

Figure 2.8 Monitoring methods applied in New Zealand management areas.

2.4.13 Population modelling data

It would be beneficial to have up to date information on population modelling data during the compilation of the recovery plan. Besides the plan, it would also be useful to see how many sites capture this type of data for future use. Respondents were therefore asked if they held data for their species on topics such as: carrying capacity, recruitment and mortality rates, survival rates and reproductive success (refer Figure 2.9). The three main types of data recorded by sites are census counts (89%), nest sites (56%) and adult survival rates (50%).

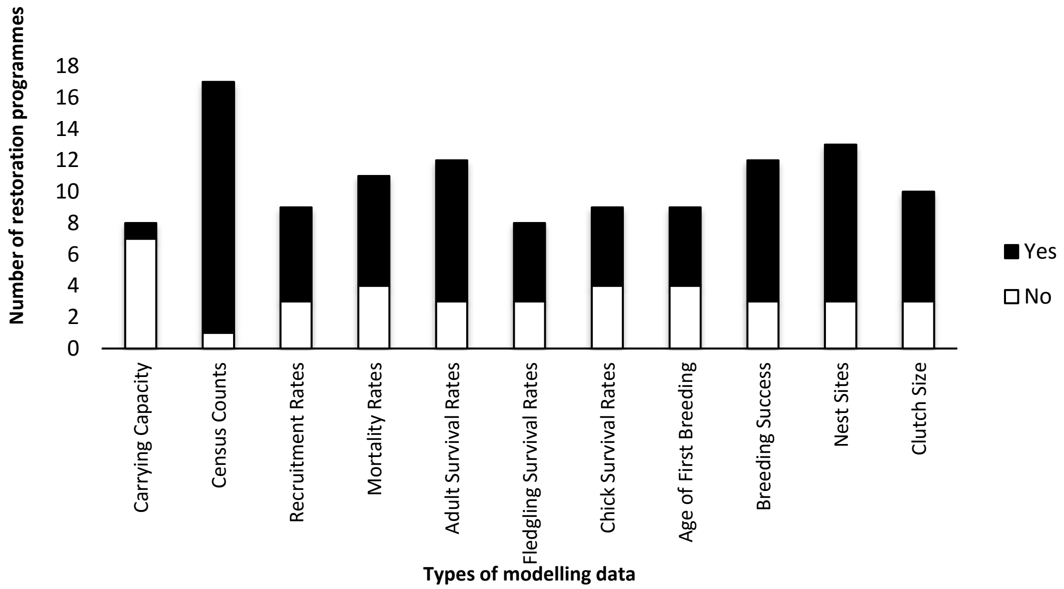

Figure 2.9 Population modelling data maintained for released species in New Zealand.

From those respondents that maintain population modelling data, 22.2% maintain this information for kākā. Those respondents that capture data on kākā were all willing to share this data for the purposes of the recovery plan.

2.4.14 North Island kākā participation

Respondents were asked whether they are or have been releasing kākā in their management areas (refer Table 2.9). Twenty-two point seven percent either released kākā in the past or are currently releasing kākā. An additional 18.2% are planning kākā releases in the future and a further 27.3% are interested in participating.

When asked if respondents believed that their management area would be suitable for kākā, the majority (57.1%) believed that it is, whereas only 4.8% believed that it is not (refer Table 2.9). An additional 38.1% were unsure; the plan should specify the requirements for kākā which in turn should help establish whether these sites are suitable for kākā.

Interestingly, when asked if North Island kākā naturally occur in their management areas, 50% of the respondents said “yes”, whereas 31.8% said “no”. A further 18.2% were unsure (refer Table 2.9).

For those sites that do have kākā in their management areas 27.3% have resident kākā and 27.3% have transient kākā, whereas 36.4% of the sites have both. An additional 9.1% were unsure (refer Table 2.8). The respondents were asked to estimate the North Island kākā population size in their management area, answers varied from as little as 13 birds to estimates of 188 birds. A total of 72.7% of respondents sighted kākā every day.

Table 2.8 Frequency of occurrence of North Island kākā in management areas.

Frequency of occurrence of NI kākā in management areas	Percent of responses
Resident	27.3%
Transient	27.3%
Both resident and transient	36.4%
Unknown/ Unsure	9.1%

Questions regarding kākā reproduction included whether the respondents have observed breeding behaviour in their management area (refer Table 2.9). The majority (72.7%) confirmed they have observed breeding behaviour, the last time this behaviour was noted was in the 2015-2016 season. Actual nesting behaviour was observed in 62.6% of the management areas, all of which reported to have observed nesting behaviour in the 2015-2016 season.

To find out whether sites would be able to provide birds for other release sites, respondents were asked if they could capture chicks for translocation (refer Table 2.9). This question is specifically to determine whether sites can access nest sites when required, 36.4% said they could capture chicks and a further 36.4% said they were unsure. Only 27.3% said they would not be able to.

Table 2.9 Overview of North Island kākā stakeholder survey responses (n =22) regarding current North Island kākā involvement and presence. MA = Management Area.

Survey question	Yes (%)	No (%)	Unknown (%)
Are you currently releasing North Island kākā in your MA	9.1	90.9	-
Is your MA suitable for North Island kākā	51.7	4.8	38.1
Do North Island kākā naturally occur in your MA	50.0	31.8	18.2
Has breeding behaviour of North Island kākā been observed in your MA	72.7	27.3	-
Has nesting behaviour of North Island kākā been observed in your MA	63.6	36.4	-
If breeding was successful in your MA, would you be able to catch chicks for translocation	36.4	27.3	36.4

To ensure that proposed kākā releases in the plan would not be compromised, respondents were asked whether there are any landowners near the management area that could be negatively impacted by kākā releases (refer Table 2.10). Most sites believed there were no issues to be expected regarding kākā causing problems once released in their management areas (54.5%), an additional 27.3% were unsure. A definite 18.2% of the sites advised there would possibly be some negative impacts, examples given were macadamia farms, forestry companies, general farms and gardens.

When asked if respondents could think of any aspects near their management area that could negatively impact on kākā once they were released, 40.9% said they believed there would be no issues and a further 40.9% were unsure (refer Table 2.10). Where respondents advised there would be issues (18.2%) examples given included lead roofs and public feeding.

Subsequently, respondents were asked what their release sites may require to be able to participate in the re-establishment of North Island kākā. Responses included topics such as more founders, larger areas (and pest control), increased volunteer numbers, funding for aviaries, support in determining sustainability/ suitability of site, husbandry expertise, staffing, strategies for anchoring birds and cooperation between sites.

Table 2.10 Measure of potential human – kākā conflict post release in management areas.

Survey question	Yes (%)	No (%)	Unknown (%)
Could landowners be negatively impacted by kākā releases	18.2	27.3	54.5
Could kākā be negatively impacted by aspects surrounding areas	18.2	40.9	40.9

2.5 Discussion

Questionnaires are a widespread and well recognised method used to test research hypotheses when subjective information is required from a target population. They are considered particularly suitable for collecting information on topics such as stakeholder perceptions in business management, community psychology, ecological management, large-scale studies, studies of human impacts on wild species, and interdisciplinary studies that include ecological and non-ecological components (White, *et al.*, 2005; Sterling, *et al.*, 2017).

Sterling *et al.* (2017) noted that despite at least four decades of calls for increased local stakeholder participation in biodiversity conservation, evidence on the efficacy of these efforts is only beginning to emerge. White *et al.* (2005) also found that the use of questionnaires in ecology had increased over the preceding decade. The University of Florida for example have distributed a short questionnaire to stakeholders to determine current problems and future research needs in restoration (Reinhardt- Adams & Wiese, n.d.) and the organisation River Restoration utilise a short project survey to determine whether new project applications meet the requirements for their support (River Restoration.org, 2018). However, in-depth questionnaires involving stakeholders of restoration projects have seldom been done.

The main goal of any restoration project is ultimately the recovery of a species or ecosystem. The success of a project does not only rely on researchers/scientists, it also requires input from stakeholders (such as land owners, local officials and tangata whenua) (Guerrero, *et al.*, 2017). The support that stakeholders provide may be just as crucial to the project as the physical work completed in the recovery project. Pragmatic arguments for stakeholder engagement include: 1) the possibility that increased diversity in decision making bodies may lead to higher quality decisions that are better adapted to the local social-cultural and environmental contexts; 2) development of common ground, trust and reduction of conflict between stakeholders; 3) stakeholder ownership may increase support and successful implementation; and 4) the potential for reduced implementation costs (Sterling, *et al.*, 2017; Reed, 2008; Woolsey, *et al.*, 2007). Therefore, if stakeholders are included from the beginning of the project, it can help achieve the restoration goals more efficiently.

Here, I used a stakeholder questionnaire to gather information about the past and current contributions release sites are making to restoration of native species, as well as establishing what their future expectations are regarding re-establishment projects with emphasis on North Island kākā re-establishment. The survey was distributed to 68 stakeholders based in the North Island of New Zealand and the response rate was 44%. This is above the generally accepted mean response rate for electronic surveys (Baruch, 1999; Cook, *et al.*, 2000), the reasons for this higher response rate could indicate the correct audience was targeted. To include stakeholders who are currently not involved in kākā re-establishment, but may potentially be interested in participation has not been recorded before. Recovery projects could greatly benefit by broadening their project to scope for future potential participation, such as I did for this research.

There were four overarching topics in the survey to establish suitability of the release sites for participation in the kākā recovery plan. These topics were: 1) habitat suitability and site description; 2) predator control; 3) release management and 4) participation in North Island kākā re-establishment.

First, to determine whether release sites currently meet the North Island kākā's habitat requirements, stakeholders identified the flora in their management sites. This demonstrated that nearly 40% of the sites have trees tall enough to meet nest site requirements for North Island kākā. Furthermore, only a third of the sites have aviaries on site to allow for soft-release (with some additional sites planning to build aviaries in the future). Additionally, only half of the sites have predator proof boundaries. For kākā re-establishment to have a chance to be successful sites need to ensure they meet the habitat requirements for kākā, such as providing sufficient nest boxes where trees are of insufficient height for nesting, building (temporary) aviaries to allow for soft-release and maintaining some form of predator proof boundary.

Second, questions relating to predator control identified that nearly 97% of sites have some form of pest control, with the majority providing continuous control. The main target species in the release sites are rats and stoats, the latter being the key threat to wild kākā populations. Considering predator control is the main factor in determining success in North Island kākā re-establishments (refer Chapter 3), the fact that most sites already conduct predator control, means that release sites already meet the requirement for kākā habitat to be free of predators. Interestingly, over 70% of the sites rely on volunteers to complete predator control. Even though the use of volunteers has many advantages (such as "free" labour), the disadvantage is that recruitment and retaining of volunteers can be just as costly, especially when regular commitment to the job is required (Brudney, 1993).

Third, questions regarding release management aimed at determining past success was covered by questioning the rating of re-establishment success. In general, there is an absence of uniform measures for rating the success of re-establishment programmes. The rating scales used in this survey are based in part on the systematic review that was completed as part of this thesis (e.g. Fischer and Lindenmayer (2000) stated that for their review a reintroduction was considered successful if it resulted in a self-sustaining population) and in part from the views of the researcher. It is important to note that these measures of success have been compiled without discussion with the global community, however, but could be considered for future research.

Furthermore, the survey identified that the most frequently used source of birds are translocated adults. In contrast, global parrot reintroductions recommend the use of juvenile birds especially for species with strong (natal) site fidelity (such as kākā). Additionally, most release sites used single release events of 10 specimens or more. Griffith *et al.* (1989) demonstrated that there is a substantial gain by dividing releases into multiple events. The survey showed that the preferred release method is hard-release and less than half of the release sites supplementary feed birds post-release. White *et al.* (2012) and Grajal and Sanz (2002) both noted that soft-release and supplementary feeding can help aid in the transition to new environments as well as promoting site-fidelity.

Finally, the questions relating to participation in North Island kākā re-establishment showed that a fifth of the stakeholders are planning to participate in kākā recovery, with a further quarter interested since the survey. The majority of the release sites are considered suitable for North Island kākā and half already have kākā occurring in the area naturally. Furthermore, human-wildlife conflict has been identified by the sites and in 18% of the sites there is some concern for potential damage that kākā may cause to surrounding farms and gardens. There are also potential health risks for kākā from lead roofs on nearby properties and public feeding of birds. Advocacy for kākā will be instrumental in reducing human-wildlife conflict prior to release in those areas.

The survey results demonstrate a range of management practices that release site managers apply to enable successful reintroductions. The results also reveal where there are similarities, which can be utilised to develop standardised reintroduction management practices. The differences in opinion on best practice may be related to the differences in species each site focusses on, or because there currently are no standardised techniques for all species.

A suggestion for further study is to increase cooperation between release site managers to enable more species to benefit from the successful management of areas (e.g. more emphasis could be placed on entire ecosystem restoration rather than individual species recovery programmes). As with most conservation activities, financial support is often a limiting factor, however cooperation between sites could assist in reducing costs (Sterling, *et al.*, 2017) and improving best practice techniques.

Interestingly, in New Zealand, where only three species of endemic large parrots remain, most restoration efforts are spent on other taxa such as Passeriformes. According to the Department of Conservation translocation summary database, just over 40% of translocations are for weka (*Gallirallus australis* spp), followed by saddleback (*Philesturnus* spp) (11.5%) and kiwi (*Apteryx* spp) (8.2%) (Department of Conservation, 1998). The Department of Conservation translocation register demonstrates that only 1.5% of approved translocations are for kākā (both subspecies), with the majority of translocations focussing on kiwi (*Apteryx* spp) (16.4%) and robins (*Petroica* spp) (11.6%) (Department of Conservation, 2016). Considering kākā are an indicator species for the New Zealand forests (Monks, *et al.*, 2013; Ministry for the Environment, 2007), it is surprising that kākā do not feature more in re-establishment projects.

The entire survey was completed with the use of an electronic survey tool. This method allows for fast communication between a researcher and the participants as well as a more efficient way of collating the data. On the other hand, this method is less personal and may have therefore contributed to a reduced number of stakeholders participating in the survey. Future surveys could also include hard copy questionnaires to be distributed or an initial introduction letter inviting stakeholders to participate on-line.

In conclusion, it is important to note that a relatively small number of release sites in the North Island completed the survey, therefore not all viewpoints or management methods were captured. It is possible that the results may not be a complete reflection of the types of management practices release sites are applying. Additionally, the viewpoints captured in this survey may not necessarily correspond to the viewpoints of release sites around the rest of New Zealand. At the same time, it has been a good indicator of the cooperative nature amongst release sites and organisations which in itself may justify further review.

This research can be used as an indication as to where kākā may be able to be released in the future (if areas are suitable), which is covered in the recovery plan. The combination of these data, together with the expert survey and systematic review, allows for a more detailed description of kākā requirements that in turn may enable successful re-establishments.

2.6 Acknowledgements

My thanks are extended to all the stakeholders who participated in this survey: Adam Willetts, Alison Wesley, Chris Smuts-Kennedy, Dale, Denis Asher, Denise Fastier, Elizabeth Kay, Gillian Wadams, Hans Pendergast, John Dawn, John Simmons, Judy Gilbert, Keith Buswell, Mandy Brooke, Mark McAlpien, Myfanwy Emeny, Neil Philips, Nicholas Singers, Pete Shaw, Peter Gaze, Richard Robbins, Rosemary Gear, Sarah Orton, Simon Collins, Steve Scott, Todd Jenkinson and the members of Matakohe Limestone Trust.

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Chapter 3 Kākā expert survey

3.1 Introduction

During my appointment as captive coordinator for North Island kākā (*Nestor meridionalis septentrionalis*), I would frequently hear statements regarding what people believe makes a re-establishment for kākā successful. In general, it is difficult to tell whether widespread beliefs are based upon the summation of a range of studies, from a well-designed experiment, from experience in one site, or from someone using their best guess as to the best approach (Sutherland, *et al.*, 2004). Considering very few of the statements relating to kākā re-establishment are captured in the published literature, important data explaining the reasoning behind the success or failure of a reintroduction might not be shared with the right people. This in turn can lead to other reintroduction projects starting off with the wrong information and therefore reducing their chance of success.

Previous research by Sutherland *et al.* (2004) found that current conservation practice faces the same problems as old-fashioned medical practice did. For example, most decisions are not based upon evidence, but upon anecdotal sources. Furthermore, very little evidence is collected on the consequences of current practice so that future decisions cannot be based upon experience. Much accumulated experience is solely in the memory of individual practitioners, and the collection of information in a form that could be used by others is very limited (Sutherland, *et al.*, 2004). Quantifying information acquired through grey literature and expert opinion is therefore impossible.

A major problem with defining a reintroduction programme as a success or a failure is that, by any criteria, this definition is limited in time (Seddon, 1999). Where one person might quantify success as initial survival post release, another may consider success only once successful breeding has taken place. Failure to objectively evaluate programmes could lead to the acceptance of practices that may be suboptimal and unevaluated practices may be adopted simply because they have been used in the past (Gusset, *et al.*, 2010). This could lead to detrimental results for future re-establishment efforts around New Zealand if evidence-based information is not conveyed properly.

The need to capture expert information on re-establishment of North Island kākā (to increase the success of future re-establishment efforts) led to the development of a survey which was distributed amongst several experts in the field of kākā re-establishment in New Zealand. Whether someone was considered an "expert" in the field of kākā re-establishment was based on their current or past contribution to reintroduction projects, sites or research. The main aim was to establish what the general opinion is on the factors that determine successful kākā re-establishments. These factors will be integrated in the draft recovery plan for North Island kākā (hereafter “the plan”).

The survey method used was the Delphi technique, this technique was developed by the RAND corporation in the 1950’s and its aim was to forecast the impact of technology on warfare (RAND Corporation, 2016). The method entails a group communication process that aims at conducting detailed examinations and discussions of a specific issue for goal setting, policy investigation, or predicting the occurrence of future events. Where common surveys try to identify “what is,” the Delphi technique attempts to address “what could/ should be” (Hsu & Sandford, 2007).

Mukherjee *et al.* (2015) found that the Delphi technique is relatively little used in ecology (five documents) or conservation (22 documents) in the last 60 years, even though it may be well suited particularly for dealing with biodiversity management issues that are equally complex and involve multiple stakeholders and trade-offs. There are four categories of the Delphi technique that are relevant for ecology and conservation: decision, scenario, policy and argument (Mukherjee, *et al.*, 2015). This thesis utilised the Delphi technique for decision making, which is like the examples noted by Mukherjee *et al.* (2015) where this type of decision making was used to develop a plan for wildlife conservation as well as design criteria and indicators for prioritisation of restoration efforts. This thesis used the technique for a combination of both examples.

3.2 Research objectives

This research had one principle objective which was “to capture expert knowledge on North Island kākā reintroductions and translocations”. I wanted to find out what factors determine the success of a re-establishment project. I therefore searched for people that have previously (or are currently) involved with kākā reintroductions, supplementations or translocations. Furthermore, I wanted the experts to consider their colleagues’ opinions and evaluate the priority levels for each factor. The final goal was to create a shortlist of factors that will determine the success of kākā re-establishment.

3.3 Methods

This research was conducted using SurveyMonkey®. SurveyMonkey® is an online survey development company that uses cloud-based software (SurveyMonkey, 2016). The decision was made to only email out links to the surveys (rather than sending out hard copies of the survey by standard mail) considering email responses would allow for easier administration (e.g. sending reminders) (Cook, *et al.*, 2000). Because of the quick turnaround with email responses and the limited amount of time available for the survey, it was decided this was the most appropriate method.

The survey (refer Appendix IV) was designed in line with the Delphi technique, this method is a widely used and accepted technique for gathering data from respondents within their domain of expertise. One of the primary characteristics and advantages of the Delphi technique is subject anonymity, which can reduce the effects of dominant individuals, which often is a concern when using group-based processes used to collect and synthesize information (Hsu & Sandford, 2007; Mukherjee, *et al.*, 2015). The goal is to reduce the range of responses and arrive at something closer to expert consensus (RAND Corporation, 2016).

The approximate size of a Delphi panel is generally under 50, however many Delphi studies have used between 15 and 20 respondents (Hsu & Sandford, 2007). For this research, the panel was established after a thorough literature search on kākā re-establishments and from my own knowledge as the previous captive coordinator for North Island kākā. This produced a list of 25 experts. One of the experts was approached to review the list of experts, this resulted in an additional eight experts. Once circulated an additional person was added to the panel as the main contact had permanently left the organisation that was approached.

The first survey was distributed on the 14th June 2016, followed by the second survey on the 4th July 2016 and the final survey on the 26th July 2016. The final survey closed on the 8th August 2016, 55 days after the initial contact with the panel, this is in line with Hsu and Sandford (2007) who suggest that a minimum of 45 days for the administration of a Delphi study is necessary. It is also recommended to give Delphi participants two weeks to respond to each survey (Hsu & Sandford, 2007). Therefore, each survey allowed the panel approximately two weeks to reply and reminder emails were sent out for each of the survey components on two occasions (at one week and three days prior to the surveys' close off dates).

3.3.1 Ethics

This survey was evaluated by peer review and judged to be low-risk. This meant that it did not need to be reviewed by the University's Human Ethics Committee. However, respondents were advised that any concerns could be raised via email to humanethics@massey.ac.nz.

3.3.2 Survey design

The actual surveys were developed in SurveyMonkey® and consisted of three questionnaires (refer Appendix IV). The Delphi technique solicits the opinions of experts through a series of carefully designed questionnaires interspersed with information and opinion feedback in order to establish a convergence of opinion (RAND Corporation, 2016). The number of questionnaires selected for this research was based on the report from Hsu and Sandford (2007) where they considered that three iterations were often sufficient to collect the needed information and to reach a consensus in most cases (Hsu & Sandford, 2007). The format of the questionnaires was as follows:

1) The first questionnaire is traditionally an open-ended question. In this study, the question was: In your professional opinion which factors determine successful Kākā re-establishment (list up to 15 factors).
2) Following the replies attained in the first round, the participants are sent a second survey in which they are asked to review the items provided in the first survey. In this case, the participants were asked to rank the 25 factors identified in the first survey according to importance (not at all important, slightly important, important, fairly important and very important).
3) Finally, the survey participants are sent a third survey which includes the factors and the overall ratings. The participants are asked whether they agree with the ratings and if they have any comments regarding their reasoning if they disagree. In this case, the participants were asked if they felt that the top five factors from the second survey are indeed the most important factors to determine successful kākā re-establishment.

3.3.3 Sample Size

To guide the selection of Delphi subjects, individuals are considered eligible to be invited to participate in a Delphi study if they have related backgrounds and experiences concerning the target issue, can contribute helpful input, and are willing to revise their initial or previous judgments to be able to reach or attain consensus (Hsu & Sandford, 2007).

A link to the first two surveys was initially emailed out to 32 experts in the field of kākā research or reintroduction. From these 32, one person advised that they felt they were not experienced enough to participate and one other person was no longer employed at the organisation that was contacted. Subsequently, an alternative person was contacted and a personal email address was located for the expert. One of the experts had provided an additional four email addresses for experts whose email addresses were not located earlier. A total of 35 experts were approached to participate in the surveys. The group was made up of 23 male and 12 female respondents. Furthermore, 14 out of the 35 were employed by the Department of Conservation at the time of the first survey. The remaining 21 experts have either previously been employed by the Department of Conservation or are involved in private kākā restoration projects and/ or academic research.

Thirteen experts did not reply to either the first or the second survey, and so were excluded from the final survey (refer Table 3.1). Therefore 22 (13 male and 9 female respondents) out of the 35 were asked to contribute to the final survey. The final survey was completed by a total of 16 (9 male and 7 female) respondents.

According to Kittleson (1997), electronic surveys can expect a response rate of between 25% - 30% (Cook, *et al.*, 2000), which would mean approximately ten experts would need to reply to meet this target. However, considering the research topic and the past involvement of these experts with kākā re-establishments, cooperation would be expected to be much higher than that.

Table 3.1 Kākā expert selection outcomes.

Email outcomes	Survey 1	Survey 2	Survey 3
Experts approached	32	34	22
Did not want to participate	1	0	0
No longer employed at organisation	1	0	0
Additional experts added	5	0	0
No response received	17	14	6
Completed survey	18	20	16
Response rate	51.4%	58.8%	72.7%

3.4 Results

3.4.1 Response rates

Questionnaire 1

The first survey ran from the 14th June 2016 to the 1st July 2016, with 18 out of the 35 respondents completing the survey (response rate 51.4%). This rate is above the generally accepted mean response rate for electronic surveys (34.66%) but slightly below the average response rate for paper surveys (55.6%) (Baruch, 1999; Cook, *et al.*, 2000).

Questionnaire 2

The second survey ran from the 4th July 2016 to the 19th July 2016, with 20 out of 34 respondents having completed the survey (response rate 58.8%). This rate is above the generally accepted mean response rate for electronic surveys (34.66%) and above the average response rate for paper surveys (55.6%) (Baruch, 1999; Cook, *et al.*, 2000).

Questionnaire 3

The final survey ran from the 25th July 2016 to the 8th August 2016, with 16 out of 22 respondents having completed the survey (response rate 72.7%). This rate is well above the generally accepted mean response rate for both electronic surveys (34.66%) as well as for paper surveys (55.6%) (Baruch, 1999; Cook, *et al.*, 2000).

3.4.2 Factors limiting kākā re-establishment

According to Wolf *et al.* (1996) there are 19 factors that influence the success or failure of translocations (refer Table 3.2). Although rigorous quantitative conclusions could not be drawn from their open-ended question regarding the perceived causes of the translocation outcomes, the responses were generally consistent with results obtained from quantitative analysis. Throughout their research, factors frequently identified as promoting translocation success or failure were predation, behavioural and species-specific characteristics and human-related elements. Staff experience was rarely cited as a factor contributing to success or failure (Wolf, *et al.*, 1996).

Table 3.2 Factors reported as influencing the success or failure of translocations. Data accumulated in response to the question: "What is your professional understanding as to the cause(s) of the outcome of this translocation?" (Wolf, *et al.*, 1996).

Influential factor	Self-sustaining	Declining	Gone
Habitat quality/ quantity	67	12	11
Public relations/ attitudes	26	0	0
Number of animals released	15	3	6
Habitat improvement	22	0	0
Predation	6	5	11
Species-specific traits	12	6	3
Hunting/ trapping/ poaching	13	3	1
Protection from human disturbance	13	0	0
Methodology (e.g. staff experience)	9	1	2
Source of individuals	8	2	1
Competition with other species	5	1	2
Stochastic environmental events	0	4	1
Number of releases	4	0	0
Purpose of translocation	4	0	0
Disease	0	2	1
Range in relation to historical distribution	1	0	1
Condition of animals	2	0	0
Number of years of releases	1	0	0
Miscellaneous (e.g. budget limitations)	1	0	4

In the first questionnaire of the expert survey, the respondents were asked to list a maximum of 15 factors that they believed contributed to a successful kākā re-establishment. In total 179 factors were identified, which equals an average of 10.1 factors per respondent. Once assessed the 179 factors were grouped into 25 overarching factors (refer Table 3.3). The most frequently proposed factors were habitat suitability, predator control and pre- and post-release training.

Table 3.3 Factors determining successful kākā re-establishment.

Factor #	Factor heading	Frequency
1	Age of birds released (juveniles preferred)	6
2	Assessment of impacts of kākā on wider release site	2
3	Birds released and release site must be disease free	7
4	Captive-sourced birds used for release	4
5	Community collaboration and receptive to kākā establishment	10
6	Genetically suitable birds used for release	7
7	Habitat suitable for kākā (includes nest and natural food availability)	23
8	Introduced Psittacines controlled (limits spread of disease and competition)	2
9	Kākā proof pest control techniques (e.g. traps and bait stations)	1
10	Large founder base from source population	10
11	Managing cause of local extinction/ decline prior to release	2
12	Multiple release events	3
13	No or minimal supplementary feeding after release	2
14	Post-release Monitoring	6
15	Predator control	20
16	Provide and manage predator proof nest boxes	6
17	Release season	3
18	Sex ratio balanced (close to 1:1)	4
19	Size of release site large enough to sustain viable population	7
20	Soft-release and pre-release training (e.g. anchoring by exposure to feeders and nest boxes)	18
21	Sound management of release site (e.g. financially stable and experienced)	11
22	Sufficient number of birds released	9
23	Supplementary feeding after release	9
24	Using captive birds for anchoring released birds	2
25	Vicinity of other kākā populations	5
	Total	179

3.4.3 Rating of factors

The 25 factors mentioned above were subsequently re-distributed to the experts in the second questionnaire. Respondents were asked to rate the importance level of each of the 25 factors according to the following scale: 1) not at all important; 2) slightly important; 3) important; 4) fairly important and 5) very important.

Based on the above ratings, the top five factors were (in order of importance) (refer Figure 3.1):

1) Predator control
2) Managing cause of local extinction/ decline prior to release of new birds
3) Habitat suitable for kākā (includes nest and natural food availability)
4) Sufficient number of birds released
5) Post-release monitoring

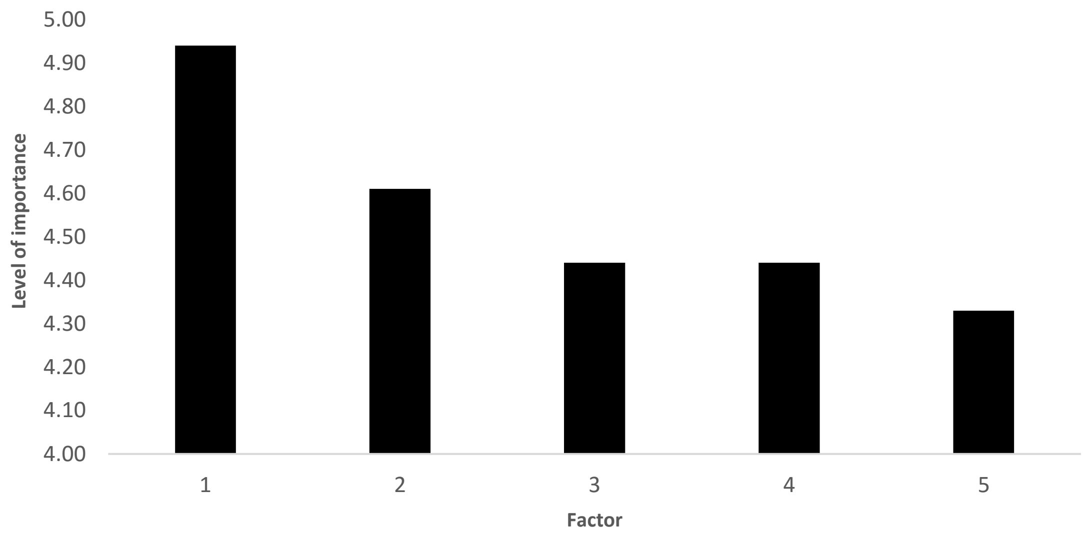

Figure 3.1 Top five factors determining successful kākā re-establishment, measured by importance level: 1) Predator control (n =17); 2) Managing cause of local extinction (n =18); 3) Habitat suitability (n =18); 4) Sufficient numbers released (n =18) and 5) Post-release monitoring (n =18).

The order of the remaining 20 factors indicate that all the factors are considered to be important to the success, however for the purpose of this research the top five were considered to represent the consensus.

3.4.4 Consensus

The top five factors for success were circulated to the experts in the final questionnaire, asking them whether they agreed that these were indeed the most important factors to a successful kākā re-establishment. The majority (68.8%) agreed with the top five. The remainder (31.3%) did not agree, with the most frequent comment being that they felt that post release monitoring does not affect the success but rather should be considered purely as a measure of the success.

3.4.5 Additional clarification questions

The experts were also asked to clarify a few questions, which came forward by reviewing the 179 factors.

The first question was what an acceptable level of predator control would be in the release area. It was interesting that none of the experts believed that both “no control” as well as “fully predator free” were required for successful kākā re-establishment. In general, the experts believe that the area should have low numbers of predators. The majority (81.3%) believe that these low numbers should be for stoats and possums. Out of the 81.3%, half of the experts also believe that there should also be low numbers for rats. What the exact Residual Trap Catch (RTC) rates should be to ensure an area is suitable for kākā is unclear at this stage.

The second question asked respondents how long kākā should remain in soft-release aviaries prior to release. The timeframe most frequently selected (30%) was two months, however, most of the experts (35%) opted for the “other” option. Their reasoning behind this selection indicated that there is no real standard currently. According to the experts the duration should depend on the source of the animals as well as the presence of resident birds in the area. The other timeframes selected were less than one month (20%) and three to four months (15%).

The final clarification question was how long kākā should be supplementary fed post release. Supplementary feeding of highly social species (such as psittacines) apparently promotes and facilitates site fidelity and flock cohesion. Both factors contribute to the social interactions necessary for pair formation and subsequent breeding efforts, which is a key component of reintroduction success (White Jr., *et al.*, 2012). The responses regarding the optimal duration of supplementary feeding was varied, most of the experts chose “continuous” or “more than 12-months post release”. Forty percent selected “other”. The comments indicated that there was no real agreement on a standard timeframe. Some experts noted that it should be determined based on the site. Others did not know for certain and therefore did not want to comment. White Jr. *et al.* (2012) noted that when releasing parrots to augment existing wild populations, supplementary feeding should be balanced with the need to optimize integration of released birds into wild flocks.

3.5 Discussion

The Delphi technique is a process that aims to develop a consensus of expert opinion, over several rounds of review, with the purpose of enhancing and validating formal and informal knowledge on a specific topic (RAND Corporation, 2016). The underlying assumption of this process is that combining the expertise of multiple individuals provides more accurate results than could be delivered by any one expert (Delbecq, *et al.*, 1975). The use of expert and specialist opinion is arguably an underutilised approach within conservation biology and biodiversity management. However, it has been applied to diverse conservation issues, for example, in the development of a habitat suitability index model for burrowing owls (*Athene cunicularia*) (Uhmann, *et al.*, 2001), in the analysis of the cost-effectiveness of woodland restoration (Macmillan, *et al.*, 1998) and in the development of a model to improve the quality of forest habitat for Western capercaillie (*Tetrao urogallus*) (MacMillan & Marshall, 2006).

For the conservation of biodiversity, a consensus of opinion can directly assist the use of this knowledge by conservation managers and practitioners. Here, I have used the Delhi method to develop a consensus on the factors important for the successful re-establishment of kākā populations. Three rounds of surveys of kākā experts were implemented and the response rates of all surveys was higher than 50% (more than 16 respondents participated in each survey). Among the experts surveyed, I found considerable consensus in the identification of factors that support successful kākā re-establishment. Due to this consensus, factors were subsequently grouped into a list of 25 general issues that affect successful re-establishment. Of these 25 factors, the top five was sent to the experts to establish consensus on the five main factors that need to be considered as a minimum when re-introducing kākā to the mainland. These factors were: 1) pest control, 2) managing cause of local extinction/ decline prior to release of new birds, 3) habitat suitable for kākā, 4) sufficient number of birds released, and 5) post-release monitoring.

First, predator control was determined to be the main factor that supports successful kākā re-establishment. It has been noted that in areas where no predator control takes place, kākā populations are small and declining, additionally they suffer from strong male sex-ratio skews. The strong male sex-ratio skews in turn affect sustainable kākā populations since there are insufficient breeding pairs to maintain a population, additionally, males may disperse from sites once they are of breeding age and in need of finding a female companion.

Second, managing the cause of local extinction or decline prior to the release of new birds was identified as being a high priority. The cause of extinction will vary per site, and could include causes such as increased competitor levels, human-wildlife conflict or habitat degradation. A SWOT analysis should be completed as part of the permit application to ensure that past causes are no longer of concern for the species once released. Some of the work required for this factor will be covered in the Government's plan to become predator free by 2050. Ecological restoration sites managers can obtain financial support to remove some of the known predators and competitors to kākā at their sites. Furthermore, advocacy can support in the establishment of further sites as well as promote awareness of the species to promote recovery projects success.

Third, ensuring the recovery sites are made up of suitable kākā habitat prior to permit approval is essential. Each (potential) release site or corridor should undergo a SWOT analysis, comparing the species requirements (as noted in the recovery plan) will help determine whether the site is currently suitable, or which actions need to be taken to make it more suitable. Aspects that need to be considered are the presence of (predator-proof) nest cavities and the availability of natural food sources. The latter will be supporting the ongoing sustainability of the populations, rather than promoting reliance on food supplementation.

Fourth, experts considered that each release site should have a sufficient number of birds released for the size of the site. Global parrot reintroductions have found that a minimum of 30 birds can support the recovery process. Furthermore, separating the time of release of these birds into multiple releases increases success (Robert, *et al.*, 2015; Grajal & Sanz, 2002; Griffith, *et al.*, 1989; Collar, 2006). Site analysis should be completed by the Department of Conservation appointed kākā coordinator (as recommended in the recovery plan), to ensure sound population management analysis takes place prior to approval of sites and selection of birds.

Finally, the fifth factor identified was post-release monitoring. As noted in the systematic review (refer Chapter 4) there is little evidence in the published literature about the after care of the recovery project. To determine success of a project, and to be able to increase management if needed, post-release monitoring is a crucial aspect of every re-establishment programme. Measurements such as survival rates, mortality rates, release conditions, breeding success, etc should all be captured and reported back to the kākā coordinator. Standardised templates for post-release monitoring should be circulated to site managers and post-release reports should be included in the permit conditions. Once the consensus for the top five priorities was checked, the feedback received on whether post-release monitoring should be included in the top five showed that some experts felt that post-release monitoring should have been excluded. It is possible that some experts have analysed the question differently than others, where they may have only considered the actual release itself, rather than the entire release project.

The abovementioned factors all indicate that the main aspect that is needed for kākā is the overall management of the species. There is a large amount of knowledge and experience in the kākā conservation community, however, the lack of coordinated efforts has limited the potential of the programme so far. The appointment of a coordinator can support the five factors (and the remainder of the factors as identified by the experts) and ensure that the species' requirements as well as the individual requirements for the sites can be considered appropriately.

Some of the other factors that were most frequently mentioned by the experts included: rigorous management of the release site to ensure that the projects are financially stable and the management of the site includes experienced personnel (n =11); community collaboration and establishing a community that is receptive to kākā recovery (n =10); as well as covering sound population management by ensuring a large founder base is used from source populations (n =10). Once assessed by all the experts, these factors rated eight, tenth and thirteenth respectively.

Interestingly, one of the three most frequently proposed factors (pre- and post-release training (n =18)) did not make it to the final top five factors once the rating had been calculated. My expectation was that training would be considered one of the most important factors influencing success as it was raised by almost all the experts. As the experts considered all 25 factors at once, it is likely that they deemed the training factor was less important compared to the other 24 factors.

The factors that were mentioned the least included: performing a complete assessment of impacts of kākā on the wider release site (n =2); control of introduced psittacines, thereby reducing the spread of disease as well as competition (n =2); minimal (or no) supplementary feeding post release (n =2); and utilising captive birds for anchoring of released individuals (n =2). Again, once all the experts ranked the importance of these factors, they rated over sixteenth place

Interestingly, two of the least mentioned factors were: managing cause of local extinction or decline prior to release (n =2) and using kākā proof pest control techniques (n =1), however, once assessed by the experts these factors became the second and sixth most important factors determining successful kākā re-establishment.

Overall, the factors mentioned by the kākā experts, are similar to the survey completed by Wolf *et al.* in 1996. However, each species involved in re-establishment programmes has specific requirements that need to be identified independently. It is therefore important to capture expert knowledge for both successful as well as failed aspects of re-establishment programmes. This information can support future plans for the species in other areas, and assist in the planning of other species around the world (Sutherland, *et al.*, 2004).

The Delphi technique was developed as a method to forecast the impact of technology on warfare. Today, the Delphi technique is an established method in a range of disciplines, such as medicine, nursing, social policy, tourism and sustainability science (Mukherjee, *et al.*, 2015; Warner, 2017). Despite its increase in use, it currently still has a limited number of users in the field of conservation biology.

I felt that the Delphi technique was useful in establishing a consensus on the factors that impact kākā re-establishment. In a relatively short timeframe, experts could have an indirect input in the development of a recovery plan. Being able to complete the survey when it suited them best, away from the influence of other expert's opinion made the data more valuable in my eyes. I think the resulting response rate indicate that the correct target audience was approached. As for why some of the experts did not participate, it is possible that (as was the case for one of the respondents) they felt they were not experienced enough or they merely preferred not to participate in a longer-term survey. The last could potentially be eliminated in future research situations if the research surveys are accompanied by an introduction from an authority on conservation (e.g. the Department of Conservation). For future re-establishment projects, I recommend the use of the Delphi technique to ascertain the expectations, possibilities and limitations that are currently part of the programme, and whether these ideas are merely entrenched in the mind of a conservation manager or whether the conservation community agrees with these views.

The results show that despite the complex aspects of a re-establishment, twenty experts can (without consultation with each other) create a thorough list of factors affecting success and reach consensus on the five most important factors. Based on this research, it is recommended that this style of capturing expert knowledge/ experience could be used for other species' recovery plans or for wildlife conservation purposes in general. Additionally, the Delphi technique does not require participants to be brought together physically which in turn makes this method more efficient in terms of time and cost.

Similar to the stakeholder contribution survey (refer Chapter 2) there is the possibility that the electronic survey has excluded some participation in this survey. Where people might be receiving many emails a day, it is easy to overlook some or where someone might have the intention to complete a survey they might not find the time to complete it before the due date. It could be useful to send a hard copy invitation in advance to attempt to increase participation. Furthermore, it may have been harder for someone to commit to a longer-term survey participation if they are away at any stage during the survey period.

In conclusion, there are only a small number of experts on kākā re-establishment, mainly due to the limited number of reintroduction programmes involving kākā. There are currently only six sites that have released kākā in the North Island, some of these sites have had great success whereas others are currently still in the early stages of their re-establishment (Joustra, 2015).

This research has been used to support a draft recovery plan for North Island kākā. The combination of these data, together with the stakeholder contribution survey and the systematic review, allow a more detailed description of kākā requirements to enable successful re-establishments.

3.6 Acknowledgements

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Additional thanks go out to Terry Greene for providing me with some additional suggestions to my list of experts.

Chapter 4 Global psittacine re-establishments: A systematic review

4.1 Introduction

The purpose of this systematic review is to establish which psittacine species have been part of re-establishment projects and the methods that were applied to these projects. More generally, my aim was to determine whether there are any similarities in projects worldwide that lead to success or failure of a re-establishment programme. These data presented here were then used to support the compilation of the draft recovery plan for North Island kākā (*Nestor meridionalis septentrionalis*). This review will be particularly helpful in areas where there is overlap in requirements between North Island kākā and other psittacines. This chapter is the first systematic review on avian re-establishments.

Systematic reviews have primarily been used to inform evidence-based policy and practice in human medicine, but more recently this approach has been extended to conservation and environmental management (Gusset, *et al.*, 2010). Even though there is much information available regarding reintroductions of mammal species, to date the only published systematic review which is related to re-establishments was completed by Gusset *et al.* (2010) and dealt with reintroduction success of African wild dogs (*Lycaon pictus*). Similarly, there is a large quantity of information available on bird reintroductions. When it comes to systematic reviews however, there is hardly anything available in the published literature.

As a group, psittacines are generally non-territorial, flocking, canopy dwelling species that present unique challenges to researchers and managers. Consequently, traditional ornithological theory and techniques do not always transfer or readily apply to members of this avian taxon (Brightsmith & White, Jr., 2012) hence why this systematic review is limited to psittacines only. A comparison with other avian taxa would likely return information that could not be applied to North Island kākā due to their biological or behavioural differences. The data obtained during the systematic review are included in the development of the recovery plan.

4.2 Research objectives

The objective of this study was to investigate the factors that contribute to the success or failure of re-establishment programmes globally, with particular reference to species similar in biology and behaviour to North Island kākā.

4.3 Methods

This research was conducted by performing a systematic review. A systematic review is associated with rigorous methodological and statistical protocols to minimise bias and improve transparency and repeatability of a literature review (Cook, *et al.*, 2013). A good systematic review follows strict criteria for assessing the quality of data in each study (Sutherland, *et al.*, 2004). These criteria make systematic reviews more comprehensive and less open to potential bias than other review formats that summarise the literature in an unstructured way (Cook, *et al.*, 2013; Collaboration for Environmental Evidence, 2013). Systematic reviews start with a question, rather like primary research, but unlike the latter, systematic reviews collect and synthesise existing data in order to attempt to answer the question (Collaboration for Environmental Evidence, 2013).

4.3.1 Literature Search

A literature search was completed between March and September. During this time, two electronic databases were consulted (Web of Science and Google Scholar). Two other databases (DogPile and AlltheWeb) were reviewed for additional articles that were not already covered in the first two databases. Most of the search results in DogPile (2,231) and AlltheWeb (109,266) were either already covered in the original search, or included search results that were unrelated to the topic.

In accordance with guidelines from the Collaboration for Environmental Evidence (2013), individual terms should be combined where appropriate using Boolean operators (‘AND’, ‘OR’, ‘NOT’, ‘SAME’, etc.). Based on this, the following search strings were used for Web of Science and Google Scholar:

1) Psittacine “AND” reintroduction “OR” re-establishment “OR” re-establishing “OR” translocation “OR” translocate “OR” release “OR” captive “AND” release “OR” soft-release “OR” restoration

2) Psittacidae “AND” reintroduction “OR” re-establishment “OR” re-establishing “OR” translocation “OR” translocate “OR” release “OR” captive “AND” release “OR” soft-release “OR” restoration

Additional search terms were tested initially to review their relevance to the topic, some of these terms were excluded based on their non-relevant returns (refer Table 4.1).

Table 4.1 Terms excluded from literature review and reason for exclusion.

Term	Reason for exclusion
Parrot	High return of unrelated data (mainly focussing on pet parrots)
Introduction	Irrelevance to intervention, where introduction tends to refer to behavioural studies (e.g. introducing animals together)
Supplementation	High return of unrelated data (mainly refers to diet related studies such as vitamin supplementation)
Transfer	Irrelevance to the topic, where transfer tends to refer to disease related studies (e.g. transmission of disease)
Recovery	Irrelevance to the intervention where recovery tends to refer to health studies (e.g. recovery from anaesthetics)

The functionality of different literature databases varies considerably and terms that are useful in one source will not always be appropriate in others (Collaboration for Environmental Evidence, 2013). Search strings were adapted for each database as indicated in paragraph 4.3.2 (inclusion and exclusion criteria).

Further consideration was given to publication databases including ResearchGate (30 hits); DeepDyve (125 hits); JSTOR (40,731 hits); ScienceDirect (1,678 hits) and CAB Direct (168 hits). One of the publication databases (ResearchGate) was fully compared to the data captured in the other electronic databases. All the search results were already covered in the electronic database searches, hence why the publication databases were further ignored.

Additional searches were completed in data sources previously identified in a general literature search. These sources included the Avian Reintroduction and Translocation Database from Lincoln Park Zoo (Lincoln Park Zoo, 2016), the IUCN Global Reintroduction Perspectives series (Soorae, 2016) and the Department of Conservation translocation databases (Department of Conservation, 2016).

4.3.2 Inclusion and exclusion criteria

Before the initial literature review was completed, individual articles were verified for eligibility. Considering that searches must balance sensitivity (getting all information of relevance) and specificity (the proportion of articles that are relevant) (Collaboration for Environmental

Evidence, 2013), the following requirements were necessary for an article to be considered for inclusion:

1. Relevant subject: Psittaciformes only
2. Relevant intervention: Re-establishment programmes for the purpose of native species recovery
3. Relevant outcomes: Discusses success or failure of the programme
4. Relevant countries: Include all global programmes
5. Relevant timeframes: All available data

4.3.3 Data collection and analysis

Data analysis was completed in accordance with the systematic review process as described by the Collaboration for Environmental Evidence (2013). Their guidelines are intended as a standard for the conduct of systematic reviews and takes the researcher through the five key stages of the review process: 1) initial consideration; 2) identifying the need for evidence and systematic review; 3) planning the review; 4) conducting the review and 5) dissemination and reporting on the outcomes of the review.

Collection of articles started on the 1st March 2016 and was completed by the 30th September 2016. To assist in the effective dissection of the articles, a data extraction form was designed in Microsoft Word 2016 (refer Appendix V). Additionally, this type of form also allows for efficient data comparison once the review is completed.

Once all the data were reviewed and recorded on the data extraction forms, the data were collated in a Microsoft Excel 2016 spreadsheet. This spreadsheet captured a variety of data under four main topics as captured on the form: 1) article details (including publication type and verification of the study); 2) bird data collection (e.g. the species and release details); 3) environmental data collection (relating to the location and methods of release) and 4) project rating (whether success indicators were identified and if the project was deemed successful).

4.4 Results

4.4.1 Databases

The two electronic databases (Web of Science and Google Scholar) together returned 1,016 results. Following this, a removal of duplicates and a review of titles and abstracts narrowed the potentially relevant articles to 56. These 56 articles were screened by reading the full texts, which led to a further 46 articles be excluded as the full text did not match the relevant intervention or the relevant outcome of the project. The data in the remaining ten articles were fully extracted in the excel spreadsheet.

A further search was completed on the internet and in journals to find additional articles related to the topic that may not have been returned during the database review. An additional 74 results were identified by reviewing species which have been reintroduced and analysis of reintroduction newsletters. All 74 articles were included in the abstract review. During the abstract review phase, an additional 32 articles were excluded and data from the remaining 42 articles were extracted in the excel spreadsheet (refer Table 4.2).

Table 4.2 Outcomes of electronic database and hand searches.

Database	Results	Excluded immediately	Taken to abstract review	Excluded after abstract review	Final useable articles
Web of Science	202	189	13	9	4
Google Scholar	814	771	43	32	6
Hand search	-	-	74	32	42
Totals	1,016	960	130	78	52

4.4.2 Review of double up studies

During the data extraction phase, it was found that some articles covered multiple species. These were all treated as separate entries, therefore a total of 66 studies were recorded in the excel spreadsheet. These 66 studies comprised 15 articles returned during electronic database searches and 51 articles returned during hand searches.

Once this extraction phase of the review was finalised an assessment for additional double-up articles was completed. Twenty-eight articles were determined to be double-ups, as they included projects that were either captured in follow-up studies or were part of a summary for the species in a larger report. Once all double-ups were removed from the database, there were

38 unique studies remaining for the final aspects of the systematic review (refer Table 4.3). These studies were described in 31 publications.

Table 4.3 Double up articles removed during extraction phase of the systematic review.

Database	Hits
Number of articles remaining	52
Number of projects/ studies described (in 52 articles) - Electronic (15) - Hand searches (51)	66
Double up articles removed	28
Unique projects/ studies remaining (in 31 publications)	38

4.4.3 Publication information

From the 38 articles identified during the systematic review, most were dated between 2001 and 2010 (refer Figure 4.1). It appears that publishing data on re-establishment projects has decreased in the last 7 years. Additionally, many articles did not clearly state a publication year. These articles were summaries found on the Avian Reintroduction and Translocation Database (Lincoln Park Zoo, 2016).

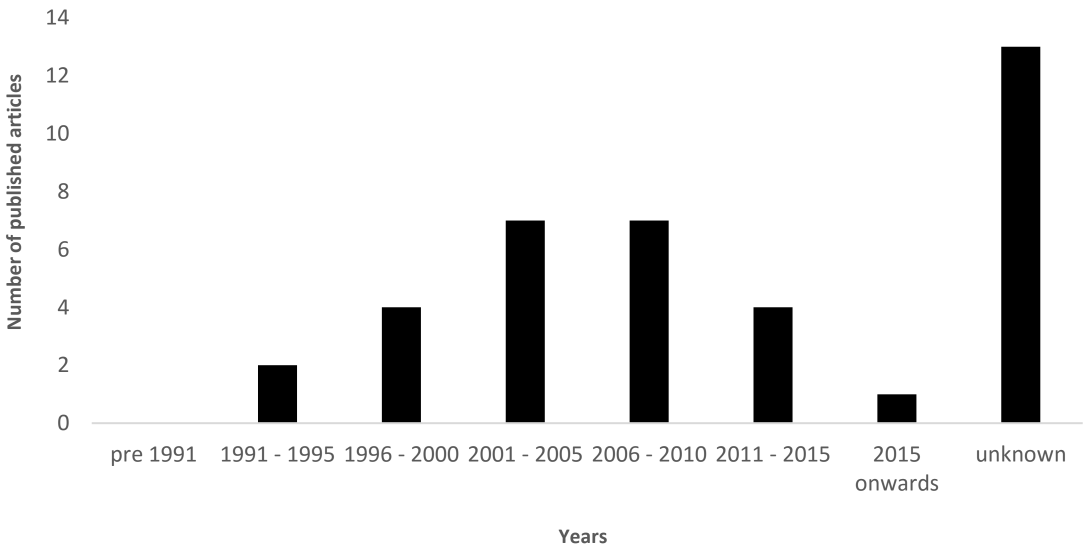

Figure 4.1 Number of publications per five-year period (n =38).

4.4.4 Species

A total of 31 publications with 38 articles relating to psittacine re-establishments were found, covering only 7.5% of all Psittaciformes species (n =414). The small percentage is surprising as the parrot order is one of the most endangered avian groups in the world (White Jr., *et al.*, 2012).

The species covered in the review ranged in IUCN threat classifications as follows: CR = 8 species (21.1% of the global psittacine data); EN = 12 species (31.6% of the global psittacine data); VU = 4 species (10.5% of the global psittacine data); NT = 6 species (15.8% of the global psittacine data) and LC = 8 species (21.1% of the global psittacine data). Despite the small percentage of parrot species covered in the literature, it is encouraging to see that the majority of re-establishment projects focus on the more endangered species rather than the more common species.

Table 4.4 Articles relating to Psittacine re-establishments.

Review Nr	Article	Author	Species
1	The Spix's Macaw Conservation Programme	(Schischakin, 1999)	*Ara maracana; Cyanopsitta spixii*
22	Reintroduction of the Scarlet Macaw to Playa San Josecito, Golfito	(Varela-Benavides & Janik, 2008)	*Ara macao*
34	The Tambopata macaw project: Developing techniques to increase reproductive success of large macaws	(Brightsmith, 2001)	*Ara ararauna; Ara chloroptera; Ara macao*
45	The use of hand-raised psittacines for reintroduction: A case study of scarlet macaws (Ara macao) in Peru and Cost Rica	(Brightsmith, *et al.*, 2005)	*Ara macao*
47	Optimal allocation of captive-reared Puerto Rican parrots: decisions when divergent dynamics characterise managed populations	(Collazo, *et al.*, 2013)	*Amazona vittata*
56	Reintroduction of the Scarlet macaw in the tropical rainforest of Palenque, Mexico: project design and first year progress	(Estrada, 2014)	*Ara macao cyanoptera*
63	Ultramarine lory update	(Kuehler & Lieberman, 1993)	*Amazona vittata*
73	The release of captive-bred echo parakeets to the wild, Mauritius	(Woolaver, *et al.*, 2000)	*Psittacula eques echo*
78	Reintroduction of kākā, kiwi and kōkako to Pukaha/ Mt Bruce forest	(Adams, 2005)	*Nestor m. septentrionalis*
85	Bird reintroductions to Karori Wildlife Sanctuary	(Empson, 2003)	*Nestor m. septentrionalis*
88	Reintroductions to Karori Sanctuary	(Empson, 2006)	*Nestor m. septentrionalis*
89	Reintroductions to Maungatautari	(Smuts-Kennedy, 2007)	*Nestor m. septentrionalis*
89a	Rimatara lorikeets to Atiu, Cook Islands	(Lieberman & Gourni, 2007)	*Vini kulii*
96	Successful reintroduction of captive-raised Yellow-shouldered Amazon parrots on Margarita Island, Venezuela	(Sanz & Grajal, 1998)	*Amazona barbadensis*
101	Survival of captive-reared Hispaniolan parrots released in Parque Nacional del Este, Dominican Republic	(Collazo, *et al.*, 2003)	*Amazona ventralis*
102	Military macaws in Guatamala	(Wille, 1992)	*Ara maracana*
108	Reintroduction of Yellow-crowned parakeet to Long, Mana and Motuara Islands	(Adams & Cash, 2010)	*Cyanoramphus auriceps*
109	Reintroduction of Vinaceous Amazon parrots in the state of Sao Paulo, Brazil	(Saidenberg, *et al.*, 2013)	*Amazona vinacea*
110	Reintroduction of the Vinaceous-breasted Amazon at the Araucarias National Park, Santa Catarina, Brazil	(Kanaan, 2016)	*Amazona vinacea*
111	Avian Reintroduction and Translocation Database – Red-lored Amazon	(Lincoln Park Zoo, 2016)	*Amazona autumnalis*
112	Avian Reintroduction and Translocation Database – Yellow-shouldered Amazon	(Lincoln Park Zoo, 2016)	*Amazona barbadensis*
114	Survival of captive-reared Puerto Rican parrots released in the Caribbean national forest	(White Jr., *et al.*, 2005)	*Amazona vittata*

115	Avian Reintroduction and Translocation Database – Blue and Gold Macaw	(Lincoln Park Zoo, 2016)	*Ara ararauna*
118	Avian Reintroduction and Translocation Database – Golden-capped conure	(Lincoln Park Zoo, 2016)	*Aratinga auricapillus*
121	Avian Reintroduction and Translocation Database – Orange-fronted kākāriki	(Lincoln Park Zoo, 2016)	*Cyanoramphus malherbi*
122	Avian Reintroduction and Translocation Database – Red-crowned kākāriki	(Lincoln Park Zoo, 2016)	*Cyanoramphus novaezelandiae*
123	Avian Reintroduction and Translocation Database – Orange-bellied parrot	(Lincoln Park Zoo, 2016)	*Neophema chrysogaster*
124	Avian Reintroduction and Translocation Database – South Island kākā	(Lincoln Park Zoo, 2016)	*Nestor meridionalis meridionalis*
125	Avian Reintroduction and Translocation Database – North Island kākā	(Lincoln Park Zoo, 2016)	*Nestor meridionalis septentrionalis*
127	Avian Reintroduction and Translocation Database – Thick-billed parrot	(Lincoln Park Zoo, 2016)	*Rhynchopsitta pachyrhyncha*
128	Avian Reintroduction and Translocation Database – Kākāpō	(Lincoln Park Zoo, 2016)	*Strigops habroptilus*
130	Avian Reintroduction and Translocation Database – Ultramarine lorikeet	(Lincoln Park Zoo, 2016)	*Vini ultramarina*

4.4.5 Distribution

There are an estimated 414 species of Psittaciformes, which can be found on all continents except for Antarctica. The literature review, however, demonstrates that the focus of parrot conservation is restricted to a few continents: Africa (1 species); North America (9 species); South America (13 species) and Oceania (15 species).

Additionally, there was no notable difference in the number of projects carried out on the mainland (n =20 or 53%) versus islands (n =18 or 47%).

4.4.6 Types of re-establishment programmes

A comparison between the types of re-establishments demonstrated that most of the re-establishments were for “reintroduction” (15 projects) and “supplementation” (10 projects). Some projects involved “reintroduction and subsequent supplementation” (1 project) or “translocation” (2 projects). “Translocations only” were used for five projects and “translocation followed by subsequent supplementation” was used for one project. Where it was not clearly specified whether a species was already present in the area the type of re-establishment was recorded as “unknown” (four projects).

4.4.7 Release events and numbers of birds

The number of the release events per project (the number of times that the species has been released to re-establish the population as part of the same project) varied between one and 24 events. However, many of the projects had two events (10.5% of the projects), followed by one, four and six events (all approximately 8% of the projects). Unfortunately, approximately 37% of the projects did not list the number of release events (refer Figure 4.2).

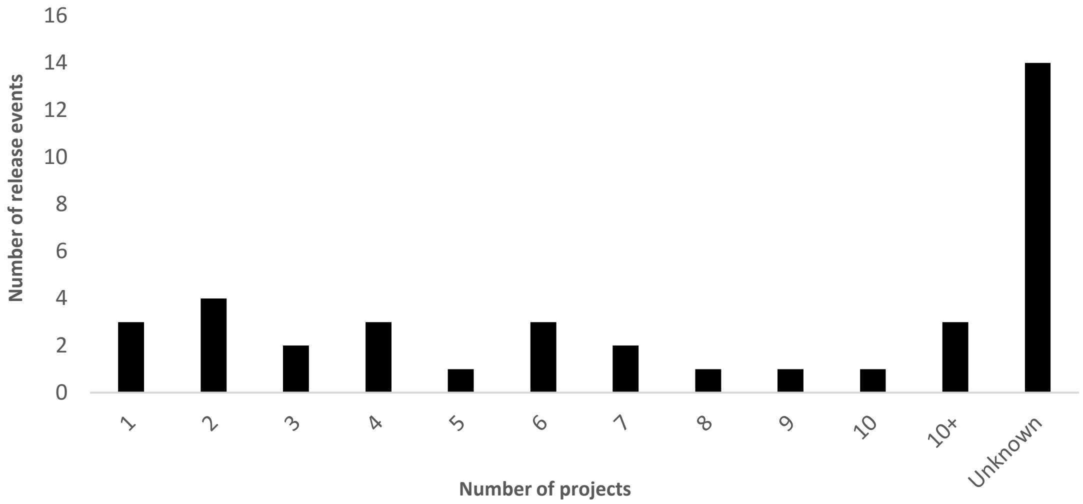

Figure 4.2 Number of release events per project (from systematic review data).

The total number of birds released per project also varied quite substantially from a single female Spix's macaw (*Cyanopsitta spixii*) in Brazil to 314 Orange-bellied parrots (*Neophema chrysogaster*) in Australia. Most projects released either 27 birds or more than 100 birds (both 10.5% of the projects), this was closely followed by 6 birds (7.9% of the projects). It is likely that the number of birds released per project depends on the availability of birds, the location where birds are to be released and the funding available for the releases.

The timing of the release events was not captured in the majority of articles (56.8%). Out of the 19 that reported the season of release, 63.2% (n =12) released in summer and autumn, with only three and four releases in spring and winter respectively.

4.4.8 Source of birds

During re-establishments, project managers need to determine whether they use captive or wild-sourced birds. The majority of projects utilised captive birds only (44.7%), whereas 34.2% used wild caught birds only. An additional 7.9% used both captive and wild birds and a further 13.1% did not clearly specify which birds they used for their projects.

Previous research on animal relocations (Fischer & Lindenmayer, 2000), also indicated that the majority of their 116 projects involved captive-sourced animals (44.8%) rather than wild-sourced animals (38.8%). A possible explanation for the difference in sources is that release permits for captive-sourced birds require that the post-release outcomes are written up as part of the permit conditions.

In 15 out of the 38 projects there was no age category recorded for released birds. For those that did capture the age categories of their released individuals, most projects used juvenile birds only (43.5%) or a combination of juveniles and adults (39.1%). In 17.4% of the projects only adult birds were released.

A few projects (23.7%) described the use of hand-reared birds in their re-establishment projects. Sixty-six percent of these projects used hand-reared birds only, the others used a combination of hand-reared as well as parent-reared birds.

4.4.9 Predator management

In only one of the projects was it specifically mentioned that the release area was fully predator proof fenced. In 34.2% of the projects there was no fencing, and in 63% of the projects the presence or absence of a fence was not disclosed.

Only two projects (5.2%) indicated that the release area was fully free of predators. In 26.3% of the projects predators were present in the release area and a further 68.4% did not mention the presence or absence of predators in the area.

The majority of the reports (55.3%) did not indicate that they performed predator control in the release area, however, in 42% of the projects there was no predator control in the release area. Only one of the projects (2.6%) indicated they completed predator control.

It is important to note that globally the main threats to parrots are habitat loss and poaching for the pet trade. Introduced pests have proven to be a serious threat to some parrot species (Moorhouse, *et al.*, 2003), however these species may not have been described in this review.

4.4.10 Release management

Soft-release (acclimatising) was the main method of release for the projects (55.3%), hard-release (direct, no delay) was used in 5.2% of the projects and another 5.2% of the projects used both methods. Again, there were some articles (34.2%) that did not clearly indicate whether soft- or hard-release was utilised.

For the projects that did use soft-release, the duration of the acclimatisation period varied considerably from between one week to one year. The most frequently used timeframe was six months (13% of the projects) followed by one month (10.5% of the projects). Some of the projects that held birds for six months decreased their acclimatisation period upon subsequent releases.

Supplementary feeding was used in 44.7% of the projects, an additional 44.7% did not specify whether supplementary feeding was used. Only one project (2.6%) specified that supplementary feeding was not used and a further 7.9% used supplementary feeding in some cases but not in all. The duration of the supplementary feeding varied from one week to more than one year. The majority of the projects noted that supplementary feeding was offered continuously, which I assumed to be at least for the duration of the project.

4.4.11 Success measures

There is no general agreement on what constitutes a successful reintroduction, although a variety of definitions of success have been discussed: breeding by the first wild-born generation; a three-year breeding population with recruitment exceeding adult death rate; an unsupported wild population of at least 500 individuals; the establishment of a self-sustaining population; or first-year survival > 0.50 and released birds breeding with conspecifics, either captive-reared or wild (Seddon, 1999; Brightsmith & White, Jr., 2012).

Only twenty-one articles captured some success measures such as breeding success post release, and individual mortality and survival rates. In 27 of the projects (71%) the released individuals did indeed breed, whereas only one case reported that no breeding took place (the Spix's Macaw, where the female died a couple of months' post-release) and another where breeding had potentially occurred. In nine of the projects (23.7%) there were no data on breeding observations. Where data was recorded, most reported no clear timeframe of the breeding success.

Mortality rates were only available (or able to be calculated) in 44.7% (n =17) of the projects (refer Figure 4.3). Mortality rates varied between 4.76% and 60% (and one case of 100% due to the loss of the single animal that was released). Where cause of death was recorded, the majority included predation or trauma (e.g. due to collision with power lines).

In 44.7% (n =17) of the projects survival rates were recorded (or able to be calculated) (refer Figure 4.3). Survival rates varied between 30% and 100%, however the timeframes were not all identical due to the duration of the post monitoring period (e.g. some only measured survival one-week post-release, whereas others measured survival one-year post-release).

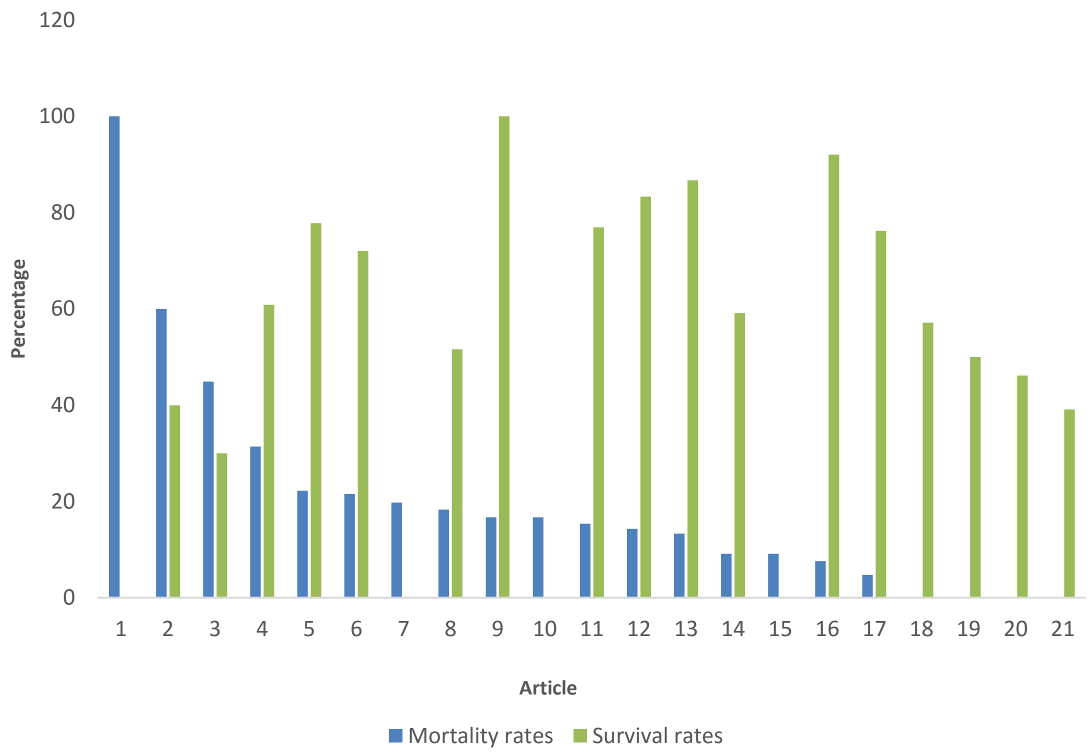

Figure 4.3 Minimum mortality and survival rates post-release for psittacine species.

Given there is no uniform standard for measuring success, the projects' outcomes were only included if there was an opinion recorded. Half of the articles did not specify whether a project was considered successful or not. In the authors' opinions only one project was considered a "failure" (2.6%), two (5.3%) were considered "partially successful", 12 (31.6%) were "successful" and four (10.5%) were "highly successful". It is important to note that the opinions on failure or success can vary quite substantially based on definition of success.

4.5 Discussion

In this study, I used a systematic review to establish which psittacine species have been part of re-establishment projects and the methods that were applied to these projects. The advantage of a systematic review is that it incorporates strict methodological and statistical protocols for assessing the quality of data in a study (Cook, *et al.*, 2013; Sutherland, *et al.*, 2004). The protocols used in systematic reviews should clearly state the question addressed, how and where the documents were searched and the criteria used to select the final dataset (Lowry, *et al.*, 2010). The underlying purpose of systematic reviews is to establish evidence-based policy and practice for a particular subject. Even though the use of quantifiable data is a common occurrence within conservation biology, it is less common in the field of species reintroductions, with only one other systematic review (on wild dogs in South Africa) captured in the published literature (Gusset, *et al.*, 2010).

For reintroduction projects, a thorough review of similar species' reintroduction requirements can support the development of species recovery plans here in New Zealand. Here, I used this technique to review 1 090 database and hand searched results. After disregarding irrelevant articles and removal of double up articles the remaining 38 projects (in 31 publications) were utilised to investigate the factors that contribute to the success or failure of re-establishment programmes globally (restricted to psittacine species only). Notable issues that I discovered during the systematic review included: there is no definition of success; detail on projects is limited; project managers do not specify the outcomes of the project;

Similar to the stakeholder contribution survey, it was hard to define "success" of re-establishment programmes. During the reintroduction of African wild dogs, survival and breeding of the release generation was considered a pragmatic criterion for short-term reintroduction success (Gusset, *et al.*, 2010). Fischer & Lindenmayer (2000) demonstrated that success was reported for 116 cases as follows: 30 (26%) were classified as "successful", 31 (27%) were classified as "failure", while the outcome of 55 (47%) reintroductions was classified as "unknown" at the stage of publication.

The majority of the articles that were used in this review lacked detail in relation to the re-establishment projects. It is recommended that more re-establishment projects are published in articles that are made available to other re-establishment communities. These articles should cover the entirety of the project (e.g. from the planning phase through to capturing post-monitoring results). It is important that articles either include more detail about the project or offer a method for acquiring the background detail. This type of information could be very valuable to other re-establishment projects. Ideally a template could be circulated amongst re-establishment projects to ensure all parties capture the same information as a minimum. This could potentially be distributed via the IUCN's Reintroduction Specialist Group

In this review, half of the projects did not specify their outcomes. It is important to note that there is no definition of re-establishment success that project managers can refer to when determining the success of their re-establishment projects. Going forward it would be recommended that a definition of success would be agreed upon on a global level. Again, this could be initiated or distributed through the IUCN's Reintroduction Specialist Group.

Even though this review did not clearly indicate whether the number of birds released was linked to success of the project, previous research demonstrated that releasing approximately 100 individuals led to a higher chance of success than releasing fewer individuals (Fischer & Lindenmayer, 2000).

Aside from the number of birds released, there are other factors that can determine success, including ecological factors such as habitat quality, genetics or competition. In addition, non-ecological factors may affect reintroduction success. The latter factors include public relations and education, good team management, social factors, legal considerations and litigation costs as well as long-term commitment to the reintroduction project (Fischer & Lindenmayer, 2000). Most of these non-ecological factors are not clearly described in the articles found during the systematic review, but it is recommended that this type of detail be included in future articles.

The most recurring issue during the systematic review was the lack of detail that is captured in the published literature on parrot re-establishment projects. This caused many of the articles to be excluded from the review altogether. Furthermore, this systematic review appears to be the first to cover re-establishment success of psittacines to date. To support parrot conservation globally it should be considered that all future re-establishment projects are published in some form to allow research comparisons in the future. This in turn could assist in better preparation of future re-establishment projects. Whether a project is published will ultimately depend on the personnel involved and the time available to write up details, however as a minimum, notes should be shared to allow the data to be maintained rather than lost when personnel leave.

Publications should include failed attempts as well to ensure a full understanding of re-establishment issues is captured

I anticipated finding a larger number of articles that could be included in the review, however, according to the guidelines utilised during the review, a high-sensitivity and low-specificity approach is often necessary to capture all or most of the relevant articles available, and reduce bias and increase repeatability in capture. Typically, a large number of articles are therefore rejected (Collaboration for Environmental Evidence, 2013). Additionally, this review appeared to be in line with a systematic review completed on African wild dog reintroductions, where the internet search engine returned 378 results (after removal of duplicates), of which 22 were deemed relevant and 32 were considered possible leads (39 URL's were not available) (Gusset, *et al.*, 2010).

In the past, systematic reviews have primarily been used to inform evidence-based policy and practice in human medicine, but more recently this approach has been extended to conservation and environmental management (Gusset, *et al.*, 2010). The use of systematic reviews in reintroduction biology however is yet to be recognised.

A disadvantage of systematic reviews, particular of unpublished literature, is that they can be highly time-consuming and can often include irrelevant material. For this thesis, the systematic review was completed over a seven-month period by a single researcher; the time period was not predetermined. Towards the end of this period, finding suitable articles was becoming increasingly sporadic hence although continued searching may have uncovered additional material the cost of doing so outweighed the advantage. In hindsight, the study would have benefitted from a time/ search limit. Despite this, the results I obtained from the review have proven useful to the development of the recovery plan for North Island kākā. If I had restricted my research to kākā only, I would have limited myself in the possibility of obtaining data that has ultimately assisted in the compilation of the plan.

In conclusion, considering that there are 414 species of Psittaciformes, it is surprising that so few projects (22 species) have been reported on in the literature. This could mean that few re-establishment projects focus on the Psittaciformes or that their reintroduction efforts are not captured in the literature. Sutherland *et al.* (2004) found that the consequences of conservation action are rarely documented; my results show that this appears to be the case for psittacine re-establishments. Furthermore, my research demonstrates that a greater focus on psittacine re-establishments may be justified as they are one of the most endangered avian groups in the world. I anticipate that the findings from this thesis will have a positive effect on future commitments to psittacine re-establishment projects.

Chapter 5 Recovery plan: North Island kākā
(*Nestor meridionalis septentrionalis*)

Foreword

This threatened species recovery plan is a draft version which will be sent to the Department of Conservation for comment and sign off. The intent of this draft is to encourage the finalisation of an in-depth approach to the recovery of North Island kākā (*Nestor meridionalis septentrionalis*) on the mainland of New Zealand. If the plan is accepted it would be reviewed in 2028, or sooner if new information or technology leads to a significant change in management direction. In the meantime, this plan should 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'.

There is currently no dedicated Recovery Group or Recovery Plan for kākā. I was previously the captive coordinator for North Island kākā and during my tenure, it became clear that a recovery plan for the species could benefit current and future planning for the species' re-establishment around the North Island. It is important that the Department of Conservation assign responsibility of the management of this plan to a coordinator(s) (or establish a recovery group of responsible people) to ensure that progress in implementation of the final plan is monitored and where required this person(s) will recommend to managers any changes that may be required in management.

Drafts will be sent to relevant conservancies for comment and to people or organisations with an interest in the conservation management of kākā. Changes to the plan will be made following consultation. The recovery planning process provides opportunities for further consultation between the Department of Conservation, tangata whenua and others regarding management of this species.

Threatened species recovery plans are statements of the Department of Conservation's intentions for the conservation of a species of plant or animal, or group of species during 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; and
- Stimulate the development of best-practice techniques and documents, which can be transferable across similar species recovery programmes.

This draft version was developed as part of my Masters of Science thesis and is based on the collation of data available on North Island kākā biology, ecology and re-establishment as well as the latest data available on global psittacine reintroductions. Additionally, the opinions of kākā experts as well as stakeholders are considered in the development of the topics and objectives as listed in the plan. The layout of this plan is based on published recovery plans for species such as takahē (*Porphyrio hochstetteri*), kiwi (*Apteryx* spp) and whio (*Hymenolaimus malacorhynchos*) (available on: http://www.doc.govt.nz/about-us/science-publications/series/threatened-species-recovery-plans/).

Contents

North Island kākā (*Nestor meridionalis septentrionalis*) recovery plan

2018 - 2028

Tineke Joustra

Abstract

The North Island kākā (*Nestor meridionalis septentrionalis*) is an endangered species that is listed as Nationally Vulnerable under the New Zealand Threat Classification System (2013) due to a significant decline in abundance and distribution. Active management is needed to ensure the species' long-term survival, as kākā are dependent on *in situ* management in suitable forest habitats, and require protection from the key threat of stoat (*Mustela erminea*) predation. This is the first national recovery plan for North Island kākā and follows on from previous research reports (i.e. 'Research plan for kākā (1996 – 2002)' and 'Research summary and options for conservation of kākā') as well as the 'PVA for Kea and Kākā'.

This 10-year plan is a guide for the Department of Conservation (DOC) and interest groups involved in conserving North Island kākā. Its first priorities are to secure populations to a minimum of 650 pairs at five 'Natural Stronghold Sites' as well as 50 – 150 pairs at 'Existing Release sites' throughout New Zealand by 2028. To achieve this, the kākā recovery programme will control introduced predators, and target research towards gaining a further understanding of kākā biology, threats and management requirements.

The second priority is to select new release sites and corridors to encourage the natural dispersal of kākā around the North Island. The recovery programme will continue to investigate translocation/re-establishment techniques and improved predator control management. Public awareness, education and community involvement are important tools that will be used to assist the recovery of kākā.

Keywords: *Nestor meridionalis septentrionalis*, North Island kākā, captive breeding,

threatened species recovery, predation, habitat quality.

1. Introduction

The North Island kākā (*Nestor meridionalis septentrionalis*) is endemic to New Zealand. Kākā were originally widespread and common around the North Island, however their distribution has decreased significantly, with numbers remaining low in remnant tracts of virgin podocarp/ hardwood forest and on off-shore islands. Kākā are an iconic species for New Zealand, and are an indicator species for New Zealand forests and its inhabitants.

The kākā's decline is attributed to habitat destruction and degradation, and to direct predation and competition by introduced mammals. Today, kākā are classified as 'Nationally Vulnerable' under the New Zealand Threat Classification System (NZTCS). The IUCN red list ranks kākā as 'Endangered' because its small population is estimated to be declining very rapidly, owing to the effects of introduced competitors and predators.

Stoat (*Mustela erminea*) have been identified as the main agent of decline for kākā at some sites, and are also one of the most manageable threats. Consequently, stoat control is the main focus of management activities in this plan. Kākā are protected on some predator-free offshore islands, and some mainland islands where predator control occurs. However, there has been no nationwide approach to re-establishment of the species throughout its former range. Current efforts are very *ad hoc* and uncoordinated. Kākā survival on the mainland is dependent upon in-situ management of key threats as well as increased collaboration between stakeholders.

The goal of this recovery plan is to ensure the retention of viable wild kākā populations throughout their natural range, by protecting the species at their 'Natural strongholds' as well as at five 'Existing release sites". These sites range in requirements from research on sex-ratio skews to population analysis to determine population viability. Second-priority are the 'Proposed release sites', these sites are suggested areas where releases should occur in line with the overall aim to re-establish the species around the entire North Island. Additionally, a corridor strategy to link the various sites is considered, giving suggested areas for habitat improvement in preparation for future kākā distribution.

Prior to engaging in the reintroduction process it is necessary to have good knowledge of the species basic biological needs, its biotic and abiotic habitat needs, its interspecific relationships and any critical dependencies (IUCN/ SSC, 2013), for this purpose this re-establishment plan starts with a description of the biology of kākā, followed by habitat requirements.

2. Plan term and review date

Term of the plan: 10 years, from February 2018 to February 2028

Review date: February 2023

3. Context

3.1 Overview of species

3.1.1. Taxonomy

The New Zealand *Nestor* parrots (kākā and kea) are globally significant because, together with *Strigops* parrots (kākāpō), they form a 40+ million-year-old (Ma) superfamily (Strigopoidea) that is a sister taxa to all other parrot species (Tennyson, *et al.*, 2014). The *Nestor* and *Strigops* genera comprise an ancient New Zealand lineage that diverged from all other parrots with the break-up of Gondwana circa 85 million years ago (Powlesland, *et al.*, 2009). Molecular research indicates that the kākāpō and *Nestor* lineages separated 23-29 Ma. The separation of the kākā and kea lineages has been dated to 2.3- 4.4 Ma (Tennyson, *et al.*, 2014).

Kākā in turn evolved into four distinctive taxa within the New Zealand archipelago (Norfolk Island kākā *Nestor productus*[4], Chatham Island kākā *Nestor* n.sp.[5], North Island kākā *Nestor meridionalis septentrionalis* and South Island kākā *Nestor meridionalis meridionalis*) (Tennyson, *et al.*, 2014). The exact taxonomic status of North and South Island subspecies is unknown as there are no genetic or consistent morphological differences in the skeletal structure between the subspecies (Powlesland, *et al.*, 2009; Sainsbury, *et al.*, 2006; Dussex, *et al.*, 2015). Additionally, the mobility of the bird (Cook Strait may not be wide enough to be a geographic barrier for kākā) further questions the validity of the existing distinction between North and South Island subspecies (Moorhouse & Greene, 1998).

3.1.2. Species ecology and biology

The kākā is an endemic parrot species found only in New Zealand's forests. Kākā are large and often quite noisy birds that tend to call loudly from tall emergent trees (Greene, *et al.*, 2010). The kākā is strictly arboreal in its habits (Buller, 1873).

Kākā are sexually dimorphic. Standardised measurements of weight, culmen length and depth are significantly greater in male North Island kākā. There is no significant variation in plumage

[4] Extinct mid – late 1800's (BirdLife International, 2016)
[5] Extinct 1500's (Millener, 1999)

colouration between the sexes and no readily detectable sexual differences in calls (Greene & Fraser, 1998).

The kākā is a medium sized parrot measuring approximately 45cm in length (tail to beak) and weighing from 350 to 690gr (Powlesland, *et al.*, 2009; Department of Conservation, 2016). On average, the female is smaller than the male. Additionally, the male's beak is longer and wider than the female's beak (Moorhouse, *et al.*, 1999; Wilson, *et al.*, 1998), with measurements included in Table 3.1.

Table 3-1 Average kākā measurements *(Moorhouse, et al., 1999)*.

Variable	Male	Female
Culmen length (mm)	48.9	42.5
Culmen depth (mm)	18.5	16.3
Culmen width (mm)	12.7	12.0
Body mass (g)	454	403

The plumage on the forehead and crown are greyish-white and the nape is greyish-brown. Neck and abdomen plumage is more reddish, while the wings are brownish. Both sub-species have a strongly patterned brown/green/grey plumage with orange and scarlet flashes under the wings. Colour variants can be found showing red to yellow colouration, in particular on the breast. South Island kākā are generally larger with more vivid colouring than the North Island Kākā (Department of Conservation, 2016).

Kākā are mainly diurnal but are active at night during fine weather or a full moon. Kākā are a gregarious species, with flocks of kākā gathering in the early morning and late evening to socialise. During the day kākā are less sociable (Department of Conservation, 2016). Non-breeding kākā are essentially solitary (Moorhouse, 1997). Little is known about the ecology of kākā populations within podocarp or other northern mainland forests where they still occur (Moorhouse & Greene, 1998).

Kākā are estimated to live over 20 years in the wild (Leech, *et al.*, 2008). In captivity kākā live over 40 years (with the oldest recorded ages in captivity being 42 years for females and 47 years for males) (Joustra, 2016).

Breeding biology

Given the apparent dependency of kākā on periodically superabundant food crops (masting events) for successful breeding, mast fruiting trees may have played a major role in the evolution of their reproductive biology (Moorhouse, 1997; Beggs & Wilson, 1991). Kākā are episodic breeders regardless of habitat (Powlesland, *et al.*, 2009) and are breed as infrequently as once every four to five years (Moorhouse & Greene, 1998). However, captive kākā can nest every year on a completely artificial diet, which suggests that adequate nutrition alone is sufficient to induce nesting (Moorhouse, 1997; Joustra, 2015).

Foraging activity increases approximately a month prior to breeding (Moorhouse, 1997). Kākā breed between October and July, however, breeding intensity is strongly influenced by the size of the seed crops produced by certain forest trees, this being the principle food of nestlings and fledglings (Moorhouse, *et al.*, 2003). In seasons when most radio-tagged females nested at Waipapa and Whirinaki, egg-laying occurred about a month earlier than in seasons when only a small proportion of females nested (Powlesland, *et al.*, 2009).

Pairs can fledge two broods in one year if seed crops are sufficiently abundant (Moorhouse, *et al.*, 2003), females that failed at their first breeding attempts at Waipapa and Whirinaki occasionally produced a replacement clutch (Powlesland, *et al.*, 2009). The mean clutch-size and largest clutches of kākā are greater than those of the kea and kākāpo (both 2.5 and 4). Powlesland *et al.* (2009) believe that the larger mean clutch-size, compared with those of similar-sized parrots, reflects the kākā's irregular breeding.

Table 3-2 Kākā reproduction and life history parameters.

Parameter	**WILD**		**CAPTIVE**		**Source**
	Estimated	**Range**	**Approx.**	**Range (years)**	
Age at first reproduction (female)	4	1 - unk	8.11	1 - 9	(Leech, *et al.*, 2008; Moorhouse, *et al.*, 2003; Joustra, 2016)
Age at first reproduction (male)	Unknown	-	10.11	1 – 21	
Age at post-reproduction (female)	>20	-	29	-	
Age at post-reproduction (male)	>20	-	31	-	
Longevity	>20	-	42		(Joustra, 2016)
Breeding Season	Oct - Jul	-	May - Feb	-	(Greene & Fraser, 1998; Moorhouse & Greene, 1998; Joustra, 2016)
Peak egg laying	Nov - Dec	-	Oct – Jan	-	
Clutch size	4	3 - 8	2.8 chicks	1 – 10 chicks	(Moorhouse, *et al.*, 2003; Powlesland, *et al.*, 2009; Joustra,
Incubation period	20-23	-	24 days	-	(Moorhouse, 1997; Moorhouse, *et al.*, 2003; Joustra, 2016)
Nestling period	60	-	60 days	-	
Fledgling period	120	-	120 days	-	

The mean egg-laying Interval is 3.5 days; similar to that of large (>400g) Cacatuidae parrots that lay clutches of 1-4 eggs (Powlesland, *et al.*, 2009). Kākā incubation time is 20-23 days (Powlesland, *et al.*, 2009; Joustra, 2016; Jackson, 1963). Powlesland, *et al.* (2009) found that eggs had a mean length of 41.5mm ±1.25mm and maximum breadth was 31.5mm ± 0.83mm, these measurements were similar to those in captivity being 40mm x 30mm (Joustra, 2016). The average sized kākā egg weighs approximately 22.4g (or 5.61% of mean female body weight at 400g) (Powlesland, *et al.*, 2009).

Incubation is solely by the female, with the male calling her off the nest at regular intervals and feeding her nearby. Generally, males with incubating mates approach to within about 20m of the nest trees and call. Females invariably emerge and fly with their mates circa 50m from the nest, where they will be fed regurgitated food (Powlesland, *et al.*, 2009). Parrots of the genus *Calyptorhynchus* (Cockatoos) have the same incubation behaviour, where the female incubates and the male feeds her. However, for each of the four *Calyptorhynchus* species for which information is available, the number of times females were fed during the day was 1-4, much less often than the 8-12 times of the kākā (Powlesland, *et al.*, 2009; Jackson, 1963).

Kākā hatching success ranges from 39 to 66%, depending on locations; predator-free off-shore islands have higher success than mainland sites. It is likely that many nests may be missed due to early predation (P. Gaze, 2017. Pers.comm). In comparison, hatching success of large (>400gr) Cacatuidae parrots in Australia varied from 60 to 76% (Powlesland, *et al.*, 2009). Low productivity, such as low annual fledging rate, is commonly observed in many mainland kākā populations and attributed to mammalian predation. Another cause of low productivity is annual variability in food availability (Van Horik, 2011).

Poor hatching success is often characteristic of bird populations with low genetic diversity. Studies by Sainsbury *et al.* (2006) found that despite substantial levels of genetic variation, there is little genetic difference between kākā populations throughout New Zealand (Powlesland, *et al.*, 2009; Sainsbury, *et al.*, 2006).

The pair bond between male and female kākā usually remains stable throughout the duration of the breeding season when any fledglings become independent (Greene & Fraser, 1998). Furthermore, pairs can remain paired for subsequent years (Powlesland, *et al.*, 2009).

Nestlings

During the first 10 days after hatching, kākā nestlings are covered in white down, and their eyes are closed. When not being brooded, they huddle closely together, raising their heads only when stimulated by the female. Between 10 and 20 days, nestlings develop a dense covering of grey down, have partially open eyes, develop the ability to sit up on their haunches, move about readily, including to the edge of the nest floor to defecate, and respond quickly to the female entering the cavity by stretching up to be fed. Between ages 21 and 30 days, nestlings' eyes open fully, development of remiges begins to extend beyond their down, and nestlings become active about the base of the nest cavity, rather than mainly remaining huddled together. Nestlings aged 31-40 days old develop a partial covering of contour plumage, but their remiges and rectrices are still growing. At 41-50 days of age, kākā nestlings are almost completely covered by contour plumage, especially towards the end of this age class. These nestlings spend much time chewing on cavity walls and attempting to climb up to the entrance if they are in deep cavities. For nestlings of age classes 51-60 and 61-70 days, their contour plumage is essentially complete, but some primaries and all rectrices are still developing. When not asleep, they interact with each other, sometimes quite noisily, preening and attempting to climb to the nest entrance (Powlesland, *et al.*, 2009).

Fledglings

Initially kākā fledglings are poor fliers, some ending up on the ground and remaining there for 3-4 days until strong enough to either climb into the canopy or fly away. Fledglings on the ground usually attempt to hide under low vegetation or logs, fledglings in vegetation perch in under-storey shrubs and trees, or in the canopy (Powlesland, *et al.*, 2009).

Diet

Kākā feed on fruits, berries, seeds, flowers, buds, nectar, sap, plants and invertebrates (Berry, 1998; Innes, *et al.*, 2010). The beak is used to obtain seeds from trees, to remove bark to feed on sap and to dig out invertebrates. Its brush tongue is used to enable feeding on nectar (Charles & Linklater, 2013). Feeding on wood or bark dwelling invertebrates was the predominant foraging activity of kākā on Kapiti Island over most of the year (Moorhouse, 1997). The kākā feeds on sap by removing bark from a range of tree species. Although kākā have a diverse diet, sap is an important seasonal food source and considerable time may be spent foraging for sap (Charles & Linklater, 2013). Like all honey-eaters, kākā act as pollinators of a range of tree species (Buller, 1873).

Moorhouse (1997) noted that in the North Island, sap-feeding appeared to be restricted to female kākā, making it consistent with observations of South Island kākā populations. However, Charles and Linklater (2013) found that sap feeding by females was not significantly more than expected by chance. Furthermore, observations of males and juveniles sap feeding suggest that sap is not only a supplementary food for females before breeding, but is important across the lifecycle for both sexes. Additionally, they found that sap feeding is unlikely to be necessary to meet energy needs since supplementary feeding in Zealandia does not prevent sap feeding in Wellington. Further provision of supplementary food is therefore unlikely to be an effective strategy for reducing sap foraging damage (Charles & Linklater, 2013).

Breeding during mast fruiting years

Kākā are described as episodic breeders regardless of habitat, with timing of reproduction closely linked to mast production of seeds and fruit (Greene, *et al.*, 2004). It is unusual for species (other than raptors) not to attempt to breed due to insufficient food resources (Moorhouse, 1997). Kākā have been found to predominantly breed in full beech mast seeding years, which occur on average every 4–6 years (Leech, *et al.*, 2008). Increases in the productivity of kākā associated with increased food supplies occur in the season prior to heavy seedfall. They appear to anticipate masting events and breed prior to the peak in seedfall (O'Donnell & Hoare, 2012).

Greene *et al.* (2004) found that the consistent trend linking diet with productive breeding seasons was the mast fruiting of kahikatea, rimu, and to a lesser extent mataī and miro. In the Waihaha Ecological Area (WEA), most tagged females (73-94%) attempted to breed only when there was mast fruiting of podocarps (in 1997/98; 1998/99 and 2001/02). Similarly, at Whirinaki, when there was mast fruiting of podocarps most tagged females bred (69-89%) (in 1998/99 and 2001/02). In the non-masting breeding season of 2000/01 at both the WEA and Whirinaki, a small proportion (5-29%) of females bred. Overall, at the two North Island podocarp forest sites, a significantly higher proportion of females bred in masting years than non-masting years (Powlesland, *et al.*, 2009).

In summers when mast fruiting of podocarp trees occurred, kākā had long breeding seasons where the season extended over 8 months in some years (Powlesland, *et al.*, 2009). Additionally, at Whirinaki in the mast-fruiting seasons of 1998/99 and 2001/02, two out of four unsuccessful females re-nested and 67% of six unsuccessful females re-nested respectively, but none of the females re-nested in the 2000/01 breeding season when mast fruiting did not occur (Powlesland, *et al.*, 2009).

Mast fruiting can be predicted from phenology observations 18 months prior to food ripening (Powlesland, *et al.*, 2009), which can allow for more targeted protection of kākā and more successful breeding. The amount of beech seed fall in a year is a clear indicator of predator levels and predation risk over the subsequent year. Furthermore, beech seeding indicates that food resources are sufficient for kākā to breed (O'Donnell & Hoare, 2012), this in turn supports the need for increased predator control around mast fruiting years.

3.1.3. Status and species recovery phases

The kākā is currently classified as 'Endangered' under the IUCN redlist classification system. Its status was upgraded from 'Vulnerable' to 'Endangered' in 2005 (following an upgrade from 'Near Threatened' to 'Vulnerable' in 1994) (BirdLife International, 2016). Under the New Zealand Threat Classification System kākā are classified as 'Nationally Vulnerable' (Robertson, *et al.*, 2013). The criteria used for this ranking is that there is a moderate population (1 000 - 5 000 mature individuals) with a trend that is declining (10-50%).

The Department of Conservation's Recovery Action Model has four phases (refer Appendix I): 1. Research – identify cause and key agent(s) of decline; 2. Security; 3. Recovery and 4. Maintenance. The various managed populations of North Island kākā fall into the second or third phases. In general, the agent/s of decline of the kākā have been identified, in some areas (e.g. Great Barrier, Little Barrier and Kapiti Islands) the species is secure from immediate extinction and recovery has been established. In other areas, the population continues to decline and to achieve recovery more intensive management is required. Kākā will remain under some level of threat and require ongoing management for the foreseeable future.

3.1.4. Past and present distribution

Although once widespread and common throughout New Zealand in the 1800's, they began to decline between 1885 and 1900. By 1930 their distribution had become localised (Wakelin, 1991; Powlesland, *et al.*, 2009). Today, kākā are uncommon and are continuing to decline throughout their historical range (they now populate less than 20% of their historical range (Ministry for the Environment, 2007)). North Island kākā are now rare in most districts, with population strongholds (refer Topic 1: Natural strongholds) restricted to a few larger remnant tracts of virgin podocarp/ hardwood forest (Pureora and Whirinaki) in the central North Island and a few pest-free offshore islands, in particular Kapiti, Great and Little Barrier Islands (Greene & Fraser, 1998; Leech, *et al.*, 2008; Sainsbury, *et al.*, 2006; Moorhouse, 1997; O'Donnell & Rasch, 1991; Ministry for the Environment, 2007; Berry, 1998).

Table 3-3 Overview of the status of North Island kākā populations *(O'Donnell & Rasch, 1991)*.

DOC Conservancy	Areas	Status	Source
Northland	All mainland forests	Very rare/ absent	Ogle (1982); S. King pers. comm.
	Hen and Chickens Islands	Common	G. Taylor pers. comm.
Auckland	Mainland forests	Very rare/ vagrants, probably juveniles from the islands	Workshop participants
	Great Barrier Island	Moderate density	Ogle (1980)
	Little Barrier Island	Common	Workshop participants
Waikato	Coromandel	Rare vagrants	Workshop participants
	Mercury Islands	Regular in very low numbers	A. Tennyson pers. comm.
	Western forests	Almost gone	O'Donnell (1983); Moynihan (1986)
	Pureora/ Waihaha	Still moderate numbers/ highest numbers on NI Mainland	Imboden (1978); S. King pers. comm.
Bay of Plenty	Mamaku Plateau	Very rare/ declining	Saunders (1983)
	Mayor Island	Present/ may be breeding	Workshop participants
	Whirinaki	Moderate numbers/ second NI stronghold	Moynihan *et al.* (1979)
East Coast	Urewera	Scattered/ some local concentrations/ declining recently	Workshop participants; Saunders (1983)
	Raukumara	Low numbers but could be isolated populations	S. Moore pers. comm.
Tongariro/ Taupo	All forests	Very few/ no viable populations	Workshop participants
Wanganui	All forests	Very rare/ virtually gone	O'Donnell (1983); Workshop participants
Hawkes Bay	All forests	Very rare/ virtually gone	Workshop participants
Wellington	Mainland forests	Very low numbers only in Tararuas	Workshop participants
	Kapiti Island	Common	R. Moorhouse pers. comm.
	Wellington City	Common	(McArthur, *et al.*, 2017)

3.1.5. Agents of decline and threats

Kākā were abundant in native forests as recently as the 1930's. However, the species is susceptible to habitat destruction and degradation, and to direct predation and competition by introduced mammals (Recio, *et al.*, 2016; Moorhouse, *et al.*, 2003; Greene & Fraser, 1998). Although, forest clearance and logging have in the past greatly reduced suitable kākā habitat, rates of forest clearance are now relatively low. However, many forest patches that are suitable for kākā are now too small to be able to maintain sustainable populations. Additionally, they are often scattered too far away from other significantly suitable habitat to encourage birds to move freely between sites. In historical times collection has reduced population numbers when Māori collected kākā for both food and use in feather cloaks while Europeans used kākā for food and pet collections (O'Donnell & Rasch, 1991).

The most important agents of decline for kākā has been predation and competition by mammals introduced to New Zealand during the 19th and 20th centuries (refer Table 3.4). While there is some evidence that brushtail possum (*Trichosurus vulpecula*), cat (*Felis catus*), rats (*Rattus norvegicus* and *R. rattus*) and ferret (*Mustela furo*) prey upon kākā, the main agent of decline for kākā is the stoat (*Mustela erminea*) (Moorhouse & Greene, 1998; O'Donnell & Rasch, 1991; Innes, *et al.*, 2010).

Nesting females, eggs, nestlings and fledglings are particularly vulnerable to predation by stoats. Low productivity and a male-biased sex ratio have also been observed throughout their range (Ministry for the Environment, 2007), which are most likely attributable to predation, mainly by the stoat. Possum also prey on nesting females as well as their chicks (Greene, *et al.*, 2004; Innes, *et al.*, 2010; O'Donnell & Hoare, 2012).

Where kākā co-exist with introduced avian species such as the sulphur-crested cockatoo (*Cacatua galerita*) and eastern rosella (*Platycercus eximius*), the introduced parrots compete for food and nest sites (Innes, *et al.*, 2010). Additionally, these parrots are hosts to avian diseases (such as psittacine beak and feather disease) which could have devastating impacts on kākā populations (Collen, 2010; Joustra, 2016). Furthermore, native avian predators, such as New Zealand falcon (*Falco novaeseelandiae*) and the Australasian harrier (*Circus approximans*), have both been observed hunting and feeding on kākā fledglings where they still co-occur (Powlesland, *et al.*, 2009). This predation however, is a natural process and therefore does not require management.

Table 3-4 Overview of known threats to kākā. P = predation; C = competition; Y = definite impact; N = no (known) impact; Cr = current; H = historical.

	Introduced pests										Natural		Human induced				
	Stoat	Possum	Ferret/ Weasel	Cat	Rat	Wasp	Deer	Goat	Pig	Cockatoo/ Rosella	New Zealand Falcon	Australasian Harrier	Forest clearance	Logging	Collection for food	Collection for pets	Feeding unsuitable feeds
Predator/ Competit	P	P/C	P	P	P/C	C	C	C	C	C	P	P	-	-	-	-	-
Adult	N	N	N	N	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	N	Y
Adult female	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	N	Y
Nest/ eggs	Y	Y	Y	Y	Y	-	-	-	-	-	N	N	Y	Y	N	N	Y
Nestlings	Y	Y	Y	Y	Y	-	-	-	-	-	N	N	Y	Y	N	N	Y
Fledgling	Y	N	Y	Y	N	-	-	-	-	-	Y	Y	Y	Y	N	N	Y
Sub-Adult	N	N	N	N	N	Y	Y	Y	Y	Y	N	N	Y	Y	Y	N	Y
Current/ Historical	Cr	Cr	Cr	Cr	Cr	Cr	Cr	Cr	Cr	Cr	Cr	Cr	Cr	Cr	H	H	Cr
Managea ble	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	Y	N	N	N	Y

3.1.6. Past management and species' response

Past management

There has been no specific management for North Island kākā in the wild, however in the past this was identified as a requirement for kākā during the 1991 Population Viability Analysis (PVA) workshops held by the Conservation Breeding Specialist Group (CBSG) and the Department of Conservation. The PVA lists the following recommendations (Seal, *et al.*, 1991):

Recommendations for management in the wild:

1. Develop a management plan for kākā that encompasses both wild and captive populations within the next year;
2. Evaluate supplementary feeding as a means of enhancing kākā productivity in the wild;
3. Evaluate current techniques for control of predators and competitors for their effect on kākā populations (i.e. what are the effects of trapping and 1080 poison on kākā?);
4. Develop techniques for the reintroduction of captive-bred kākā into the wild;
5. Develop techniques for translocation of kākā from island strongholds onto the mainland; and
6. What is the extent of poaching of kākā for food or the illicit bird trade? Harvesting impacts in the models?

Recommendations for management in captivity:

1. Establish a 'Nuclear 1 (or 2?) captive population (i.e. a captive nucleus to always represent 98% of the wild gene pool);
2. Follow recommendations of the captive species management plan under the leadership of the species coordinator;
3. Stock excess to programme requirements should be made available to research programmes and public advocacy work;
4. Use captive population as a resource for prioritised research purposes;
5. Provide support for the field programme;
6. Establish a comprehensive husbandry manual;
7. Establish comprehensive health profiles for kākā in the wild and in captivity;
8. Develop techniques to successfully effect reintroduction with collaborative post-release monitoring;
9. Explore the value of kākā as analogues for conservation work on the endangered kākāpo (*Strigops habroptilus*); and
10. Encourage public advocacy of collaborative work by high profile exhibit interpretation.

Recommendations for research in the wild:

1. What is the actual mortality of adult females and the interbirth interval?
2. Obtain a standardised index of kākā abundance in key habitats;
3. What is the historic pattern of kākā population decline in different regions and how does this compare to the models' predictions?
4. Clarify the respective role of competitors and predators in the decline of kākā and evaluate the likely success of management options?

5. How does the diet of the kākā vary seasonally and what are the phenology patterns of foods important for breeding? And
6. Clarify the taxonomy of North and South Island kākā?

Recommendations for research in captivity:

1. Promote molecular genetic work to establish taxonomic relationship of North and South Island kākā populations;
2. Surgically sex stock to confirm existing sexing to establish a group of birds able to provide reliable morphological data. Identify these birds with permanent ID;
3. Vet/ health aspects:
    a. Establishment of normal values
    b. When do males start and stop producing viable sperm
4. Complete nutritional work; and
5. Trial Donna Corp rings and Trovan microchip implants.

Unfortunately, most of the management recommendations identified in the PVA process have not been started or completed. The research recommendations for the wild have seen some progress with ongoing research on topics such as taxonomy clarification. Additionally, the 'Research plan for kākā (1996 – 2002)' and the 'Research summary and options for conservation of kākā' have continued to prioritise kākā conservation research throughout New Zealand (Moorhouse & Greene, 1998; Greene, *et al.*, 2004). Despite the research efforts, some kākā populations continue to decline and more stringent management is required if further declines are to be prevented.

To date there have been five release sites that have actively participated in the restoration of North Island kākā. Each site is described in more detail below, most sites have had the occasional kākā visit the area however there were no resident kākā prior to commencement of the restoration programme (Adams, *et al.*, 2008; Smuts-Kennedy & Parker, 2013).

Pukaha Mount Bruce Reserve

The Pukaha Mount Bruce Reserve is located approximately 27km north of Masterton, along State Highway 2 (SH2). The protected forest measures 942ha and is managed by the Department of Conservation (Blackie, 2015). It was the first location that successfully reintroduced kākā on the North Island of New Zealand (Berry, 1998; Miskelly, 2009).

The first release in 1996 consisted of four birds, followed by an additional five in 1997. Since the first releases in 1996/1997 a total of 51 captive-bred birds (19 males, 18 females and 14 unsexed individuals) from 10 captive pairs have been released in the reserve. The last reintroductions of captive-bred kākā took place in 2010 (Joustra, 2015). The current population size was estimated at 166 birds in 2011, with the aim to establish a self-sustaining population of 600 birds (Blackie, 2015). The sex ratio of the current population is not known.

The establishment of the current population is attributed to the ongoing pest control methods such as baiting and trapping (target species are mustelids, cats, rats and possums), and fencing to keep out ungulate species. Additionally, the birds are given support by providing soft-release and supplementary feeding occurs continuously (Berry, 1998; Blackie, 2015).

Zealandia (Karori Wildlife Sanctuary)

Zealandia is an urban ecosanctuary in Wellington. The sanctuary measures 225ha in size and is managed by the Karori Sanctuary Trust, which is a not-for-profit community-led organisation. Zealandia has supported the only population of kākā in an urban landscape as the birds travel freely between Wellington city and the sanctuary (Charles & Linklater, 2013). Kākā are now frequently breeding outside the sanctuary, with many birds living in the wider Wellington area (McArthur, *et al.*, 2017).

Kākā were first reintroduced into Zealandia in 2002 with the release of six captive-bred birds. In total, the captive programme contributed 14 birds (6 males, 5 females and 3 unsexed individuals) from five pairs to the sanctuary (Joustra, 2015). Since the first releases more than 750 individuals have been fledged and banded in Wellington (Karori Sanctuary Trust, 2016). The current kākā population in Wellington is estimated to be between 180 and 250 birds (Charles & Linklater, 2013; Miskelly, *et al.*, 2005). In 2013, the sex ratio in the Wellington city population was believed to be relatively balanced (males and females of confirmed sex (n =97) did not differ significantly from 0.5) (Charles & Linklater, 2013).

The establishment of the current population is attributed to the fact that the sanctuary is fully enclosed by a predator-free fence and is connected to a green-belt surrounding Wellington city (Recio, *et al.*, 2016). The sanctuary has a strict monitoring programme in place to ensure that incursions are avoided (Karori Sanctuary Trust, 2016). Supplementary food in artificial feeders is provided year-round (Recio, *et al.*, 2016).

Sanctuary Mountain Maungatautari

The Sanctuary Mountain Maungatautari is found in the central Waikato, located between Cambridge, Te Awamutu and Putaruru (Smuts-Kennedy & Parker, 2013). The sanctuary measures approximately 3 300ha and is managed by the Maungatautari Ecological Island Trust.

Two birds were released in the sanctuary in 2003, however, the official project was not initiated until 2007. Since these first releases in 2003 a total of 29 captive-bred birds (11 males and 18 females) from five captive pairs have been released in the reserve (Joustra, 2015). This is currently the only breeding site for kākā in the central Waikato, with the first recorded breeding in 2010 (Maungatautari Ecological Island Trust, 2015). The current kākā population is unknown.

The establishment of the current population is attributed to the fact that the sanctuary is fully enclosed by a predator-free fence (Maungatautari Ecological Island Trust, 2015) approximately

47km long. Once the fence was established, the entire site was cleared from pests with the use of aerial brodifacoum poisoning (Smuts-Kennedy & Parker, 2013). The sanctuary has a monitoring programme in place to ensure that incursions are avoided. Additionally, the birds are given support by providing soft-release and are supplementary fed in artificial feeders year-round (Maungatautari Ecological Island Trust, 2016).

Boundary Stream Mainland Island

Boundary Stream Mainland Island is located in the Hawke's Bay area, approximately 60km north of Napier. It lies along the eastern sides of the Maungaharuru Range (Department of Conservation, 2016; Adams, *et al.*, 2008). It encompasses the 702ha Boundary Stream Scenic Reserve as well as 100ha of private land (Poutiri Ao o Tane, 2016). Boundary stream is managed by the Department of Conservation in conjunction with local community groups.

Since the first release in 2013 a total of 11 captive-bred birds (6 males and 5 females) from five captive pairs have been released in the reserve (Joustra, 2015). To boost the newly established population, translocations of wild kākā have taken place as well (Department of Conservation, 2016). The current kākā population is unknown, however those individuals released in 2013 have been observed in the area and breeding behaviour was sighted the following year (Fastier, pers. comm.).

The kākā re-establishment project in Boundary Stream is supported by a strict pest-control regime using a combination of hunting, trapping, ground and aerial 1080 poisoning. The main target species are mustelids, possums, goats, pigs and cats (Department of Conservation, 2016). Prior to release kākā are held in purpose built aviaries for three to five months for acclimatisation. Additionally, the birds are given supplementary feeding during the initial release phase (Fastier, pers. comm.; Joustra, pers. comm.).

Cape Sanctuary

Cape Sanctuary is located on the Cape Kidnappers peninsula in the Hawke's Bay, approximately 20km south of Napier. It measures approximately 2 500ha of private land. The management of the sanctuary is completed by the Lowe Corporation (Lowe Corporation Limited, 2016; NatureSpace, 2016).

The first release occurred in 2014 when six captive-bred birds (2 males and 4 females) from three captive pairs were released in the sanctuary. The sanctuary housed a captive pair of kākā from 2012 – 2016 to use for advocacy, breeding and anchoring of juvenile kākā (Joustra, 2015). Besides the captive-bred birds, additional supplementation of wild kākā has taken place. These birds were sourced from Zealandia (Joustra, pers. comm.). The current size of the kākā population is unknown.

The establishment of kākā was made possible by the 10.6km predator-proof fence which was erected at the neck of the peninsula in 2006. Ongoing pest-control is taking place in the sanctuary via trapping and baiting. The main target species are mustelids and rodents (NatureSpace, 2016). The birds are held in aviaries prior to release to allow for acclimatisation as well as for anchoring (Joustra, pers. comm.). A year-round supplementary feeding regime is in place to continue to monitor and anchor birds to the peninsula (Parker, *et al.*, 2016).

3.1.7. Options for recovery

Predator control: Stoats are the main cause of decline of kākā on the mainland (Greene, *et al.*, 2004; Moorhouse, *et al.*, 2003). The preferred option for recovery of kākā is therefore to manage the species at selected sites within their natural range by controlling introduced predators, particularly stoat, and by supplementing population growth by translocating wild-caught kākā or releasing captive-reared and/or captive-bred kākā.

Security phase (strongholds and existing sites): This recovery plan begins with a 5-year security phase (2018 - 2023), during which time representative kākā populations will be secured. The security phase concentrates on the natural population strongholds and five existing release sites. The strongholds can protect a minimum of 650 kākā pairs. Ultimately the existing release sites should be able to maintain a minimum of 130 pairs each. However, within the 10-year plan there are currently only two sites with sufficient numbers to reach this target during this timeframe; these sites should be encouraged to expand the population to their carrying capacity. The remaining three sites will require more intensive management to be able to meet these population targets, and their initial phase should be to aim for 50 kākā pairs at their sites. At the same time, sites need to be identified which will be the focus of recovery efforts following the establishment of pairs at the existing release sites.

Recovery phase (proposed sites): The second stage of the plan is a 5-year recovery phase (2023 - 2028), during which the management techniques developed and refined during the security phase will be applied at a wider range of proposed release sites. The proposed sites should be near current kākā strongholds or release sites, to enable the natural dispersal of kākā allowing them to mix within the entire meta-population. This may also mean that next recovery efforts should be focussed in corridor areas between existing kākā populations to encourage natural integration between sites. Some of these proposed sites are already receiving intensive management as part of other recovery programmes (i.e. whio or kiwi), it is therefore strongly recommended that managers of kākā recovery programmes work in collaboration with managers for other recovery programmes.

The priority for resources should focus on ensuring that current sites and strongholds (in the first five years of this plan) are fully operational before initiating new release sites. Opportunities may arise where sponsors want to contribute to the kākā recovery programme; where possible, they should be guided to help secure kākā at existing sites, but the sponsor's initiative should be supported where possible.

3.2 Strategic directives

3.2.1. New Zealand Biodiversity Strategy

This plan supports three of the four goals of the New Zealand Biodiversity Strategy (Ministry for the Environment, 2000), as well as key associated principles, actions and strategic priorities:

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 hapū interests in indigenous biodiversity, and build and strengthen partnerships between government agencies and iwi and hapū in conserving and sustainably using indigenous biodiversity.

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

Maintain and restore a full range of remaining natural habitats and ecosystems to a healthy functioning state, enhance critically scarce habitats, and sustain the more modified ecosystems in production and urban environments; and do what else is necessary to 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 Strategic Direction

This plan is aligned with the Department of Conservation's Strategic Direction (Department of Conservation, 2007) and all four of the strategic approaches that will help deliver the Strategic Direction in the medium term: The overarching purpose of the Department is to 'increase the value of conservation to New Zealanders'. This leads to enhanced care of New Zealand's unique heritage for people to benefit from and enjoy.

To do this the Department will:

1. Seek to entrench conservation as an essential part of the sustainable social and economic future of New Zealand;
2. Be recognised as an effective manager of the lands, waters, species, historic places, and roles entrusted to it;

3. Lead, guide, and facilitate conservation gains throughout New Zealand, wherever conservation is most needed;
4. Weigh society's values, nature's inherent qualities, and scientific criteria in its decision-making; and
5. Actively promote outdoor recreation for New Zealanders, especially through fostering recreation, use, and enjoyment on conservation land.

3.2.3. Department of Conservation Statement of Intent

This recovery plan is in line with the Department of Conservation's Statement of Intent 2013–2017 (Department of Conservation, 2013). It aligns with the expectation of the Department's outcome statement: 'New Zealanders gain environmental, social and economic benefits from healthy functioning ecosystems, from recreational opportunities, and from living our history'.

The Department works towards this outcome statement through five intermediate outcomes which are:

1. The diversity of our natural heritage is maintained and restored.
2. Our history is protected and brought to life.
3. More people participate in recreation.
4. More people engage with conservation and value its benefits.
5. Conservation gains from more business partnerships.

One of the medium-term (5 years) priorities for the Department that link to the development of recovery plans are:

> *To optimise species and ecosystems management to achieve better value for money, the results they expect to see for 2012- 2017 are to increase the number of species actively managed through nationally prioritised prescriptions from 50 in 2011- 2012 to 300 over the next four years (these goals are to be reset in 2016-2017).*

Specific reference to the strategic focus of this recovery plan and species management is referred to within Intermediate outcome 1 (Natural Heritage) and has links with outcomes 3 (Recreation), 4 (Engagement) and 5 (Business partnerships).

Under Intermediate outcome 1, the following aspects are covered in a recovery plan:

1. Conserving a full range of New Zealand's ecosystems to a healthy functioning state;
2. Conserving nationally threatened species to ensure their persistence;
3. Maintaining or restoring nationally iconic natural features;
4. Maintaining or restoring populations of nationally iconic species;
5. Maintaining or restoring locally treasured natural heritage through partnerships; and

6. Holding public conservation lands, waters and species for now and for future generations.

Through the implementation of the recovery plan and the collaborative efforts of DOC, iwi, communities, groups, private individuals and organisations, North Island kākā populations can be secured and restored, thereby improving the functioning of ecosystems. More people will be engaged in conservation through their active involvement, increasing the value of New Zealand's natural heritage. Opportunities can be fostered with tangata whenua, communities, groups, organisations, private individuals and businesses through the management of kākā, increasing economic prosperity and delivering greater conservation gains and thereby connection to our natural heritage. Through this process, we can support the Department of Conservation's vision: 'New Zealand is the greatest living space on Earth'.

3.3 Cultural importance

Traditionally, Māori believe there is a deep kinship between humans and the natural world. This connection is expressed through kaitiakitanga – a way of managing the environment. Māori revered te ngahere (the forest) for its beauty, spiritual presence, bountiful food supply, medicines and weaving and building materials. The kākā has always been taonga (treasure) to tangata whenua (iwi or hapū that have customary authority in a place), who have a strong cultural, spiritual and historic association with the bird. The special traditional relationship between tangata whenua and kākā has been recognised through the Section 4 requirements of the Conservation Act 1987 (to give effect to the Principles of the Treaty of Waitangi), and through Treaty settlements legislation and protocols set up under the legislation, which require the Department of Conservation to consider places and species of significance to tangata whenua.

3.4 Public awareness

North Island Kākā are an important advocacy species, highlighting New Zealand's endemic biodiversity, the benefit of introduced mammal control, and importantly the positive impact the community can have in ecological and species restoration projects. Unfortunately, they are also an example of human conflict with native wildlife (for example, kākā have been found injured by gunshot and the damage they cause to trees in urban areas is reason for concern for the birds). Prior to committing to the re-establishment project, it is crucial to analyse the socio-economic circumstances, community attitudes and values, motivations, expectations and behaviours as well as the anticipated costs and benefits of the re-establishment project (IUCN/SSC, 2013). Spending sufficient time on this analysis can in turn help increase the success of the project.

The fact that kākā are an iconic species provides the potential to attract considerable publicity to restoration projects. The captive breeding programme in New Zealand has given the zoos the additional benefit of promoting conservation, raising public awareness, and educating the public. (Fischer & Lindenmayer, 2000).

Research by Wolf *et al.* (1996) showed that out of 47 programmes no one cited poor public relations and attitudes or the lack of protection from human disturbance as a cause of the failure of a translocation. Furthermore, four translocations reported declining populations notwithstanding community education and public-relations programs. This suggests that translocations that fail are likely to do so for reasons predominantly intrinsic to the biology of the translocated animals or programme methodology as opposed to extrinsic anthropogenic factors. Conversely, it is impossible to say how many successful programmes would have failed without community involvement (Wolf, *et al.*, 1996).

In New Zealand, however, advocacy can be a useful tool to ensure the community is accepting and willing to support the re-establishment of the species. It is encouraging to find that despite some damage caused by kākā in Wellington city, a 2012 survey of its residents reported that over 80% of those surveyed felt that native birds should be in the city and that inconveniences or minor damage should be tolerated (Linklater, 2016). This together with the newly introduced government strategy of making New Zealand predator free by 2050, demonstrates there is an opportunity to get the nation on-board with the North Island kākā re-establishment project.

Besides the Wellington region, there are limited opportunities for people to see wild kākā on the mainland, currently Sanctuary Mountain Maungatautari and Pukaha Mount Bruce National Wildlife Centre provide supplementary feeds to wild kākā. Additionally, wild kākā can be encountered on islands which allow public access (e.g. Kapiti and Great Barrier islands). Captive kākā are held for display/ advocacy at Rainbow Springs Nature Park, Otorohanga Kiwi House, Mount Bruce National Wildlife Centre, Nga Manu Nature Reserve, Victoria Esplanade Aviaries and at Wellington, Hamilton and Auckland zoos.

3.5 Partnerships

There are currently no partnerships for kākā recovery which other New Zealand bird species benefit from (i.e. takahē and Mitre10, kiwi and BNZ, whio and Genesis Energy). In the past Air New Zealand has provided free flights for kākā as part of their threatened species translocation programme where these birds were part of an active recovery programme.

It could be beneficial for kākā (and species that will benefit from kākā conservation) to find a suitable partner to increase kākā restoration around the North Island. Considering kākā are significantly different to other species that have partnership agreements there should be good options out there to promote a business while conserving a unique species to New Zealand.

4. Goals

4.1 Long-term recovery goals

The long-term goal for kākā recovery is to ensure the retention of viable wild populations throughout their natural range.

Kākā will ultimately be maintained in their existing range and re-established to a series of strategically chosen release sites located in their former range, which are close enough together to be linked by natural dispersal via corridors. An important milestone will be reached when the IUCN threat status (Endangered and population decreasing) has improved by at least one category and the New Zealand Threat Classification System (NZTCS) (Robertson, *et al.*, 2013) ranking has improved from 'Nationally Vulnerable' to a lower category of threat, i.e. 'At risk' with a population size over 5 000 North Island kākā. Currently kākā are managed at a subspecies level, it would therefore be a better reflection of the actual status of the species to separate the listing of kākā to reflect actual estimates of both the North Island as well as the South Island population numbers. This would likely upgrade the New Zealand threat listing from 'Nationally Vulnerable' to 'Nationally Endangered'.

4.2 Recovery plan period goals

4.2.1. Management

To secure kākā in New Zealand such that there is a minimum of 650 pairs at five natural stronghold sites.

Within the 10-year period of this plan, the meta-population will comprise a minimum of 650 pairs distributed between five sites (i.e. a minimum of 130 pairs at each site, current MVP= 258 birds). Sites will be managed such that kākā populations are stable or increasing. Exact population numbers need to be confirmed at each site to determine whether the number of pairs should be increased.

To secure kākā in existing release sites such that there is a minimum of 150 kākā pairs at two of the five sites (Zealandia and Pukaha Mount Bruce Reserve).

The two sites at Zealandia and Pukaha Mount Bruce were the first two sites to participate in kākā re-establishments. Re-establishment at these sites has been successful to date, however their carrying capacity has not been achieved yet. Pukaha Mount Bruce is estimated to be able to maintain a population of 600 birds, however their current population size is estimated at only 166 birds (Blackie, 2015). These sites should therefore receive further support to increase their populations to around 150 pairs.

To have at least 50 kākā pairs in each of the remaining three existing release sites (Sanctuary Mountain Maungatautari, Boundary Stream Mainland Island and Cape Sanctuary).

An additional 50 kākā pairs will also be protected at three of the existing release sites that are being managed for kākā. Once kākā security has been achieved and the targets met at these three sites, additional strategically located release sites will be identified for management to increase the number of populations that are protected to restore their natural range (refer Topic 4: Proposed release sites).

Select new release sites and corridors to encourage the natural dispersal of kākā on the North Island.

Additional sites (refer Topic 4: Proposed release sites and Topic 5: Strategic corridor management) need to be set up to bridge the gaps between the current strongholds and existing release sites, this could be accomplished by identifying the integration with other predator control or ecosystem restoration programmes (i.e. where current projects maintain predator levels to low numbers, kākā could be reintroduced to these sites even though they are not the main target species).

4.2.2. Community relations and engagement

New Zealanders' awareness and support of kākā and the kākā recovery is enhanced. Additionally, corporate sponsorship funding is sourced to assist with the recovery of the species.

4.2.3. Research and innovation

Promotion of investigations into factors likely to limit population recovery. Sex-ratios on the mainland are investigated and appropriate actions to correct any skewed sex ratios is captured. Environmental, breeding and survival records will be analysed to identify key factors affecting population recovery.

5. Implementation

This section provides short-term direction for DOC managers, iwi, community groups and organisations involved in kākā recovery, by identifying desired actions for achieving the objectives specified in this plan. This plan is grouped into three themes which are common to species recovery programmes (management, community relations, and research). Under each theme are topics with background, issues and objectives. In total 27 topics are covered in this version of the recovery plan. The final version of the recovery plan, should be populated with actions to resolve the issues and/or complete the objectives. The actions allocated to an objective may provide opportunities to work toward the goals of the other themes. Therefore, notes identifying how these actions or areas of work can contribute to the other themes can be included. The actions are to be prioritised as 'essential', 'high' or 'medium'. This classification is based on the following recommendations made during the development of this plan:

Essential: Recommended as essential for the recovery of kākā. These actions should be carried out in the first 5 years of this plan, subject to resources being available and existing decision-making processes.

High: Recommended as necessary for achieving the long-term goal for kākā recovery. These actions should be carried out during the 10-year term of this plan, subject to resources being available and existing decision-making processes.

Medium: Recommended to support the recovery of kākā. Some progress should be made towards these actions during the 10-year term of this plan, subject to resources being available and existing decision-making processes.

Once actions have been decided on, a timeline for recovery actions should be compiled and added in Appendix II.

5.1 Management

5.1.1. Topic 1: Natural strongholds

There are a few areas that maintain natural strongholds of kākā, where management is either non-existent or minimal. These natural strongholds include: 1) Great and Little Barrier Islands; 2) Te Urewera forest; 3) Pureora forest; 4) Whirinaki forest and 5) Kapiti Island (Department of Conservation, 2016; Forest Lifeforce Restoration Trust, 2017; Greene & Fraser, 1998; O'Donnell & Rasch, 1991; Powlesland, *et al.*, 2009).

It is important to note that some of these population strongholds are thought to be declining (Ministry for the Environment, 2007), these sites should therefore be monitored to determine whether some (or additional) management may be required to maintain the populations in these areas. Active pest control management is required in these areas (P. Gaze, 2017.

Pers.comm.). Additionally, some of these strongholds have highly skewed sex ratios which require further investigation.

Some of the populations in these sites may also be used for translocation purposes to supplement existing release sites or establish populations at proposed release sites, however the removal of birds from these sites should only be considered after a full site review has been completed.

Issues

Issue 1.1: Kākā population strongholds are all thought to be in decline.

Issue 1.2: Some strongholds have highly skewed sex ratios, which are negatively impacting on population growth.

Issue 1.3: There are no up to date population parameters available to assist in determining whether populations can manage with harvesting of kākā to translocate to release sites.

Objectives and actions

Objective 1.1: To monitor naturally occurring kākā populations to determine whether additional management is required to support reversal of declines.

Objective 1.2: To establish accurate sex ratios for sites around the North Island.

Objective 1.3: To promote supplementation of female kākā in natural strongholds where active pest control is taking place.

Objective 1.4: To investigate population parameters to determine whether populations can cope with (ongoing) harvesting for translocation purposes.

5.1.2. Topic 2: Release site requirements

Area requirements are likely to differ from site to site based on resource availability, type of forest, and expanse of habitat available to kākā (Leech, *et al.*, 2008). The restriction of kākā to podocarp and beech forests on the main islands of New Zealand could be because these are the only remaining forest types which produce periodically superabundant seed crops that are not limited by possums or other introduced herbivores (Moorhouse, 1997).

The IUCN guidelines for conservation translocations state that there should be strong evidence that the threat(s) that caused any previous extinction should have been correctly identified and removed or sufficiently reduced (IUCN/ SSC, 2013). Seddon (1999) however notes that it can be beneficial, or even necessary, to release individuals before all formal pre-release criteria have been met, for example to supplement individuals to a local wild population before they become locally extinct.

There are a number of factors that release sites should consider to determine whether they would be suitable to be a part of the re-establishment programme for North Island kākā, some of these are described below:

Size of release site

Adult kākā require relatively small home ranges (between 20 and 240ha) (Greene, *et al.*, 2004), however they require large tracts of forest to survive. Within their home range, the birds have an area they use most (the core area) which measures between two and 21ha. Kākā can fly large distances (>30km), especially juvenile birds will travel prior to establishment of their own home ranges (O'Donnell & Rasch, 1991; Recio, *et al.*, 2016; Greene, *et al.*, 2004). This is an important consideration when using juvenile birds for release, these birds need more anchoring to ensure they make their home range in the release area. This anchoring can be done via delayed release and supplementary feeding (refer Topic 13: Pre-release training (soft-release)).

The movement of juvenile birds (and to some extent adults as well) has huge implications for the success of protected areas within mainland forests. If the designated areas are too small, very little or no recruitment into protected areas may occur, compromising the long-term sustainability of residual kākā populations (Greene, *et al.*, 2004). Moorhouse *et al.* (2003) noted that in podocarp forests, 1 100ha was considered large enough to contain a self-recruiting population. However, every site will be different when considering other environmental aspects of the release site (e.g. the proximity of wild kākā populations).

Boundaries

There are different types of boundaries that could be considered for a release site, such as natural (i.e. rivers, lakes and mountain ridges) or artificial (i.e. pest proof fencing). It is important to note that even when using natural boundaries, the movements of some pests may be limited but in most cases, such barriers cannot be relied on to provide adequate protection from immigrating pests (Saunders & Norton, 2001). Stoats and rats are able to swim long distances to pest free islands.

Saunders and Norton (2001) considered islands the most defensible against invasion by terrestrial pests because they are surrounded by water. For that purpose, it is not unreasonable to assume that mainland peninsulas, which are largely surrounded by water, may be more defensible than other mainland sites considering these have more entry points for pests. Habitat complexes (where a core management area is located within a larger complex of similar habitat), are probably the least defensible, however they present opportunities to expand operational areas as management regimes are refined (Saunders & Norton, 2001).

The Xcluder® pest proof fence is a frequently used artificial boundary for many release sites in New Zealand, which allows release sites to reduce the time spent on ongoing pest control to instead monitor for incursions only as is the case for Zealandia and Sanctuary Mountain Maungatautari.

Each release site will need to assess which type of boundary they can best utilise and determine which forms of predator control or monitoring is best for their purposes and location. Areas that currently already have predator free fencing could be suitable options for participation in the re-establishment of kākā in the North Island.

Issues

Issue 2.1: Adult kākā require large forest tracts to survive.

Issue 2.2: Juvenile kākā will travel prior to establishment of their own home ranges.

Issue 2.3: Mainland sites in habitat complexes are the least defensible against invasion by terrestrial pests.

Objectives and actions

Objective 2.1: To ensure that the threat(s) that caused any previous extinction/ decline in the release sites have been correctly identified and removed or sufficiently reduced.

Objective 2.2: To promote the fact that juvenile kākā need more anchoring to ensure they make their home range in the release area.

Objective 2.3: To support mainland sites in their planning to advise on the most cost-effective pest-control methods.

Objective 2.4: To encourage the participation of current predator-free areas in the recovery plan for North Island kākā.

5.1.3. Topic 3: Existing release sites

There are currently five “active” release sites for North Island kākā: 1) Pukaha Mount Bruce Reserve; 2) Zealandia; 3) Sanctuary Mountain Maungatautari; 4) Boundary Stream Mainland Island and 5) Cape Sanctuary. These sites are now at different phases in their recovery of North Island kākā. Only one of these sites has a current Department of Conservation release permit, however in the past an urgent release permit has been issued for one of these sites when the captive programme produced more birds than what should be released at one single site (due to their close relatedness to others at the release site).

Predator control (particularly stoat control) is the main management activity required at all sites. Release sites will have varying combinations of topography, habitat and predator species, therefore techniques that have proven successful at one site may not be effective at all sites. Outcome monitoring over time will determine the trend and effectiveness. Existing release sites may need additional supplementation of translocated and/ or captive-bred birds at various intervals to increase the rate of recovery and/ or to introduce additional genetic diversity in these areas.

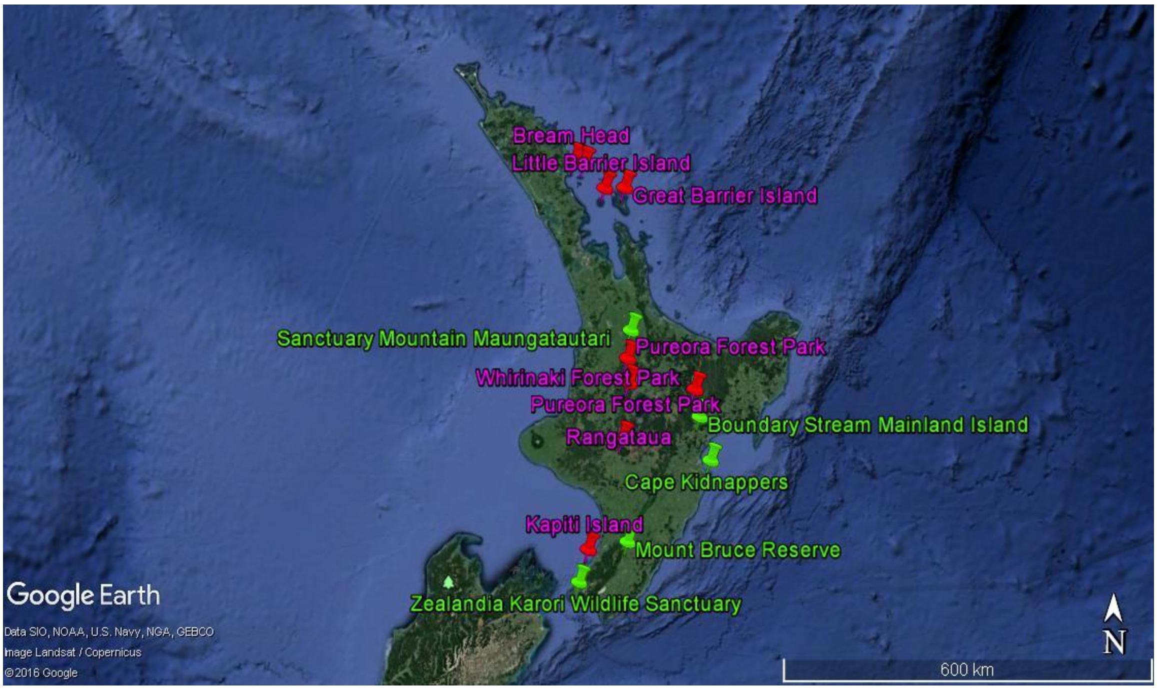

Figure 5-1 Naturally occurring populations (in purple) and previous release areas (in green).

Issues

Issue 3.1: Existing release sites are at different phases in their recovery plan for North Island kākā.

Issue 3.2: There is no national management plan for self-sustaining population targets at existing sites.

Issue 3.3: There is currently only one site with an active Department of Conservation permit for North Island kākā releases.

Objectives and actions

Objective 3.1: To review the current population status at each existing release site.

Objective 3.2: To determine each site's supplementation requirements to enhance self-sustainability.

Objective 3.3: To be proactive in planning for release permits if the captive programme is requested to provide birds for release.

5.1.4. Topic 4: Proposed release sites

The IUCN conservation translocation guidelines (2013) stipulate the difference between requirements for release sites and areas; with release sites needing to meet all practical needs for effective release with least stress for the individual. Release areas will need to meet all the species biotic and abiotic requirements. Osborne and Seddon (2011) noted that one of the key lessons of landscape conservation is that we should manage both the species and the ecosystem. Sites should be selected for reintroductions based on: being in the previous or current distribution range of the species, that the site meets the species' needs, and that the site has some form of legal protection, or at a minimum, have the threats to the species' survival removed or controlled (Grajal & Sanz, 2002). It appears that the taxa least able to benefit from small mainland sanctuaries are those that, although highly sensitive to pests, are also most mobile and with large territories (Innes, *et al.*, 2010).

When considering a site for the establishment of a new population, several pre-requisites should be met (Greene, *et al.*, 2004):

- **Anchoring:** Grajal and Sanz (2002) recommend that parrots should be liberated in areas that are in use by their wild conspecifics to enable birds to integrate faster, however if attempting to anchor kākā to a site, it would be recommended to release them in areas where they are either extinct or rare to prevent resident birds luring them away from protected sites, particularly if they are contiguous with much larger areas of potential habitat. Additionally, it may be required to provide delayed release to support anchoring the birds to a site or area (refer Topic 13: Pre-release training (soft-release));
- **Supplementation:** Supplementary foods should be provided throughout the establishment phase to entice the birds to stay in the area, as well as ensuring the area provides sufficient foods to maintain a population long-term;
- **Release area size:** Areas into which birds are to be released should be relatively large (c. 1 000ha, depending on the type of forest) so that the population can expand and become self-sustaining over time. It is important to note that kākā can travel long distances, for example a wild banded kākā observed in Palmerston North near the captive kākā aviaries at Esplanade Aviaries in September 2015 was presumed to have flown there from Zealandia (approx. 130km) (Wildbase Recovery Community Trust, 2016);
- **Pest control:** Effective pest control should be established in the area and maintained long-term;
- **Nest boxes:** Artificial nest boxes should only be used where large numbers can be provided and natural sites are relatively few. A recommended predator-proof design should be used;
- **Resources:** Sufficient resources must be available over several years to maximise the chances of success. This could include finances for holding aviaries, disease screening, transmitters, food stations, food supplements and staff time to monitor progress; and
- **Release details:** The maximum number of birds to be released and the total number of releases should be capped prior to project initiation. Regular audits of progress should

be conducted, and if these limits are about to be exceeded without reasonable prospects for successful establishment, the project should be abandoned.

A translocation (even to highly suitable areas) can fail due to a poorly-designed release (IUCN/ SSC, 2013), it is therefore important that sufficient time is spent on an analysis of the site. In the end, it is not sufficient to find suitable habitat patches; their spatial arrangement and how they will be used by the species both seasonally and as the population grows must be considered. This requires detailed knowledge of the species' resource requirements, typical home range size and movements (Osborne & Seddon, 2011).

Selection of high-quality release sites is a significant factor in psittacine reintroduction success (White Jr., *et al.*, 2012). Selection of release sites for the Puerto Rican parrot (*Amazona vittata*) was determined by using SWOT[6] analysis. White Jr. *et al.* (2012) recommended that future psittacine reintroductions use SWOT analysis to conduct thorough and comprehensive evaluations of potential release sites. This is in line with the IUCN guidelines for Conservation translocations which state that assessment of any translocation proposal should include identification of potential benefits and potential negative impacts (IUCN/ SSC, 2013).

White Jr. *et al.* (2013) propose that SWOT could provide support in the analyses by considering a broad array of suitability factors such as size of release areas, landscape connectivity, resource availability, disease threats, competition, predation, logistical and security issues, funding, infrastructure, as well as human socio-economic issues such as ecotourism potential or risk of conflicts with landowners. Temporal and spatial variations in specific factors are also considered in the analyses, allowing for incorporating relative differences in specific factors as seasonal food availability, habitat composition, or atmospheric phenomena (White Jr., *et al.*, 2013).

During the stakeholder survey (refer Thesis Chapter 2) participants were asked if they would be interested in taking part in the re-establishment plan for North Island kākā. Several sites (refer Figure 5.2) indicated some interest, whether through active reintroduction efforts or through encouraging natural dispersal to their sites. The below sites could be considered as future participants and would fit in with the dispersal plan for kākā. It is recommended that each site would complete a SWOT analysis to ensure their participation in the project will be successful for both the organisations involved as well as the species.

Individuals involved with the Moonshine Valley Reserve in Palmerston North have expressed interest to participate in the re-establishment plan. This project receives the backing of the Palmerston North City Council and is inspired by a similar project in Crofton Downs in Wellington. In both projects, the locals have taken the lead in making their local reserve predator-free to provide a safe area for native animals (Palmerston North City Council, 2017).

[6] SWOT: Strengths, Weaknesses, Opportunities and Threats

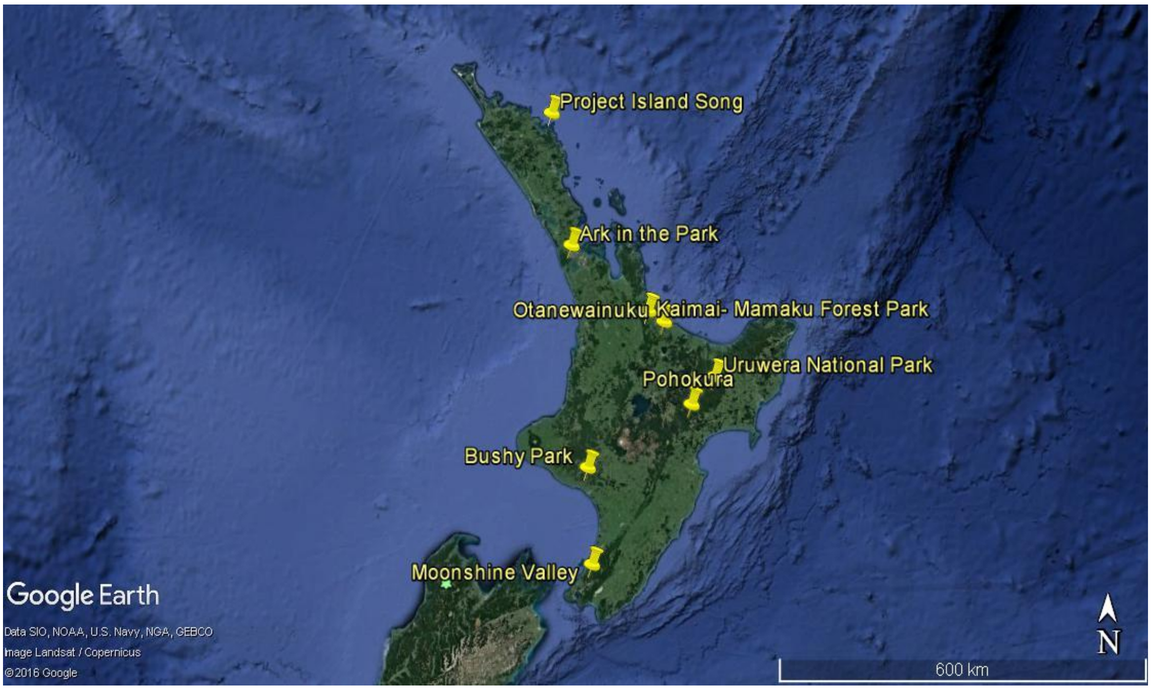

Figure 5-2 Organisations/areas interested in participating in the re-establishment of North Island kākā (Stakeholder survey, 2016).

Project Island Song

Project Island Song is a shared vision for the restoration of Ipipiri to become an archipelago rich in native flora and fauna for all to enjoy. The project is led by Guardians of the Bay of Islands, Patukeha and Ngati Kuta (resident hapū at Te Rawhiti) and DOC. It is supported by local landowners and tourism interests. The project includes the islands in the chain from Motuarohia (Roberton Island) eastwards including Moturua, Motukiekie, Okahu, Waewaetorea, Urupukapuka, Poroporo, and all their associated islets including stepping-stone islets in the Rawhiti channel. These islands of the Eastern Bay of Islands are now pest-free (Department of Conservation, 2017).

Ark in the Park

Ark in the Park is a partnership between Forest and Bird and the Auckland Council. It is a conservation project in the northern New Zealand rainforest, at the Cascade Kauri Park in Auckland's Waitakere Ranges Regional Park. They control non-native pests and predators, to restore the ecology of the area to its natural state (Royal Forest and Bird Protection Society of New Zealand Inc. , 2017).

Otanewainuku Kiwi Trust

The Otanewainuku Kiwi Trust is a community based conservation trust formed in 2002 by Te Puke Forest and Bird and other members of the community concerned at the decline of North Island brown kiwi in the Otanewainuku forest, in the Bay of Plenty. The Trust operates under a Memorandum of Understanding with the Department of Conservation who administers the land and provides technical advice and guidance on pest control and translocation of birds (Otanewainuku Kiwi Trust, 2017).

Kaimai- Mamaku Forest Park

A small group, known as the Friends of the Blade, are committed to establish a pest free area at the Kaimai Mamaku State Forest Park. The Blade is an area the size of 70ha at the southern end of Whakamarama Road and contains podocarp forest as well as swamp patches (NatureSpace, 2017). The Blade is a part of the Kaimai- Mamaku Forest Park which measures approximately 45 000ha, kākā are found in this area, however numbers have decreased over the years (Bull, *et al.*, 1985; Robertson, *et al.*, 2007). The forest park should be able to sustain a large number of kākā pairs (Leech, *et al.*, 2008).

Maungataniwha Native Forest and Pohokura

Managed by the Forest Lifeforce Restoration Trust, Maungataniwha Native Forest comprises 6 120ha of native forest straddling the ridge system between the Te Hoe and Waiau rivers in northern Hawke's Bay. To the north of the forest is Te Urewera forest (212 673ha) which is one of the kākā strongholds. To the west, the Whirinaki Conservation Forest can be found. Both forests are part of an extensive area of native forest which is publicly-owned land administered by the Department of Conservation. To the south is the Maungataniwha Pine forest. The Maungataniwha Native forest is occasionally treated with aerial applications of 1080. Additionally, the Trust also manages the Pohokura forest which comprises 11 348ha of native forest north of the Napier-Taupo highway. Pohokura also receives occasional aerial 1080 applications (Forest Lifeforce Restoration Trust, 2017).

Bushy Park Sanctuary

Bushy Park Sanctuary is managed by the Bushy Park Trust and is located on the west coast of the North Island, approximately 25km from the town Whanganui. The sanctuary is a 90ha predator-free native bird sanctuary, set amongst one of few patches of virgin lowland forest (Bushy Park Trust, 2017). Kākā are present in very low numbers in the nearby Whanganui National Park (Department of Conservation, 2017), the predator free sanctuary could provide a good location to boost numbers in the Whanganui area.

Issues

Issue 4.1: Pre-requisites for participation in kākā re-establishment have not been clearly specified.

Objectives and actions

Objective 4.1: To ensure site pre-requisites for kākā re-establishments are published and made available to proposed or future sites.

Objective 4.2: To conduct SWOT analysis for proposed or future sites, to ensure participation will be beneficial to the recovery outcomes.

5.1.5. Topic 5: Strategic corridor management

Most protected nature areas around the world are too small for many species to achieve long-term population persistence, particularly in the case of mammals and birds (Leech, *et al.*, 2008). In New Zealand, much of its remaining indigenous biodiversity, at least in the lowlands, occurs in small habitat fragments (Saunders & Norton, 2001). Long-term conservation of species such as kākā therefore relies on the cooperation between projects as well as implementation of suitable urban design to accommodate sufficient green spaces and natural areas ("corridors") (Recio, *et al.*, 2016) to allow the natural dispersal of kākā.

Several sites have been identified that would effectively provide corridors that would allow natural dispersal of kākā around the North Island. These sites are listed as a guideline to review whether current or past re-establishment or restoration projects in the area may be able to support the kākā programme as well. Some of the sites already have some kākā in the area and may already participate in kākā re-establishment such as "Project kākā" in the Tararua Ranges where the kākā is considered an indicator species for measuring the success of restoring New Zealand forest birds back to the forest (Department of Conservation, 2017). Some of the other recommended sites may currently not have any kākā in the near vicinity, and will require more planning and management to be able to fully participate in the re-establishment. Due to the differences in sites it is recommended that SWOT analyses are completed for each site to ensure they can successfully participate in this plan.

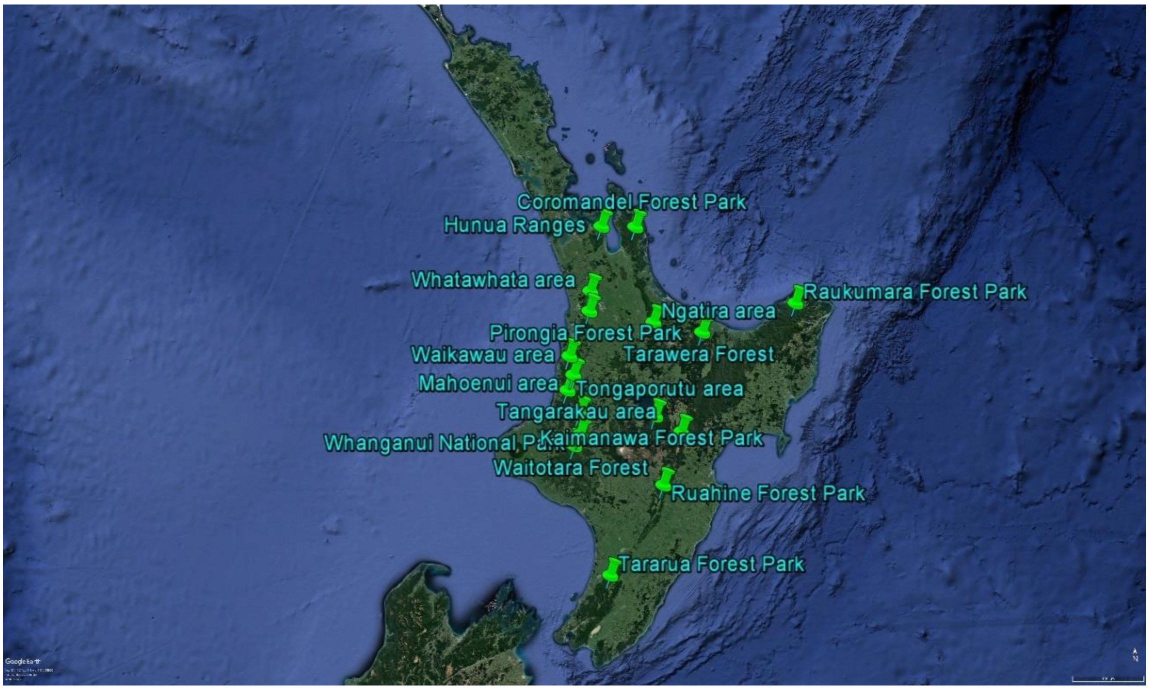

Figure 5-3 Recommended corridor sites to encourage natural dispersal of kākā in the North Island of New Zealand: 1) Tararua Forest Park; 2) Ruahine Forest Park; 3) Waitotara Forest; 4) Whanganui National Park; 5) Kaimanawa Forest Park; 6) Kaweka Forest Park; 7) Tangarakau Area; 8) Mahoenui Area; 9) Tongaporutu Area; 10) Waikawau Area; 11) Pirongia Forest Park; 12) Whatawhata Area; 13) Ngatira Area; 14) Tarawera Forest; 15) Raukumara Forest Park; 16) Coromandel Forest Park; and 17) Hunua Ranges.

Issues

Issue 5.1: Much of the remaining indigenous biodiversity, at least in the lowlands, occurs in small habitat fragments. North Island kākā re-establishment relies on cooperation between sites and sufficient corridors.

Objectives and actions

Objective 5.1: To complete SWOT analysis on recommended corridor sites to determine their possible contribution to the natural dispersal of kākā.

5.1.6. Topic 6: Habitat suitability

Matching habitat suitability and availability to the needs of the species is central to feasibility and design (IUCN/ SSC, 2013) of the reintroduction project. Without high habitat quality, translocations have low chances of success regardless of how many organisms are released or how well they are prepared for the release. Limiting factors must be identified and controlled and assurances of maintenance of habitat quality obtained prior to translocation (Griffith, *et al*., 1989). The longer the time between local extinction and the planned release, the greater the chance will be that the habitat will no longer be suitable, and the greater the need to evaluate current habitat suitability regardless of historical occupancy (Osborne & Seddon, 2011). White Jr. *et al.* (2012) found that a successful reintroduction is predicted to be nearly three times more likely when habitat quality was at the highest versus the lowest level.

Osborne and Seddon (2011) note that in general, habitats at the periphery of a species' range are more diverse, more fragmented and less favourable than those at the range core. Consequently, both population density and reproductive success or survival are often lower at the periphery than the core, with the latter acting as 'sources' and peripheral areas as 'sinks'. These sinks are therefore considered to be unsuitable for re-establishments, projects should be focussed on areas that will provide ample opportunity for reproduction, however it is important to consider that these 'sink' areas can be great corridors (refer Topic 5: Strategic corridor management) to support the entire population of North Island kākā.

It is important to consider that there is always the option that released birds may decide to reject the habitat near the release site and rapidly move long distances away before settling (Osborne & Seddon, 2011), however the chance of immediate dispersal could be mitigated by providing sufficient pre-release training and/ or supplementary feeding (refer Topic 13: Pre-release training (soft-release)). For individual kākā native forest patches are critical and despite landscape fragmentation, urban environments can support the conservation of native species (Recio, *et al.*, 2016).

Nest sites

Nearly every psittacine species nests in tree cavities, where the larger parrots require large trees. This makes parrots vulnerable due to the removal of large trees for the timber industry (Collar, 2000). Kākā are secondary-cavity nesters, using natural cavities, usually within the trunks and large branches of trees. Like most other parrot species, kākā make no attempt to construct their own cavities or line the nest cup with foreign material (Powlesland, *et al.*, 2009). Further research by Powlesland *et al.* (2009) demonstrated that most nest cavities at both Waipapa and Whirinaki were in mataī or rimu trees, with the others mainly in totara, miro, hīnau as well as dead trees of unknown species. Their research also provided a guideline for the type of characteristics required for kākā nest cavities (refer Table 5.1).

As is the case with nest boxes, to increase nesting success, natural nest cavities might need protection from predators. Greene and Jones (2003) found that accessible natural nests protected by metal collars will be far more effective and efficient than artificial cavities in preventing predation. Though locating natural cavities is considered time consuming, the fact that natural cavities can be protected for significant periods of time make them relatively cheap.

Table 5-1 Kākā nest cavity characteristics *(Powlesland, et al., 2009)*.

	Waipapa	**Whirinaki**
Tree species		
Mataī	39 (61.9%)	21 (61.8%)
Rimu	8 (12.7%)	7 (20.6%)
Totara	5 (7.9%)	2 (5.9%)
Miro	2 (3.2%)	2 (5.9%)
Hīnau	3 (4.8%)	-
Kahikatea	1 (1.6%)	-
Red Beech	-	1 (2.9%)
Unknown	5 (7.9%)	1 (2.9%)
Total	**63 (100%)**	**34 (100%)**
Tree condition score (%)	Without dead branches (37.5%)	Without dead branches (52.9%)
Cavity type score (%)	Trunk (91.5%)	Trunk (97%)
Mean nest tree height (m)	28.8m	39.4m
Mean nest entrance height (m)	11.7m	13.4m
Mean diameter at breast height (approx. 1m)	1.32m	1.25m
Mean entrance height (cm)	59cm	51.2cm
Mean entrance width (cm)	11.5cm	12.6cm
Mean cavity depth (cm)	83.8cm	72.3cm
Mean chamber diameter (cm)	47.3cm	91.2cm

Development of physical barriers preventing access of predators to kākā nests and nesting females is desirable (Moorhouse & Greene, 1998). Metal sheets or collars can be wrapped around the base of trees below the nest to be protected (Greene & Jones, 2003), though it may be required to also add collars above the nest to prevent access from the roof. Collars are relatively cheap, simple to construct and widely used (Greene & Jones, 2003), however the collars do need to be monitored regularly to ensure that they are still intact and tight enough. The addition of metal collars to suitable natural kākā nest cavities within mainland habitats is strongly recommended (Greene & Jones, 2003).

Nest boxes

If there are insufficient natural nest sites, it is recommended to add artificial nest boxes to the release area. Greene and Jones (2003) proposed that suitable area for nest boxes may include suburban parks and reserves where kākā have a regular presence, and islands or "mainland islands" with few trees of suitable cavity forming size which are regularly visited by kākā. Nest boxes are also suitable for provision to populations of released captive-reared birds that have previously been exposed to them.

If there are many natural cavities in an area but their utilisation is low, nest boxes must be provided in high enough numbers to maximise their chances of use (Greene & Jones, 2003). Whether nest boxes will be utilised will depend on a variety of factors, including nest box design, the number of nest boxes or nest sites available, the presence of competitors and whether the boxes are predator proof. Nest boxes are easily adapted to exclude both competitors (e.g. by reducing the size of the entrance hole) as well as predators (e.g. by constructing roof extensions). Additionally, specifically providing nest boxes for competitors could provide more natural cavities to kākā (Greene & Jones, 2003). Research by Greene *et al.* (2004) found that the development of a 'stoat-proof' nest box for kākā has provided some relief, but post-fledging and adult mortality remains high, therefore it is still recommended to complete pest control in addition to the stoat-proof nest boxes.

Besides the use of metal collars, the construction of barriers, baffles or tunnels can prevent access to either the nest entrance or nest chamber (Moorhouse & Greene, 1998). Greene and Jones (2003) found that very minor modifications, such as the addition of a roof extension overlapping the entrance of the nest box, had a major impact and proved critical in preventing access by stoats.

Nest "boxes" manufactured from pieces of lightweight PVC pipe (Moorhouse & Greene, 1998) are suitable alternatives for natural cavities and are successfully used by sites such as Zealandia, where all 36 nest boxes were occupied in the 2015/ 2016 breeding season (Parker, *et al.*, 2016).

Food availability

Considering the diet of wild North Island kākā mainly consists of fruits, berries, seeds, flowers, buds, nectar, sap, plants and invertebrates (Berry, 1998; Innes, *et al.*, 2010; Moorhouse, 1997), it is crucial that the release site is offering these food items naturally, rather than heavily relying on supplementary feeding. Kākā do switch to alternative food sources when they are available

(Berry, 1998), but to integrate them into the wild faster it would be more beneficial to encourage foraging for wild foods. Additionally, Moorhouse (1997) noted that adequate nutrition alone is sufficient to induce nesting, which is one of the main goals of successful re-establishment projects.

Greene *et al.* (2004) identified that there are significant differences in the food types used by male and female kākā, with the males' preference being fruit and burrowing invertebrates whereas the females' preferences were nectar, sap and surface-dwelling invertebrates. Sap feeding has been observed on a variety of tree species and tree sizes (Berry, 1998). A full list of tree species identified to be a source of food for North Island kākā can be found in Table 5.2., additionally the known source of invertebrate species consumed by kākā is included in the table as well. It is recommended that release sites identify they have sufficient food sources available for kākā based on the information provided in the table.

Table 5-2 Plant foods and invertebrates consumed by North Island kākā on Kapiti Island and Mount Bruce Reserve *(Moorhouse, 1997; Berry, 1998).* - = not observed; x = not recorded.

Plant species	Kapiti (K)/	Invertebrates	Seed	Fruit	Nectar/ Pollen	Other (e.g. Leaves, flowers)
Coprosma species	MB	Yes	Yes	Yes	Yes	Yes
Five-finger (*Pseudopanax arboreus*)	K	Yes	-	Yes	Yes	X
Flax (*Phormium tenax*)	MB	x	x	x	x	Yes
Hīnau (*Elaeocarpus dentatus*)	K + MB	Yes	Yes	Yes	Yes	Yes (MB)
Kahikatea/ white pine (*Dacrycarpus dacrydioides*)	MB	Yes	Yes	Yes	x	Yes
Kaikomako (*Pennantia corymbosa*)	MB	Yes	x	x	x	x
Kamahi (*Weinmannia racemosa*)	MB	Yes	X	X	Yes	Yes
Karaka (*Corynocarpus levigatus*)	K	Yes	Yes	Yes	-	X
Kareao/ Supplejack (*Ripogonum scandens*)	MB	X	Yes	Yes	Yes	Yes
Karo (*Pittosporum crassifolium*)	K	X	-	Yes	Yes	X
Kawakawa (*Macropiper excelsum*)	K	X	-	Yes	-	X
Kānuka (*Kunzea ericoides*)	K	Yes	-	-	-	X
Kiekie (*Freycinetia banksii*)	K	X	-	Yes	Yes	X
Kohekohe (*Dysoxylum spectabile*)	K	Yes	Yes	-	Yes	X
Kōhūhū (*Pittosporum tenuifolium*)	K + MB	Yes (MB)	-	Yes	-	X
Lancewood (*Pseudopanax crassifolium*)	K	X	-	Yes	-	X
Māhoe (*Melicytus ramiflorus*)	K + MB	Yes	-	-	Yes	X
Maire (*Nestegis cunninghamil*)	MB	Yes	Yes	Yes	X	Yes
Makomako/ wineberry (*Aristotelia serrata*)	MB	Yes	X	X	X	X
Mapou (*Myrsine australis*)	MB	Yes	X	X	Yes	Yes
Mataī (*Prumnopitys taxiflora*)	K	X	-	Yes	-	X
Miro (*Prumnopitys ferruginea*)	MB	Yes	X	X	X	Yes
Patē/ seven-finger (*Schefflera digitata*)	MB	Yes	X	X	Yes	Yes
Pigeonwood (*Hedycarya arborea*)	K	Yes	-	Yes	-	X
Pōhutukawa (*Metrosideros excelsa*)	K	X	-	-	Yes	X
Ponga and whekī/ Tree fern (*Cyathea /Dicksonia* spp.)	MB	X	X	X	X	Yes
Poroporo/ NZ Nightshade (*Solanum aviculare*)	MB	X	X	X	X	Yes
Puahou/ Fivefinger (*Pseudopanax arboreus*)	MB	Yes	Yes	Yes	Yes	Yes
Pukatea (*Laurelia novaezelandiae*)	K	X	Yes	-	-	X
Putaputaweta/ Marbeleaf (*Carpodetus serratus*)	K + MB	Yes	Yes (MB)	Yes (MB)	-	Yes (MB)
Rata (*Metrosideros* spp.)	K + MB	Yes (K)	-	-	Yes	Yes (MB)
Rewarewa (*Knightia excelsa*)	K + MB	Yes	-	-	Yes	Yes (MB)
Rimu/ "red pine" (*Dacrydium cupressinum*)	MB	Yes	X	X	X	X
Tarata/ lemonwood (*Pittosporum eugenioides*)	MB	Yes	Yes	Yes	X	Yes
Tawa (*Beilschmiedia tawa*)	K + MB	Yes	Yes (K)	Yes (k)	-	Yes (MB)
Tawhai raunui/ Red Beech (*Fuscospora fusca*)	MB	Yes	X	X	X	Yes
Tī kōuka/ Cabbage Tree (*Cordyline australis*)	MB	Yes	X	X	X	Yes
Wharangi (*Melicope ternata*)	K	X	Yes	-	-	X

Issues

Issue 6.1: Translocations have a lower chance of success without high habitat quality.

Issue 6.2: The longer the time between local extinction and the planned release, the greater the chance that the habitat will no longer be suitable, and therefore require more effort to make suitable.

Issue 6.3: Population density and reproductive success or survival are often lower at the periphery of an area than the core of the area.

Issue 6.4: Released birds may decide to reject the habitat near the release site and rapidly move long distances away before settling.

Issue 6.5: Kākā are secondary cavity nesters, requiring particular tree characteristics (refer Table 5.1) for successful nesting.

Issue 6.6: Some sites do not have sufficient natural nest cavities to encourage successful nesting.

Issue 6.7: Release sites require naturally sufficient food sources (refer Table 5.2) since adequate nutrition can induce nesting success.

Objectives and actions

Objective 6.1: Projects should be focussed on areas that will provide ample opportunity for reproduction, however it is important to consider that these 'sink' areas can be great corridors (refer Topic 5: Strategic corridor management) to support the entire population of North Island kākā.

Objective 6.2: The chance of immediate dispersal could be mitigated by providing sufficient pre-release training and/ or supplementary feeding.

Objective 6.3: To protect natural nest cavities from predators (i.e. by adding metal collars).

Objective 6.4: To add sufficient artificial nest boxes to release sites when there are insufficient natural nest cavities.

Objective 6.5: To ensure future release sites have sufficient natural food sources, thereby limiting the need to rely on supplementary feeding.

5.1.7. Topic 7: Best practice

Parker *et al.* (2016) drafted a document titled "Best practice techniques for the translocation of kākā (*Nestor meridionalis*)". This document is currently awaiting Department of Conservation sign off to become a final version which can be distributed to those participating in kākā translocations. The document covers best practice requirements for topics such as animal welfare, the translocation team, husbandry and post release management (Parker, *et al.*, 2016). It is important to note that as new information and technologies become available, they should be assessed and, if appropriate, included in the manual.

Issues

Issue 7.1: The kākā best practice manual requires regular updates.

Objectives and actions

Objective 7.1: To ensure that kākā management is undertaken to a consistent and high standard.

5.1.8. Topic 8: Review schedule

Supporting documents relevant to kākā recovery that are in existence or developed during the life-time of this plan need regular updating to maintain their relevance (e.g. husbandry manual and captive management plan).

Issues

Issue 8.1: Supporting documents require regular updates.

Objectives and actions

Objective 8.1: To ensure that key supporting plans for kākā recovery contain up-to-date and relevant information.

5.1.9. Topic 9: Disease Management

Cunningham (1997) observed that populations may lose endemic diseases as they get smaller, and thereby become immunologically naïve and at greater risk from epidemics of their previously endemic diseases. He identified the following points for minimising the risk of alien infestation or infection while in captivity: (1) hold the animals as near to the release site as possible; (2) minimise the time the animals spend in captivity; (3) prevent contact between the animals and those from a different source/ species; (4) minimise by hygiene the risk of keeperto-animal parasite transfer; and (5) avoid the transfer of parasites to animals from foodstuffs. He added the following considerations: (a) absence of disease in the animals is not proof of immunity to disease; (b) juvenile animals also carry diseases unseen; (c) clinically healthy animals should not be regarded as parasite-free; (d) reintroduction is safer than supplementation; and (e) if disease risk assessment is not possible, a programme should only continue if the conservation risk of not doing so justifies it (Collar, 2006).

Wolf *et al.* (1996) found that disease was not commonly cited as influencing translocation outcome. However, this lack of reference may reflect a low incidence of disease in translocations or, more likely, difficulty in diagnosis (Wolf, *et al.*, 1996). In general, one of the greatest issues against reintroductions is the great risks that can jeopardize the survival of released individuals as well as wild populations. The greatest risks are the possibility of disease dispersal into the wild population, genetic hybridization, and aberrant behaviours. By far, the pathological risks of disease dispersal are something for which there is never total certainty. A solid recovery plan should therefore aim to the greatest possible margin of security against disease dispersal, by following the strictest veterinary, quarantine and prophylactic methods (Grajal & Sanz, 2002). It is important to note that there is a major risk of disease transmission from captive to wild birds, which seems to be particularly high in psittacines (Collar, 2000).

The management of disease and known pathogen transfer is important both to maximise the health of the translocated organism and to minimise the risk of introducing a new pathogen to the release area (IUCN/ SSC, 2013). It is intuitively obvious that reintroductions should use only individuals that are healthy and in optimal physical condition. Releasing animals that are physically or immunologically compromised may undermine reintroduction efforts just as effectively as the selection of inadequate release sites (White Jr., *et al.*, 2012). Birds selected for re-establishment projects should therefore be assessed to be healthy, in good physical form without genetic, morphological or behavioural anomalies that reduce their chances for survival (Grajal & Sanz, 2002).

Pre-release quarantine and testing

Any birds destined for release must be held in quarantine prior to transfer and tested for diseases of concern, to ensure other birds, captive facilities and release sites are not exposed to disease (Collen, 2010; IUCN/ SSC, 2013). Tests should be completed for potential enteric pathogens (e.g. *Yersinia, Salmonella, Chlamydia*). Faecal samples should be tested for *Coccidia* and worm eggs. Blood samples should be used to test for blood parasites and for genetic analysis (Moorhouse & Greene, 1998). For kākā the risk of Psittacine Beak and Feather Disease (PBFD) is of particular concern (Collen, 2010), birds should therefore be tested for PBFD prior to housing them with new conspecifics.

Once birds have been screened to be free of any detrimental avian diseases, it is recommended that birds are moved to aviaries within the natural habitat. Facilities should include ample outdoor aviaries as well as closed areas for quarantine and other management needs (Grajal & Sanz, 2002).

Every parrot arriving in the reintroduction area should be quarantined and their veterinary health status should be tested. Ideally birds should be sexed prior to release. All birds that die during quarantine or acclimatisation should receive a thorough necropsy and the results of the post mortem should be sent to the appropriate veterinary contact for kākā (Grajal & Sanz, 2002; Joustra, 2016).

In 2015 a few captive kākā siblings were health tested due to them having increased water consumption. Research by Wildbase hospital (Massey) into the behaviour have found it to be a hereditary metabolic disorder called diabetes insipidus. Birds with this disorder are not suitable for release as their health status is compromised.

If release is delayed beyond 30 days, all health tests should be repeated to minimize the possibility of disease dispersal into wild populations (Grajal & Sanz, 2002), especially where the birds have (possibly) been in contact with un-tested individuals.

Animal welfare

The IUCN stipulates in their guidelines that regarding the welfare of the animals being transferred to a release site, individuals must adhere to internationally accepted standards for welfare, while complying with national legislation, regulations and policies (IUCN/ SSC, 2013). It is crucial that organisations involved in the re-establishment of kākā follow the most recent guidelines to ensure stress or suffering is kept at a minimum. Stresses during the translocation process can occur during capture, handling, transport and holding, as well as during pre- and post- release (IUCN/ SSC, 2013). The source of the birds will determine the level of stress at various stages in the translocation process, for example wild caught birds are more likely to have higher levels of stress if being held in captivity at the release site for long periods. Additionally, it is important to consider the impact the removal of individuals from the source population can have on established social relationships (IUCN/ SSC, 2013).

Issues

Issue 9.1: Avian diseases could cause dramatic declines in kākā populations.

Issue 9.2: Re-establishment programmes carry the risk of introducing diseased birds to new sites affecting the survival of released individuals as well as wild populations.

Issue 9.3: Disease transmission from captive to wild birds seems to be particularly high in psittacines.

Issue 9.4: Stresses during the translocation process can have a detrimental impact on the released birds and the wild populations.

Objectives and actions

Objective 9.1: To provide security against disease dispersal, by following the strictest veterinary, quarantine and prophylactic methods.

Objective 9.2: To complete full health assessments on selected birds, ensuring they are in good physical form without genetic, morphological or behavioural anomalies that reduce their chances for survival.

Objective 9.3: Organisations/ individuals involved in the re-establishment of kākā follow the most recent guidelines to ensure stress or suffering is kept at a minimum.

5.1.10. Topic 10: Sourcing birds

Establishment of new kākā populations derived from captive-reared or birds transferred from other populations has proven to be possible (Greene, *et al.*, 2004; Berry, 1998). Whether a site uses captive or wild-caught birds will be dependent on the ability of the captive programme to provide birds for release. But in general, the option of reintroducing captive-bred individuals normally will prove to be a much more expensive or riskier way of increasing wild parrot populations than simply increasing the output from existing wild nests or translocating wild birds from other locations (Munn, 2006).

The South Island kākā captive management plan by Collen (2010) states that the preferred option to set up new kākā populations will be to initially crop wild juveniles (and later, egg swaps) from restoration sites, rather than maintaining a captive programme for re-establishment. Juveniles transferred from the sanctuary populations would be habituated to artificial feed stations and nest-boxes, which can then be used at the new release sites to help anchor and protect the translocated birds. This method has been used for the North Island kākā as well, and should be considered more often in the future mainly due to the unreliable nature of the captive programme.

Based on the available evidence it would seem easier to boost dwindling mainland populations with young birds from offshore islands rather than with captive-bred birds (Moorhouse & Greene, 1998). However, the use of wild-caught kākā has proven difficult regarding anchoring birds to the release site. Berry (1998) noted that after release in 1996, the wild-caught kākā immediately dispersed from the release site. One of these was recaptured and held in an aviary for two months prior to a second release. Since the re-release, that bird has remained within Mt Bruce reserve and has been regularly sighted (Berry, 1998), hence why wild-caught kākā are recommended to be subject to the delayed release method (refer Topic 13: Pre-release training (soft-release)).

An additional option could be the release of rehabilitated rescue/ rehab birds. Annually, several kākā are handed into wildlife hospitals around New Zealand (and especially in Wellington where numbers of kākā are high). Once the birds are recovered they need to be released as soon as possible. The rehabilitation permits issued by the Department of Conservation state that animals are to be released under directive of the Department of Conservation. This could mean that they would be able to direct the release of rehabilitated kākā to release sites that need to boost their population numbers. Adding small groups to an existing population has proven to be a faster method for successful integration than large groups (Grajal & Sanz, 2002), which could make rehabilitated birds a suitable candidate for release in other areas.

Berry (1998) found that while site-fidelity was higher for captive-bred kākā than for wild-caught kākā, most of the kākā moved a limited distance from the release site, however they generally stayed within Mount Bruce Reserve. This suggests that translocated wild-caught juvenile kākā will stay near the liberation site if a delayed release method is used.

What may play an important role in the success of re-establishment is that species adapt to local environmental conditions. Therefore, if the habitat experienced by the source population does not match the habitat selected for the release, the individuals could be maladapted and success could be compromised (Osborne & Seddon, 2011). For this purpose, it is important to ensure that the release area is as close to the source area as possible.

Collar (2006) discussed that wild caught birds survive much better after release than captive-bred birds. Therefore, a general principle was established that reintroductions of parrots should preferably use wild-caught stock, especially when the target is true re-establishment rather than supplementation. They pointed out that fostering captive-laid eggs or captive-hatched nestlings in wild nests can be important in boosting wild populations. This built on research by Wiley *et al.* (1992), who also pointed out how much cheaper the translocation of wild-caught birds is by comparison with captive breeding, but who noted the drawback that the released birds may show long distance homing behaviour (Collar, 2006). Wild-caught birds will need to be soft-released to give them time to adjust to their new environment.

Conservation managers should aim to protect natural processes as well as species. For kākā this would entail preservation of naturally occurring dispersal of birds and their gene flow among populations. Special consideration may be given to Kapiti Island kākā which show reduced genetic diversity consistent with a recent human-induced population bottleneck. In the short-term it would probably be unwise to use Kapiti Island kākā as a source for transfers to other areas, although increasing diversity would be expected with assisted and natural gene flow to the island (Sainsbury, *et al.*, 2006) if this is given priority.

Work with the Echo parakeet (*Psittacula eques echo*) in Mauritius, and with Scarlet and Green-winged macaws (*Ara macao* and *Ara chloroptera*) in Manu and Tambopata, Peru, and in Costa Rica, has shown that the best way to increase the local parrot population in a wild setting is to help all wild-laid eggs survive to hatch and fledge healthy young (Munn, 2006). This is a labour intensive way of ensuring survival in the wild, however, this could be applied to kākā via protection of nests/ fledglings.

To give the release sites the best start, it is important to release birds that are as genetically varied as possible (Collar, 2006). In the past, the captive programme contributed mainly siblings to release sites. Going forward it is vital for the release sites to have a wide range of founder stock to start off their new populations. Founder selection should be aimed to provide adequate genetic diversity (IUCN/ SSC, 2013).

Ex-situ component

To date most kākā re-establishments were initiated with the use of captive-bred birds. This is in line with Fischer and Lindenmayer (2000) who found that 84% of birds used in releases came mostly from captive breeding programmes. Most of the kākā released in the North Island originate from the same 15 captive pairs. In the past, the same pairs were used to produce birds for the breed for release components, with some pairs producing as many as 30 chicks to the five different release sites. Since 2012 the captive programme was focussed on establishing new pairs and produce chicks with as wide of a genetic variation as possible, however due to the limited birds available in captivity (approximately 40), the suitability of those birds and the space constraints in the captive facilities, the contribution to the release programmes is very unreliable (Joustra, 2015; Joustra, 2016; Parker, *et al.*, 2016).

It is unclear whether the close relatedness between released populations is detrimental to the establishment of kākā around the entire North Island, especially considering the large distances kākā can travel. Moorhouse and Greene (1998) found that the dispersal of juveniles from Little Barrier to Great Barrier, and adults from Hen Island to Little Barrier Island demonstrates that the kākā of the forested northern islands are effectively one population. Dispersal has also been recorded from Little Barrier Island to the adjacent mainland and even as far as Gisborne. Berry (1998) noted that one of the wild kākā released at Mount Bruce made its way back to the west coast of the North Island 39km from the release site. The ability of the species to disperse aside, it is not in line with best practice to over-represent a few founders when reintroducing a species. It is therefore recommended that the selection process includes unrelated birds and large enough numbers for the site to ensure a genetically varied and sustainable population is achievable.

The main issue limiting breeding success for South Island kākā in captivity is related to husbandry and housing standards, and the lack of clear guidance about minimum husbandry requirements (Collen, 2010). This could be similar for the North Island kākā since captive kākā can nest every year on a completely artificial diet (Moorhouse, 1997). This should be explored further if the captive component is to continue to remain a part of the re-establishment programme for kākā.

Captive or propagated individuals should be from populations with appropriate demographic genetic, welfare and health management, and behaviour (IUCN/ SSC, 2013). The focus of the captive programme should therefore be on producing good quality birds that will be well adjusted socially and fit for release into the wild. Keepers becoming too familiar with kākā in their care can lead to imprinted birds with generally dysfunctional behaviour towards other birds and towards people. The preference for rearing of chicks is always by fostering to kākā parents rather than hand-rearing (Collen, 2010). Additionally, it is important to consider that behaviours exhibited by predator-naïve captive-bred kākā, such as spending time on the ground, greatly increase their exposure to predators, and may be a significant factor in whether populations of captive-bred kākā can be established in the wild (Berry, 1998).

The South Island kākā programme has an exit strategy where individuals that are suitable for release are translocated and the remainder is "grandparented", which means they are to be held without breeding. South Island kākā remaining in captivity that are on display may continue to be held on display until they die, provided the display meets the required advocacy criteria and standards (Collen, 2010). Besides contribution to a release programme there are other reasons for maintaining captive stock. The most obvious of these is advocacy; having kākā on display raises public awareness of the bird. Another reason is research, e.g. some aspects of kākā biology would be difficult or impossible to investigate in wild birds. Captive birds are also useful for trialling new field techniques e.g. transmitter attachment trials (Moorhouse & Greene, 1998). Whether the North Island kākā's captive programme continues to be part of the re-establishment programme will depend strongly on its ability to reliably produce birds for release.

At the start of 2016 there were 11 facilities in the captive programme of which only four held breeding pairs (Joustra, 2015). Because facilities for holding birds are limited nation-wide, eggs produced by captive birds are routinely destroyed unless there is a specific requirement for kākā nestlings (Moorhouse & Greene, 1998). This requirement can only be met by having release sites with approved release permits. Outside the timeframe of the permit the sites are unable to receive birds for release. In 2014, the captive programme produced more chicks than suitable for release at the two current release sites. For that reason, one of the old release sites obtained a special approval to release the surplus chicks from the programme, which is far from ideal either. The programme would benefit from a cooperative plan to ensure all chicks can be placed in the best location, rather than ad hoc placement of "surplus".

Captive breeding programmes that are focused on translocation should have the goal of establishing multiple self-sustaining populations so they can provide sufficient animals over several years and increase the success of these expensive programmes (Griffith, *et al.*, 1989). To date, release sites tend to apply for permits to acquire birds for translocation for a specified number of years only and without prior consultation with the captive coordinator. When applying for a permit, the captive coordinator should be consulted to determine whether the captive programme can support the re-establishment of kākā through the production of captive-bred birds.

It is important to recognise that the progeny of several generations of captive breeding is less likely to be successfully reintroduced than wild-caught translocated animals or even first-generation captive-bred animals owing to the unconscious selection by breeders for tractability and docility, hand-rearing of sickly infants (thereby limiting natural selection from the genepool), and the constant association with human beings (Collar, 2006). It speaks for itself, that if the captive programme is continuing to supply birds, it will be paramount that founders are given breeding preference over those pairs that have been captive for a long time and those that are over-represented already.

Due to the limited amount of breeding pairs in captive facilities it is vital that the captive programme should not be the only source of birds, but should rather be used for supplementation and anchoring only (Joustra, 2016). The reintroduction of birds to the wild is, at least at present, not the primary justification for keeping kākā in captivity. A more appropriate use for captive-bred birds may be as demonstrators on the utilisation of supplementary foods to wild caught birds held in captivity prior to release as well as the prevention of rapid dispersal of wild-caught birds at the release site (Moorhouse & Greene, 1998).

Hand-rearing

It is imperative that where possible any form of visual or auditory contact between birds selected for release and humans should be avoided (Grajal & Sanz, 2002), considering this could compromise their ability to adapt to their new environments. Additionally, considering parrots appear to learn all their survival skills, not just foraging, through social interaction and 'cultural transmission' (particularly involving parent and offspring) it is more beneficial for birds to be reared by conspecifics (Collar, 2000).

Berry (1998) reported that all four of the hand-reared kākā that were released at Mount Bruce were always located within 1km of the release site/ feed station area, and that they were often observed around aviaries at the Mt Bruce National Wildlife Centre during the first six months they were monitored after release (Berry, 1998). Despite this success, hand-reared birds are generally considered the least suitable for release because of their almost total lack of fear of humans and their reluctance to socialise with wild-caught or parent-reared members of their own species (Collar, 2006).

The use of hand-reared birds is not recommended for the re-establishment of North Island kākā unless the birds can be raised with minimal human interaction. The preference would be the use of fostering. Fostering is the best technique but this can only be used where (1) wild pairs are breeding, (2) some of these pairs have subnormal brood sizes; and (3) captive reproduction is synchronised with the wild pairs (Collar, 2006). In the case of fostering, the over-represented pairs in captive facilities could be used for rearing considering their demonstrated ability to successfully rear chicks.

Availability of stock

When selecting stock for a site, it would be beneficial to complete an analysis on where to source birds to use for the re-establishment. Translocations of juveniles would be a more reliable method of acquiring stock compared to waiting when captive-bred birds become available for release. Additionally, the genetic diversity of the starting population could be higher when translocated individuals are used (if selection is appropriate) than sourcing birds from the current captive population.

Issues

Issue 10.1: The use of wild-caught kākā has proven difficult regarding anchoring birds to the release site.

Issue 10.2: Several kākā are handed into wildlife hospitals annually, once rehabilitated these birds are released at their location of origin.

Issue 10.3: If the habitat experienced by the source population does not match the habitat selected for the release, the individuals could be maladapted and success could be compromised.

Issue 10.4: Kapiti Island kākā show reduced genetic diversity consistent with a recent human-induced population bottleneck.

Issue 10.5: Techniques which increases survival of wild-laid eggs and fledglings are expensive.

Issue 10.6: In the past, founding populations originating from the captive programme often included closely related individuals, which goes against the principles of sound population management.

Issue 10.7: There is a lack of clear guidance about minimum husbandry requirements for North Island kākā in captivity.

Issue 10.8: There is a lack of direction for the captive North Island kākā programme.

Issue 10.9: Any form of visual or auditory contact between birds selected for release and humans should could compromise their ability to adapt to their new environments.

Objectives and actions

Objective 10.1: To promote anchoring/ soft-release techniques for wild-caught kākā.

Objective 10.2: To coordinate the release of rehabilitated kākā to release sites.

Objective 10.3: To ensure that the release area is as close to the source area as possible.

Objective 10.4: To reduce the use of Kapiti Island kākā as a source for transfers to other areas (in the short-term). Where required, genetic considerations can still allow for use of the island's birds.

Objective 10.5: To investigate cost-effective ways to ensure survival of wild-laid eggs and fledglings.

Objective 10.6: To provide adequate genetic diversity to release sites by appropriately coordinating founder selection.

Objective 10.7: To provide the captive industry with husbandry guidelines which demonstrate how to manage the breed for release birds.

Objective 10.8: To develop a management plan which ensures an analysis on correct founder representation for each release site. This plan should also include "grandparenting" or potential release of over-represented founders.

Objective 10.9: To advise against the use of hand-rearing North Island kākā chicks (especially when used for release).

5.1.11. Topic 11: Bird selection criteria

When selecting which kākā to use for the release programme, there should be an assessment to determine whether the birds will be suitable for release. The following attributes would be preferred for kākā (Collar, 2006; Olney, *et al.*, 1994):

1) Contact with people should be kept to a bare minimum (e.g. kākā should not originate from walk-through aviaries and should not be used to hand-feeding);
2) Birds should be physically sound for release (e.g. kākā should be able to find food in the wild and fly long distances);
3) Birds should be mentally sound for release (e.g. kākā should be well socialised and able to integrate into a flock)
4) Birds should receive an appropriate level of pre-release training (e.g. diet, nest boxes and feeders should be in line with the release sites).

Had the above criteria been observed in the implementation of the reintroduction programme for the Thick-billed parrot (*Rhynchopsitta pachyrhyncha*) in the United States, it would have found that the birds were unlikely to survive because the lab-raised birds were not sufficiently able to recognise and avoid predators, that they were too slow in their feeding techniques and unable to fly at high speed for large distances (Munn, 2006).

Age at release

Parrot reintroductions generally involve release of both juvenile and adult birds (refer Topic 10: Sourcing birds), though the use of only adults is not used very frequently. Translocations of kākā are more likely to be successful when juveniles are transferred, because adult kākā have a strong homing instinct and flight capability. However, captive-bred adults have also been successfully released into already established populations (Collen, 2010). In at least some cases, the release of adults is favoured owing to the more destabilising effect on long-term age structures due to losses of juveniles from the source population (Collar, 2006). Besides the potential detrimental effects on the source population, it should also be considered that juveniles could learn behaviours linked to survival from adult birds and to encourage social interactions among them (Grajal & Sanz, 2002).

Juvenile kākā are generally considered to be less susceptible to predation than kākā of other ages (adult females, chicks and fledglings) so this may be an ideal age at which to translocate kākā to new locations. Juvenile kākā also appear to display more behavioural plasticity than adults – juveniles were the first to learn to take supplementary food in Nelson (Berry, 1998). This is in line with Grajal and Sanz (2002) who concluded that birds used for release should be young and preferably should have been obtained within the first year of life. Other good candidates include wild adults that were captured recently (Grajal & Sanz, 2002).

Quantity of birds

Most parrot reintroductions around the world release approximately 30 birds per project (this can be over several events). Because longer translocation programmes are more successful, the minimum number may be released over several years if insufficient animals are available for a single release (Griffith, *et al.*, 1989). The Department of Conservation's Translocation Proposal Explanatory Notes recommends a similar number of birds per project (i.e. at least 30 individuals), to reduce the likelihood of inbreeding and produce a genetically diverse and viable population (Collen, 2010). However, for translocations in birds, the New Zealand experience suggested that about 40 individuals should be used, although a "rule of thumb" is that fewer individuals are needed for long-lived species, which is presumably related to their low variability in lifetime reproductive success (Collar, 2006).

Wolf *et al.* (1996) found that overall, the median translocation programme released 50.5 animals over a 3-year period (n =266), and approximately 32% of the programmes released 30 or fewer animals and 62% released 75 or fewer animals. Small numbers of released individuals were associated with (1) a high probability of early failure, but (2) low long-term extinction probabilities among surviving populations, whereas the opposite pattern was observed for the population size (Robert, *et al.*, 2015). To avoid segregation, releasing small groups of parrots has a better probability of acceptance by wild flocks than the release of large groups (Grajal & Sanz, 2002).

It is important to note that the number of birds to be released per release site will be dependent on the carrying capacity of the habitat, though if birds settle outside the release area this in turn could still be contributing to the overall re-establishment of kākā in the North Island.

Sex-ratios at release

Most programmes attempt to release a balanced sex ratio, however observations and captures of kākā on the mainland suggest there is a significant bias in the sex ratio towards males in the order of three males to every female and as high as six males to every female. On the other hand, sex ratios of kākā populations on pest-free islands (such as Little Barrier and Kapiti Islands) have been almost 1:1 (Powlesland, *et al.*, 2009; Moorhouse & Greene, 1998). The predicament of sex-biased populations is not confined to the kākā, with populations of several other New Zealand forest bird species, such as the North Island robin (*Petroica longipes*) and North Island kōkako (*Callaeas wilsoni*) being in decline and male biased due to predation by introduced mammalian predators (Powlesland, *et al.*, 2009)

Observations on the mainland suggest that female kākā suffer much greater losses before or during adulthood (Greene & Fraser, 1998). The predatory activities of stoats and brushtail possums have resulted in many nesting female kākā being killed, and so unmanaged mainland kākā populations have become male dominated (Powlesland, *et al.*, 2009). An apparently static low- to moderate-density population of kākā dominated by long-lived male birds and relatively few breeding females is clearly not a healthy one. In such situations, transfer of additional female kākā in conjunction with intensive pest control may be required to resuscitate the population (Greene, *et al.*, 2004).

Therefore, depending on where birds are to be released, sex ratios should be as close to one to one wherever possible. If supplementation is required and the habitat is suitable, it might be needed to adjust the ratios accordingly (i.e. more females than males).

<u>Issues</u>

Issue 11.1: Selection of the right birds for release contributes to the success of the programme.

Issue 11.2: Releasing birds in a short programme (i.e. releasing many birds in 1 release) is less likely to be successful.

Issue 11.3: Female kākā suffer much greater losses before or during adulthood due to predation by introduced mammalian predators.

Issue 11.4: Many mainland populations of kākā have apparent static low- to moderate-density populations which are dominated by long-lived male birds and relatively few breeding females.

<u>Objectives and actions</u>

Objective 11.1: All birds should be assessed on their suitability prior to release (i.e. juvenile birds and recently captured adults over captive reared adults).

Objective 11.2: To sex all birds prior to release (to monitor sex-ratios on site).

Objective 11.3: To promote long-term release planning, ensuring that the minimum number of birds required per site will be released over several years.

Objective 11.4: To better protect female kākā on the mainland, ensuring their survival which in turn will provide better sex-ratios in the wild populations.

Objective 11.5: To establish required sex-ratios for release sites thereby preventing “flooding” the sites with additional males.

5.1.12. Topic 12: Identification techniques

All kākā used for re-establishment (whether wild or captive origin) should have some form of identification to enable successful monitoring of birds' post release. Electronic transponders and other permanent markers are also recommended if they do not compromise the bird's movements or survival (Grajal & Sanz, 2002). There are various identification methods that could be used, however it is recommended that kākā have the following identifiers as a minimum:

1) Metal bands: Grajal and Sanz (2002) advise that all individuals should be permanently marked with numbered metal leg rings. In New Zealand metal bands and their related information are available from the New Zealand National Banding Scheme (The Ornithological Society of New Zealand, 2016).
2) Microchips/ Transponders: This is the most reliable method to establish the origin of the bird when caught/ found post release (i.e. when handed into rescue/ rehab facilities). Transponder failures do occur; though they are rare. The main drawback with transponders is associated with the implantation, where a small percentage migrate in the body (American Veterinary Medical Association, 2016). At Zealandia birds were microchipped prior to 2014 when microchips had migrated into the sinus cavity of three different kākā (Parker, *et al.*, 2016), it is possible that the insertion site (the neck) was the cause of the migration of these microchips. Microchips in kākā should be inserted intramuscularly in the left pectoral muscle (World Small Animal Veterinary Association, 2016).

Moorhouse and Greene (1998) suggest that the most effective and efficient means of identifying individuals has been via radio transmitters where individuals are identified by a unique frequency. They also discussed the drawback of this method being the limited battery life of the transmitter (currently 11 months for North Island kākā). Trials with two types of transmitter aerial tags suggest that they are robust, have no effect on transmitter signal, do not appear to impede the birds in any way and are significantly more visible than coloured leg bands (Moorhouse & Greene, 1998). Transmitters would be very useful for immediate post-release monitoring or for research which requires immediate tracking of birds, however considering the limited battery life, microchips would be a better method to enable monitoring of birds for their lifetime.

<u>Issues</u>

Issue 12.1: Released birds are hard to monitor without clear identification techniques.

<u>Objectives and actions</u>

Objective 12.1: All released individuals should have clear identifiers to enable successful monitoring post release.

5.1.13. Topic 13: Pre-release training (soft-release)

Pre-release training includes measures such as inducing animals to search for hidden and spatially distributed food and to move around on natural vegetation in their enclosure, inducing them to handle pine cones and encouraging them to fly in pre-release cages (Olney, *et al.*, 1994). Berry (1998) noted the importance of exposing captive-bred kākā to aspects of the natural environment, and learning from experienced adult birds prior to release. Grajal and Sanz (2002) also recommend that the diet during the acclimatisation phase should maximize the number and variety of food items from the wild. At the same time those items should be (where possible) presented in a manner that closely resembles how they occur in the wild, this will teach the birds how to manipulate and recognise the items (Grajal & Sanz, 2002).

While housing captive-born reintroduction candidates with skilled conspecifics to demonstrate behaviours crucial to survival is beneficial, it is not necessarily required if the animals receive sufficient time to become used to less human contact and become familiar with the reintroduction site (prior to release), climatic conditions, landmarks, natural foods or other features of the natural environment (Olney, *et al.*, 1994).

The most common method to allow for pre-release training is via delayed release (also known as soft-release) where birds are temporarily held in an aviary at the release site to become accustomed to the area and feeding at feed stations, before being released (Collen, 2010). Additionally, soft-release is assisting in anchoring birds to the release site. It is important to note that throughout the soft-release period human interactions should be kept to a minimum and visual and auditory contact with humans should be avoided (Grajal & Sanz, 2002).

All kākā reintroduction projects to date have used "soft-release" techniques. Another way of supporting the success of the re-establishment of kākā can be by maintaining captive kākā in the release site aviaries (Berry, 1998). Grajal and Sanz (2002) propose that once a local population has been established, it is preferred that no captive parrots are left near the release site, as these captive animals can be a strong focus of attention for newly liberated parrots, and can make the re-adaptation period quite long (Grajal & Sanz, 2002). Considering the intention is to have the newly released birds integrate into a wild population as soon as possible, it would be recommended to hold some birds for the initial re-establishment phase only. A suggested method could be to use captive-bred kākā and maintain those in the aviary for a longer period, while at the same time releasing wild-caught kākā first. Following their successful release, release the captive-bred individuals prior to releasing supplementary individuals.

Once some birds are established in the wild subsequent releases of wild caught birds can often be accompanied by direct introductions of bird into the wild flock relying on the gregarious nature of most species to encourage rapid integration. With thick-billed parrots it was found that the faster integrations seemed to occur when singletons were released. Birds in larger release groups appeared less motivated to join the wild flock probably because they had other members of the released group available for socialisation. Where direct integrations into a wild flock are possible released birds can quickly learn important information regarding location of food, water and roosting locations from experienced birds, and rapidly become as sophisticated as their peers in interacting with their new environment (Collar, 2006).

Aviary size

Grajal and Sanz (2002) advised that aviaries used for parrot species should be big enough (vertically and horizontally) to allow some flight capacity. The aviaries should be tall enough (4 - 5m) to allow them to be accustomed to a taller perspective. The floor should be elevated to avoid contact with excrement and discards. Perches and branches should be changed frequently and food should not be offered on the floor. It is important to give kākā sufficient opportunity to build strength in their wings to support better chance of survival in the wild.

Additionally, it is important to provide a range of different perspectives for the birds to gain confidence in their release environment. Where the aviary is located is dependent on the different release sites, it is recommended that sites liaise with other sites prior to building aviaries to ensure all the pros and cons for the site are considered prior to design of new aviaries. An important factor in the design of any aviary that will house kākā for release, is that it should not be treated as a "display" aviary (i.e. the aviary should be in a remote quiet location, far enough away from regular human interactions) (Parker, *et al.*, 2016).

Supplementary feeding

Previous research published by White Jr. *et al.* (2012) discusses that for most reintroduced animals – particularly if captive reared- the post-release provisioning of food tends to aid transition to the new environment. Extended periods of supplementary feeding were associated with higher reintroduction success, due to the feeding promoting site fidelity of released birds, increased social interactions, and accelerated integration of subsequently released birds into previously established flocks. Grajal and Sanz (2002) advised that for parrots supplemental feeding at or near the release site is recommended, if this supplemental feeding is gradually reduced until reintroduced parrots are feeding on wild foodstuffs. On the other hand, at Zealandia, supplementary food is offered year-round (Charles & Linklater, 2013; Recio, *et al.*, 2016) which may support a higher carrying capacity than in areas where supplementary feeding is not taking place (Munn, 2006).

Supplementary feeding of reintroduced kākā has indeed promoted site fidelity and facilitated post-release monitoring for several release sites (Berry, 1998; Smuts-Kennedy & Parker, 2013; Parker, *et al.*, 2016). For kākāpo the supplementary feeding was linked to improved survival and breeding success of reintroduced kākāpo during short-term natural food scarcities (White Jr., *et al.*, 2012), therefore it could be expected that supplementary feeding of kākā (who are also episodic breeders) could improve breeding success. Moorhouse and Greene (1998) did indeed confirm that supplementary feeding increased the breeding success of kākā, however it did not increase the frequency of breeding. Berry (1998) also found that supplementary feeding did not appear to alter the natural feeding behaviour of the kākā.

As with habitat quality, increased supplementary feeding contributes proportionately more to subsequent breeding by released birds than to post-release survival (White Jr., *et al.*, 2012).

However, releases of Hispaniolan Parrots (*Amazona ventralis*) have shown that supplementary feeding for captive-reared birds is generally crucial to their initial survival, especially when no wild birds are available to help (Collar, 2006). Besides initial survival, Berry (1998) also noted that supplementary feeding was valuable in the period after release to ease the birds' transition to a new environment, and may have played a part in keeping the birds close to the release site.

The nutritional needs of birds change in time and space, being highest when they hatch, decreasing continuously as they grow, but increasing again for females when they breed (Innes, *et al.*, 2010). For this purpose, it may be useful to provide supplementary food at times to increase nesting success, such as during the breeding season (Berry, 1998; Moorhouse & Greene, 1998).

Auditory call playback

Auditory playback of calls is a means of behavioural anchoring. This method has been used with some success in encouraging the return of translocated sea bird chicks to sites around New Zealand, while realistic artificial decoys and calls have been used to attract the Australasian gannet (*Morus serrator*) to sites around New Zealand (Berger-Tal & Saltz, 2016). Even though this method has not been trialled on kākā before, further research into this could be beneficial considering maintaining captive parrots has proven to be successful in anchoring birds to their release site, kākā sounds could very well become a more cost-effective means of anchoring birds post-release.

<u>Issues</u>

Issue 13.1: Many kākā require some form of attachment to release sites prior to being released, to limit immediate dispersal of birds away from release site.

Issue 13.2: Many kākā require some form of training prior to being released, to adjust to their new environments.

Issue 13.3: Birds in larger release groups appear less motivated to join wild flocks probably due to having other members of the released group available for socialisation.

Issue 13.4: Aviaries used for anchoring or pre-release training should meet parrot re-establishment requirements.

Issue 13.5: Hard-releases tend to reduce a quick adaptation to the new environment.

<u>Objectives and actions</u>

Objective 13.1: To ensure release sites develop a plan to balance the sites requirements with natural parrot adjustment behaviour. This plan should demonstrate the intent to adjust release methods once an initial release has taken place.

Objective 13.2: To check aviary designs are suitable for kākā reintroduction candidates.

Objective 13.3: To promote (temporary) supplementary feeding methods for kākā.

5.1.14. Topic 14: Release events

Each site will have a minimum number of animals that should be released, however, this can be done over several years if necessary (Collar, 2006). Most parrot reintroduction projects release parrots over multiple events. Griffith *et al.* (1989) found that the probability that a single release of 300 birds will fail is 0.257 (data from 134 translocations of birds obtained from a survey conducted in 1987). Two releases of 150 birds each have individual probabilities of failure of 0.312. The probability that both will fail is 0.312 x 0.312 = 0.097 (Griffith, *et al.*, 1989). This indicates that there is a substantial gain by dividing the available birds between multiple release sites.

Once a flock has been established and more birds are required for supplementation, it may be best to drip-feed birds back into the wild one at a time (or in small groups) to encourage their rapid integration into the flock (Collar, 2006; Grajal & Sanz, 2002).

It is important to note that if captive breeding facilities are needed as part of the programme they need to be prepared to meet the requirements of the project (for example, provide breeding opportunities for several years).

Timing of release events

Most parrot reintroduction projects release birds in summer and autumn. This is in line with Grajal and Sanz (2002) and Collar (2006) who noted that when supplementing birds to an established population, the best time to release birds is toward the end of the reproductive season. This is because new fledglings would enter the population at the end of the reproductive season, which allows the release birds to enter at the time of social bonding and flocking. The reproductive period is not recommended for reintroductions, as reproductive pairs are easily aggressive towards other congeners, and this may retard social integration (Grajal & Sanz, 2002; Collar, 2006).

The release should be timed when food is likely to be widely available (Grajal & Sanz, 2002; Collar, 2006), even when supplementary feeding is going to take place. This would allow the birds to settle into their new surroundings faster, rather than releasing when food is scarce.

To date, from the 34 release events of captive-bred kākā most releases occurred in September (n = 8) and June (n =7) (Joustra, 2016). Unfortunately, survival rates of the released individuals are not recorded at each site, it is therefore hard to determine which of the months had better survival rates. However, in line with other parrot reintroductions the optimal time to release kākā would be in the months of April – June when fledglings are naturally occurring in the wild.

It is important to note that some sites would not be able to facilitate this due to upcoming winter conditions preventing access to released birds.

When using captive-bred fledglings this timeframe is unlikely to be met since captive birds require some form of acclimatisation to their new release area. For this purpose, it would be recommended that remote aviaries in release sites are set up to hold birds until the end of the next breeding season. Grajal and Sanz (2002) found that if birds originate from captive breeding facilities, then birds should be kept in the release aviaries for at least one year (and preferably two years). This allows the young parrots to recognize the seasonal food stuffs, as well as learn social interactions and vocalizations. It is not recommended to maintain the birds more than two years in captivity in the large aviaries to avoid domestication and other behavioural problems.

This would also be beneficial to release sites in New Zealand where they are unable to accommodate kākā during the winter months (i.e. Boundary Stream), the reason being that staff are unable to access the aviaries in the middle of winter when heavy snowfall limits access and aviaries are covered in snow. These types of sites could receive birds immediately after winter and release the following autumn. Evidently, if birds are of a wild origin, then these individuals can be released much earlier (i.e. once the veterinary tests are completed) (Grajal & Sanz, 2002).

Furthermore, the timing of the day can determine an individual's survival success. The most frequently used release time of the day is at dawn (Collazo, *et al.*, 2003; Saidenberg, *et al.*, 2013; White Jr., *et al.*, 2005; Wille, 1992), giving the birds sufficient time to find their bearings in their new environment as well as finding a roosting spot for the night.

<u>Issues</u>

Issue 14.1: The probability that a single large release will fail is significantly larger than multiple smaller releases.

Issue 14.2: The timing of the release events can determine successful integration into wild populations.

<u>Objectives and actions</u>

Objective 14.1: To promote long-term release plans where multiple small events are used.

Objective 14.2: To ensure that (where logistically possible) releases are in line with the reproductive cycle of kākā (i.e. April – June) when fledglings are naturally occurring in the wild.

Objective 14.3: To encourage release sites to increase individual's survival success by releasing birds at dawn.

5.1.15. Topic 15: Predator control

Significant declines in many species of forest birds in response to predation by introduced mammalian predators have been widely documented in New Zealand. Some of the earliest documented eradication programmes in New Zealand included goats, cattle, rabbit, feral cat and feral pig on a variety of islands such as Rangatira, Chatham and Kapiti Islands (Miskelly, 2009). Although predation is usually assumed to be the default explanation for bird declines in New Zealand, it is important to ensure that other factors, alone or in interaction, are also carefully evaluated (Innes, *et al.*, 2010).

Considering kākā are a hole-nesting and roosting species, female kākā (being solely responsible for incubation) are particularly vulnerable to predation (in some cases nesting females may suffer more than 80% mortality (Greene, *et al.*, 2004; O'Donnell & Rasch, 1991)), this has resulted in an excess of males in some populations on the mainland. Considering kākā are a relatively long-lived species and have a relatively low reproductive rate, the loss of females is having a detrimental effect on local populations (Innes, *et al.*, 2010; O'Donnell & Hoare, 2012; Moorhouse, *et al.*, 2003; Greene, *et al.*, 2004). These factors make them slow to respond to benefits of pest control (O'Donnell & Hoare, 2012), however, once populations have recovered it should also be possible to suspend predator management for several years (Moorhouse, *et al.*, 2003).

Kākā are vulnerable to predation throughout their breeding cycle (Greene, *et al.*, 2004). Moorhouse *et al.* (2003) found that the most common causes of nesting failure at unmanaged sites were egg mortality, predation of nesting females and nestling mortality (Moorhouse, *et al.*, 2003). Kākā females aggressively attack stoats when they enter the nest site. Powlesland *et al.* (2009) believe that their response to stoats could have readily brought about their demise. Aggressive behaviour by the female kākā even after their broods had been killed and removed from the nest, presumably reflects the relatively short time in which kākā have co-occurred with the stoat. Additionally, fledglings (who spend the first few days on the forest floor) are also especially vulnerable to predation by stoats, ferrets and feral cats in areas where no predator control is taking place (Innes, *et al.*, 2010; Powlesland, *et al.*, 2009; O'Donnell & Rasch, 1991).

White Jr. *et al.* (2012) note that the threat of predation must be taken seriously in psittacine reintroductions, and in those areas with high predation threat, either efforts to control or otherwise mitigate this danger should be implemented (e.g. trapping and translocation or lethal control of predators, aversion training of the potential prey), or alternative release sites should be chosen in areas with less predation threat (White Jr., *et al.*, 2012). Furthermore, Moorhouse *et al.* (2003) recommend that in podocarp forests, predator control should be conducted over an area at least as large as 1 100ha since this is large enough to contain a self-recruiting population.

For pest control to be successful in an area it is important to use a variety of methods, as pests can become shy of certain types of control (e.g. traps) and actively avoid control methods. Research by Robertson *et al.* (2016) found that in areas where stoats were continuously trapped, kiwi chick survival remained low (5%), however once mixed with 1080 baiting, survival of the chicks went up to 56% (Robertson, *et al.*, 2016). A combination of efforts could be an instrumental tool for kākā re-establishment where maintaining low predator levels could be combined with providing nest protection and pre-release training to increase success.

Furthermore, once a population has been restored to the habitat's carrying capacity, year-round or annual breeding season, intense control operations are no longer required (Powlesland, *et al.*, 2009; Moorhouse, *et al.*, 2003). Powlesland *et al.* (2009) also found that pulsed pest control on North Island kōkako was a good alternative to expensive continuous pest control. In the case of kākā, pulsed management is likely to be most cost-effective if pest control is timed to coincide with the masting of kākā food species. This would not only be of benefit to kākā but also to a wider variety of native forest-dwelling bird species. It is vital that pest control operations take into account all species of predators present and the months when kākā nestlings are likely to fledge (Powlesland, *et al.*, 2009; Moorhouse, *et al.*, 2003; Greene, *et al.*, 2004; O'Donnell & Hoare, 2012; Saunders & Norton, 2001; Moorhouse, 1997).

Overall, nesting success is greater at sites where pest control was carried out (and maintained to very low densities) than where no pest control occurs (Powlesland, *et al.*, 2009; Miskelly, *et al.*, 2005; Saunders & Norton, 2001; Moorhouse, *et al.*, 2003; Greene, *et al.*, 2004; Innes, *et al.*, 2010), to the extent that sites with predator control produce twice the amount of fledglings than those sites without predator control (Moorhouse, *et al.*, 2003) (refer Table 5.3). Kākā at mainland sites have been found to respond well to predator control using traps and bait stations (Miskelly, 2009).

Table 5-3 Comparison of kākā breeding success at sites with (bold type) and without, predator control *(Moorhouse, et al., 2003)*.

	RNRP	**WEA**	**Eglinton**	**Big Bush**	**Rotoroa**	**Whirinaki**
No. of nesting attempts	14	31	25	20	10	13
No. successful nests	12	27	20	2	1	5
% Successful nests	86	87	80	10	10	38
95% Confidence intervals	68 – 100	75 – 99	64 – 96	1 – 31	0 – 45	11 – 65
No. chicks fledged	35	70	55	5	4	14
No. chicks fledged/ nest	2.5	2.3	2.2	0.25	0.4	1.1

Intensive pest control that, over considerable periods, substantially reduced populations of possum (catch rate of <5% animals per 100 trap nights) and stoat (catch rate of <0.5% animals per 100 trap nights or <5% of tracking tunnels tracked) provided most benefit to kākā populations (Greene, *et al.*, 2004).

In July 2016, the New Zealand government announced their goal of a predator free New Zealand by 2050, the most ambitious conservation project attempted anywhere in the world (New

Zealand Government, 2016). This project should be able to support various council and private organisations with their aims of becoming predator free for the purpose of re-establishments of species such as kākā. The government is looking at establishing a funding scheme where the government will contribute $1 for every $2 an organisation spends on making areas predator free (New Zealand Government, 2016).

Predator species

Greene *et al.* (2004) and Moorhouse *et al.* (2003) reported that predation by stoat and possum was the most likely cause of the continuing decline of kākā populations, with post-mortem evidence largely confirming stoat (or other mustelids) as the primary kākā predator (refer Table 5.4) (Moorhouse, *et al.*, 2003; Greene, *et al.*, 2004; Innes, *et al.*, 2010). Nationally, kākā are scarce on all islands with stoat, however they are relatively common on offshore islands without stoat, even in the presence of other predator and competitor species. This cannot be a direct food effect, since the diets of stoat and kākā do not overlap, therefore predation by stoat would be the primary factor (Innes, *et al.*, 2010).

Possum are known predators of kākā, who can kill and eat kākā chicks as well as adult female kākā (Greene, *et al.*, 2004; Innes, *et al.*, 2010; O'Donnell & Hoare, 2012).

Table 5-4 Relative frequency of predation by different predators on kākā clutches, nesting females, broods and fledglings *(Moorhouse, et al., 2003)*.

Suspected predator	**Clutches**	**Females**	**Broods**	**Fledglings**	**Total**	**%**
Stoat	1	8	5	4	18	30
Stoat or ferret	0	0	0	9	9	15
Possum	2	2	1	0	5	8
Rat	1	0	0	0	1	2
Unknown	19	0	1	7	27	45
Total	**23**	**10**	**7**	**20**	**60**	

In addition to stoat and possum, Norway rat is a known predator of eggs and nestlings. Ship rat is also a likely nest predator, while cat, weasel and ferret may prey on eggs, nestlings, fledglings or nesting females (Moorhouse & Greene, 1998; O'Donnell & Rasch, 1991). Furthermore, native avian predators, such as New Zealand falcon (*Falco novaeseelandiae*) and the Australasian harrier (*Circus approximans*), have both been observed hunting and feeding on kākā fledglings where they still co-occur (Powlesland, *et al.*, 2009). Additionally, Morepork (*Ninox novaeseelandiae novaeseelandiae*) probably prey on kākā eggs and small nestlings (R. Moorhouse, 2017. pers. comm.).

Bait stations

Due to the inquisitive nature of kākā there have been some instances with kākā consuming toxic bait in a few sites around New Zealand (Berry, 1998; Parker, *et al.*, 2016). It is important to note that kākā can copy behaviour (such as opening bait stations) from other kākā.

Hunter *et al.* (2010) found that in sites where kākā are fed by humans, they may readily investigate possible food sources, and have been observed to open bait stations where kākā were supplementary fed. There is limited information on the extent to which non-supplementary fed kākā, may open bait stations (Hunter, *et al.*, 2010). Additionally, kākā at Orokonui Ecosanctuary in the South Island have been observed pulling tracking cards out of tracking tunnels (Parker, *et al.*, 2016).

Kākā have ingested baits placed in a variety of bait stations such as "hockey stick" bait stations and in ice-cream containers, for that purpose it is paramount that project managers select sturdy bait stations and apply modifications (e.g. screwing the lids closed) to exclude kākā. Additionally, the correct shape and colour of bait and pre-feed could determine whether kākā will be attracted to the bait. Poison baits should be dispensed from bait stations spaced at 100 – 150m intervals (Moorhouse, *et al.*, 2003).

Sodium fluoroacetate (1080)

The use of sodium fluoroacetate or 1080 in New Zealand has historically been used to assist in clearing sites from pests once predator proof fences have been erected (Department of Conservation, 2016). This is a useful tool in large areas or in areas with difficult terrain where large-scale baiting or trapping is not practical.

Greene *et al.* (2004) found that none of the kākā (>100 birds) monitored during the use of 1080 (ground and aerial) operations was killed, moreover, the longer-term indirect impacts were either non-existent or of little benefit. The main reasoning behind this is the fact that the timing of the 1080 operation needs to be linked to the years when kākā breed. Stoats can reinvade areas within two months of 1080 operations (Greene, *et al.*, 2004), therefore if the 1080 operation takes place outside of the main breeding years for kākā, the control will have little impact on the success of the breeding season.

When choosing to use a 1080 operation to improve breeding success for kākā, it is best to time the control in those years where mast fruiting is occurring (i.e. during the kākā breeding years), this would mean that the operation would need to take place 5-6 months prior to the breeding season (Greene, *et al.*, 2004; O'Donnell & Hoare, 2012; Powlesland, *et al.*, 2009). It is also important to note that pulsed 1080 control can assist in removal of pests that have otherwise become trap shy (Robertson, *et al.*, 2016).

When selecting captive-bred kākā for release, it is important to consider that they are likely to be more at risk from 1080 bait. Captive-bred kākā spend more time on the ground and due to a combination of having an inquisitive nature as well as being familiar with an artificial diet, kākā will investigate novel food items (Berry, 1998; Hunter, *et al.*, 2010). To ensure that captive-bred kākā are trained to avoid predators and other hazards, it would be beneficial for these birds to have a longer acclimatisation period in aviaries that specifically encourage birds to increase their time away from the ground.

Anticoagulants

Vitamin K antagonists (anticoagulants) such as diphacinone and brodifacoum are amongst the most effective pesticides in the context of 'mainland islands'. Brodifacoum is effective against both possums and rodents and has been instrumental in recent successful eradications of rats from Kapiti and Campbell Islands (Miskelly, *et al.*, 2005; Hunter, *et al.*, 2010). Intensive long-term pest control using slower-acting toxicants was a highly effective means of sustaining positive recovery of kākā populations. Although the primary aim of these operations was to reduce possum and rat numbers, secondary poisoning of mustelids was an important contributor to increased kākā productivity (Greene, *et al.*, 2004).

It is important to note however, that several kākā, including fledglings, have died as a direct result of bait ingestion (Moorhouse, *et al.*, 2003; Greene, *et al.*, 2004; Hunter, *et al.*, 2010). Hunter *et al.* (2010) found that even though a few kākā (6 out of 100 birds) had died due to ingesting poison in the Lake Rotoiti reserve, it was unlikely there had been any long-term impacts on the kākā population. The mortality rates in the controlled area were significantly lower than in sites where no control occurred, where up to 65% of adult female kākā suffer predation.

The use of an aerial brodifacoum operation at Sanctuary Mountain Maungatautari resulted in the removal of all mammalian pests (except for mice, rabbit and hares) in the sanctuary (Smuts-Kennedy & Parker, 2013), indicating this is a useful tool for initial removal of pests on mainland islands.

Despite the apparent risk to kākā fledglings from brodifacoum, Moorhouse *et al.* (2004) recommend the use of these, or similar toxins, to control pest species in kākā habitat. To prevent or limit the loss of kākā to anticoagulant poisoning it would be useful to ensure that any baits used for pest control are provided in kākā-proof stations or alternatively that baits are made unattractive to kākā (Moorhouse, *et al.*, 2003; Hunter, *et al.*, 2010).

Trapping

Powlesland *et al.* (2009) noticed in their research that it wasn't the nest height that determined success of nesting, rather it was the proximity of the nest to the nearest trap which determined whether a nest was successful or not. Nests that were successful were closer to predator traps than unsuccessful nests.

There are several traps available to support pest control, however it is important to use traps that are minimal risk to kākā. Where kākā have been caught in traps it appears more to be an individual issue rather than a species issue (as with bait stations), though it is important to remember that kākā are inquisitive birds. A relatively quick and easy way to ensure that trap boxes are not able to be pried open by kākā, is to use screws to keep the box closed.

Greene *et al.* (2004) found that no negative direct impacts had been recorded for kākā where stoat and rats had been killed using Fenn traps and snap traps. However, more recently released kākā from captive origin have been found to interfere with Fenn traps at Cape Sanctuary (Parker, *et al.*, 2016). Kākā have been caught in leg-hold traps targeted at possums (Greene, *et al.*, 2004). Additionally, a kākā was killed in a self-setting trap at Boundary Stream after placing his head in the trap (Parker, *et al.*, 2016).

<u>Issues</u>

Issue 15.1: Introduced mammalian predators are responsible for significant declines in kākā populations around New Zealand.

Issue 15.2: Considering kākā are a hole-nesting and roosting species, female kākā are particularly vulnerable to predation which in turn has a detrimental impact on kākā populations.

Issue 15.3: Ongoing pest control is expensive and not always effective as predators can become shy of ongoing control methods.

Issue 15.4: There have been some instances with kākā consuming toxic bait, with captive kākā being more at-risk due to them spending more time on the ground.

Issue 15.5: If 1080 operations take place outside of the main breeding years for kākā, the control will have little impact on the success of the breeding season.

Issue 15.6: The use of brodifacoum operations has proven to be a highly effective means of sustaining positive recovery of kākā populations.

Issue 15.7: The proximity of a nest to the nearest trap determines whether a nest is successful or not (i.e. successful nests are closer to traps than unsuccessful nests).

<u>Objectives and actions</u>

Objective 15.1: To aim for catch rates that provide most benefit to kākā populations (i.e. possum at <5% animals per 100 trap nights and stoat at <0.5% animals per 100 trap nights or <5% of tracking tunnels tracked).

Objective 15.2: To coincide pulsed management with the masting of kākā food species.

Objective 15.3: To encourage the use of a variety of control methods, to limit pests becoming shy of certain types of control (e.g. traps) and actively avoid those control methods.

Objective 15.4: To continue to investigate kākā proof pest control methods.

Objective 15.5: To ensure that any 1080 control is planned prior to the main kākā breeding seasons.

Objective 15.6: To advise the use of brodifacoum for initial removal of pests on mainland islands.

Objective 15.7: To plan trap sites close to known kākā nests.

5.1.16. Topic 16: Competitor control

There are various species in New Zealand that pose significant threat to kākā in the fact that they compete with kākā for suitable breeding spaces or for food sources. Additionally, the spread of avian diseases could have devastating impacts on kākā populations. Unlike evidence of predation (i.e. the presence of a carcass), the evidence of competition is harder to establish (Innes, *et al.*, 2010).

In general, kākā are vulnerable to competition from introduced mammalian browsers because they selectively feed on food types like those utilised by the browsers and because their preferred habitat is prone to dieback induced by mammalian predators (O'Donnell & Rasch, 1991). Innes *et al.* (2010) found that there are 14 pest mammal species that may also limit food supply for birds in New Zealand (Innes, *et al.*, 2010). The main species that are proven competitors for kākā include possum, wasps, deer, goat, pig and rodents (O'Donnell & Rasch, 1991).

It is important to note that only when predation is low, competition does not appear to affect kākā populations as much as when predation and competition are both high (Beggs & Wilson, 1991). It is recommended that each site completes a review of the potential competitors and the effect (if any) that species can have on the re-establishment of kākā.

Possum

Besides being potential predators, brushtail possum compete with kākā for nest sites. Possum also destroy nectar, fruit, and seed resources and seriously affect floristic diversity by their browsing (Wilson, *et al.*, 1998). Possum are the most likely agent of food limitation for mainland frugivores in podocarp-broadleaved forest, because they are large, ubiquitous, arboreal and can consume large quantities of flowers and fruits, suppressing fruit production (Innes, *et al.*, 2010). Considerable overlap has been found in the preferred foods of both kākā and possum, particularly the high-energy food sources kākā may require for breeding (Greene & Fraser, 1998).

Moorhouse (1997) also found that there is an overlap in the diets of kākā and possum on Kapiti Island which creates a significant food competition, additionally, the possum can suppress seed production in both hīnau and tawa which are both important food sources for kākā on the island. Possum were controlled and eventually eradicated on Kapiti Island over two periods. Kākā increased markedly on at least one count transect during the period of control and eradication although the relative roles of predation and food supply as causes of these changes are unclear (Innes, *et al.*, 2010).

Herbivores

Possum, deer and goat may modify vegetation to the extent that it becomes unsuitable for kākā (Moorhouse & Greene, 1998). Moorhouse (1997) notes that kākā productivity could be improved if introduced herbivores are removed from sites where they are browsing on plant species which are important for kākā.

Rats

Suppression of possum and ship rat in Auckland forests has permitted more fruit production, less fruit damage, more fruits maturing and more fruits consumed by birds that subsequently excreted the seed unharmed (Innes, *et al.*, 2010).

Wasps

Wasps (*Vespulid* spp.) compete with kākā for honeydew (Moorhouse & Greene, 1998). Honeydew produced by endemic scale insects (*Ultracoelostoma assimile* and *U. brittini*) in New Zealand beech forests is an important food for native birds such as kākā, tui (*Prosthemadera novaeseelandiae*) and bellbird (*Anthornis melanura*), but is monopolised by wasps for up to four months of the year (Beggs, *et al.*, 2005). South Island kākā spend about 30% of their foraging time collecting honeydew when it is available, but are strong fliers and can leave to forage elsewhere when wasps are numerous (Innes, *et al.*, 2010; Beggs & Wilson, 1991). The kākā requires the honeydew in large enough amounts to build up reserves to enable breeding in the following year (Collar, 2000).

Introduced parrot species

Two introduced parrots, the sulphur-crested cockatoo (*Cacatua galerita*) and eastern rosella (*Platycercus eximius*) might compete with native parrots for nest sites if all species were abundant and overlapping (Innes, *et al.*, 2010). Besides competition for nest sites, introduced parrots can also spread avian diseases which could become detrimental to kākā populations (especially in the early stages of re-establishment). Where these species do occur in the same habitats it could be important to establish a control programme to remove the introduced species. Innes *et al.* (2010) have found that endemic birds can out-compete non-endemic species in intact native forest when mammalian predators are absent.

<u>Issues</u>

Issue 16.1: There are various competitor species that pose significant threat to kākā (i.e. for breeding spaces or food sources).

Objectives and actions

Objective 16.1: To complete analyses for release sites to determine the impacts various competitor species may have on the re-establishment programme and which control methods would be most appropriate for the species.

5.1.17. Topic 17: Human-animal conflict

Even though kākā are classified as Nationally Vulnerable (Department of Conservation, 2016; Robertson, *et al.*, 2013), there are still instances of human-wildlife conflict that need to be analysed for each release area. In the past, Moorhouse *et al.* (2003) found an instance of poaching during their study at Whirinaki, where there is an isolated human settlement in which many of the residents have a long tradition of hunting forest birds for food. Additionally, in recent years kākā have been shot and become victims of traffic. The illegal killing (as well as the incidental killing) of kākā indicate that more advocacy for the species is required to highlight their situation (refer Topic 20: Advocacy).

Furthermore, the Wellington City Council circulated a request on social media for members of the public to stop feeding wild kākā, as their chicks are increasingly found with metabolic bone disease due to being fed a poor diet by the parents (Wellington City Council, 2017). Kākā chicks that have been fed poor quality foods provided by the adult kākā have been found to have reduced bone development, this has resulted in euthanasia of several chicks. Further advocacy around this topic would be recommended, to make members of the public aware of the effect their feeding may have on the kākā population.

Mitigating post-release conflict

Charles and Linklater (2013) believe that the success of urban wildlife conservation in New Zealand and the restoration of urban wildlife habitats has led to growing animal populations in cities and an increase in urban human-wildlife conflict in the last few decades. Kākā cause damage to trees (Buller, 1873; Linklater, 2016) and roofs to the extent that some believe that introducing kākā in urban environments is not a suitable option (Linklater, 2016).

The best way to find out how to mitigate post-release issues, is to ascertain what possible issues could arise by completing a SWOT analysis for each site (refer Topic 4: Proposed release sites), and how the weaknesses and strengths could be minimised. In the case of tree damage, there might be little one can do to existing trees, however, the future planning of areas could include the species of trees that are less prone to kākā damage (e.g. native species) and planting of kākā preferred species (e.g. exotic conifers) in areas that would not cause dangerous situations if trees do fall over from damage (Charles & Linklater, 2014).

To limit post-release issues linked to human conflict, appropriate pre- and post-release advocacy (including community involvement) can make a real difference (refer Topic 20: Advocacy).

Issues

Issue 17.1: There are ongoing conflicts (both intentional and unintentional) between humans and kākā.

Objectives and actions

Objective 17.1: To reduce human-animal conflict at release sites by increasing awareness of kākā conservation via advocacy both pre- and post-release.

5.1.18. Topic 18: Population modelling

Population models are critical for the management of reintroduction efforts, as a primary objective of these efforts is to attain viable populations (Converse, *et al.*, 2013). To determine which factors will affect the success or failure of a new kākā re-establishment site, the programme Vortex was used. Vortex is an individual-based simulation model for Population Viability Analysis (PVA). The programme simulates a population by stepping through a series of events that describe the typical life cycle of sexually reproducing, diploid organisms (Miller & Lacy, 2005). Computer modelling of a population will assist in determining which factors will affect survival of the population in question. Vortex calculates the risk of extinction based on the parameters used.

To get an accurate reflection of the potential of a population, it is important to obtain reliable estimates of the relevant population parameters (recruitment and mortality rates, adult survival and age of first reproduction) (Moorhouse & Greene, 1998). The breeding rate of kākā both on the mainland and in relatively undisturbed island populations has been shown to be low and highly variable, with no breeding occurring in some years (often consecutive) and considerable variation in the number of females attempting to breed in each season (Greene & Fraser, 1998). These variations in productivity have been strongly linked to the abundance of food.

Kākā experts agreed that the most important factor determining re-establishment success is predator control (refer Thesis Chapter 3.4.3). For this purpose, the following three scenarios were used, for a “new” kākā site:

1) No predator control occurs in the area and female mortality is 65%;
2) The site has no predator control and the sex ratio is 5:1 (adult males: adult females); and
3) A site is receiving predator control and the sex ratio is 1:1.

For all three scenarios, starting populations were varied from 30, 50 and 100 individuals, the Minimum Viable Population (MVP) size was set at 258, as per the calculations of Leech, Gormley and Seddon (2008). Data was accumulated from various sources in the literature (refer Table 5.5) and the most current data was applied over the older data where differences existed.

Table 5-5 Literature used to set kākā parameters in Vortex.

Year	Title (Author)	Source
1991	Kea - kākā Population Viability Assessment (Seal, et al., 1991)	CBSG website
2003	Control of introduced mammalian predators improved kākā breeding success: Reversing the decline of a threatened New Zealand parrot (Moorhouse, *et al.*, 2003)	Biological Conservation 110: 33-44
2004	Research summary and options for conservation of kākā (Greene, *et al.*, 2004)	ResearchGate
2008	Estimating the minimum viable population size of kākā, a potential surrogate species in New Zealand lowland forest	Biological Conservation
2009	Breeding biology of the New Zealand kākā (Powlesland, *et al.*, 2009)	ResearchGate
2010	Distance sampling to determine kākā density within Waipapa Ecological Area, Pureora (Greene, *et al.*, 2010)	New Zealand Journal of Ecology 34 (3): 297-305

Figure 5-4 demonstrates the extinction risk in the first scenario where no predator control takes place and female mortality is 65%. This area would have a probability of extinction = 1, which indicates certain extinction. Whether the population starts with 30, 50 or 100 individuals they are all likely to be heading for extinction approximately 30 years into the establishment. This is in line with Moorhouse and Greene (1998) who noted that population viability analysis suggested that predation of nesting females by stoats poses the greatest threat to the survival of remaining mainland populations.

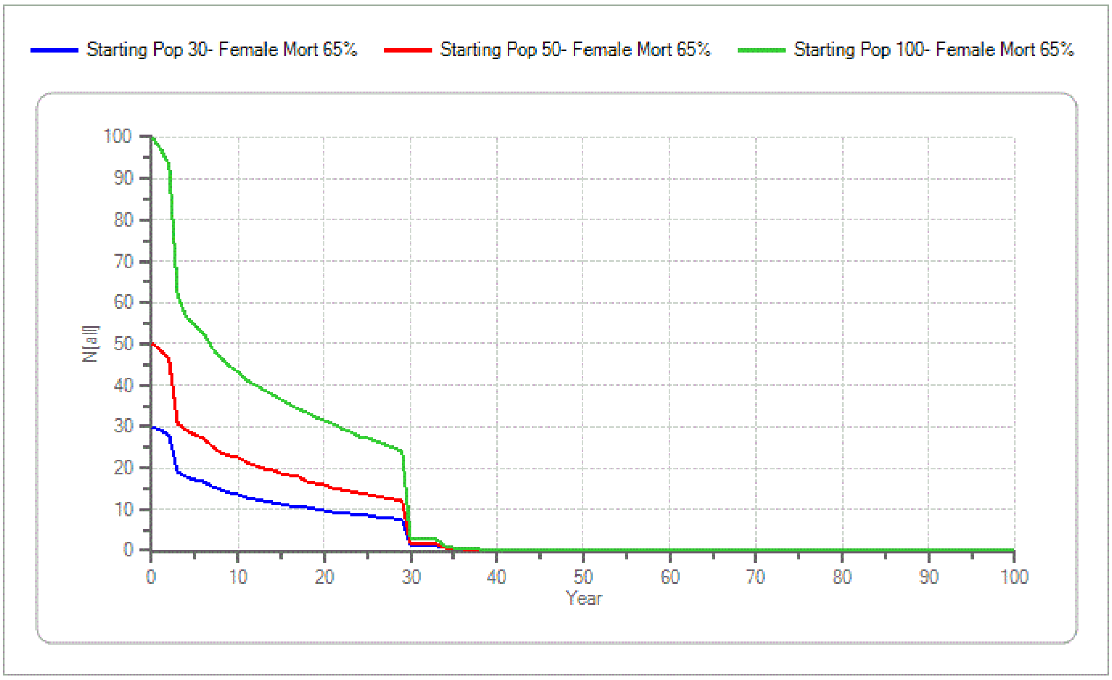

Figure 5-4 Kākā survival for new release area without predator control and where female mortality is 65%.

Scenario two (Figure 5-5) displays the risk of extinction in an area where no predator control takes place but where female mortality is set at 21%. This would equate to a population sex ratio of 5:1 (males: females) as this is often referred to as the estimated sex ratios in kākā on the mainland where no control takes place. Again, this scenario used 30, 50 and 100 birds for the starting populations with a probability of extinction of 0.94, 0.80 and 0.56 respectively. This indicates that a starting population of 100 birds (with equal sex ratio of 50:50) would have a nearly 50% change of survival, even when the population decreases to an unequal sex ratio of five males per one female.

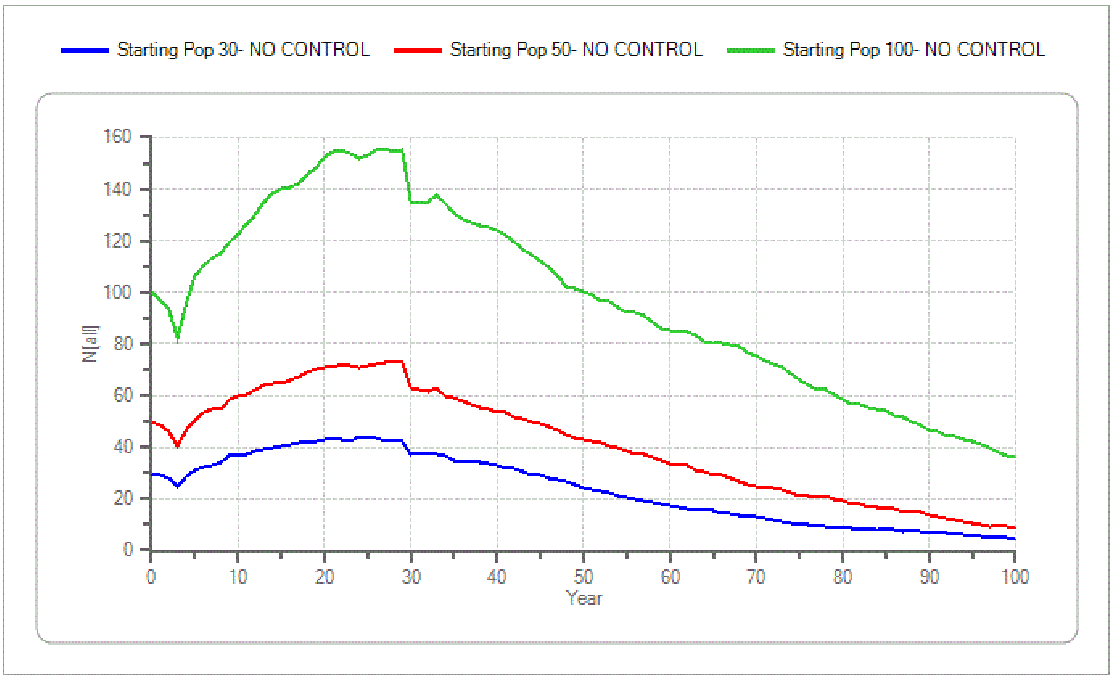

Figure 5-5 Kākā survival for new release area without predator control and where female mortality is 21%.

The final scenario (Figure 5-6) shows the extinction risk for a new area where predator control takes place and an equal sex ratio is maintained. Unlike the other scenarios, these three starting populations of 30, 50 and 100 birds all had a probability of success of 100%, reaching carrying capacity (set at 258 as mentioned above) around 35, 25 and 15 years respectively.

It is important to note that initial high mortality is a persistent feature of many reintroductions (Collar, 2006). However, this does not reflect a failure in the reintroduction project, rather it is a projection to consider when selecting initial population size.

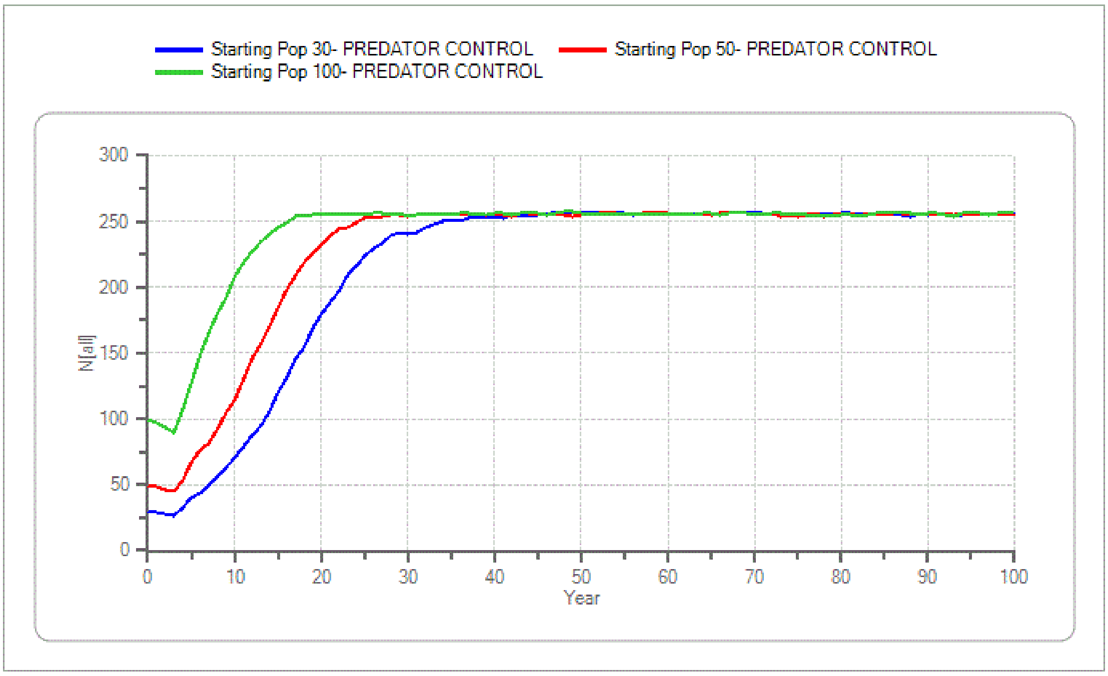

Figure 5-6 Kākā survival for new release area with predator control and where an equal sex ratio is maintained.

Based on the above modelling, it is recommended that new release sites should be predator controlled. As a minimum, it could be attempted to provide predator free sites for breeding within a bigger network. Whether kākā would select the provided habitat as their breeding ground could be promoted by selecting the right area for the breeding ground and using anchoring methods to attract and maintain kākā at the site. This method has worked well for the Wellington area, where kākā breed well in the predator controlled site of Zealandia, and can freely travel outside of the sanctuary.

Another determining factor for the success of the re-establishment is the number of birds being released. Starting with a larger initial population will decrease the amount of years prior to reaching carrying capacity. Therefore, if a site is wanting to see their results of the re-establishment faster it is recommended to start off with a larger population size. To date, most sites have started with a small population size (e.g. 10 or less birds of unequal sex ratio) which would increase the risk of local extinction. However, if a site was to start off with 5 unrelated males and 5 unrelated females, they should be able to increase the population close to carrying capacity (without catastrophic events such as lethal disease), though this would take twice as long (e.g. 60 years to increase the population from 10 to 240 birds versus less than 30 years to increase from 30 to 240 birds).

Robert *et al.* (2015) also state that whereas a small population size has been shown to be statistically related to extinction at the inter-taxon level, using it as an indicator of viability has several shortcomings. Population size is not a good predictor of the extinction risk of rapidly declining populations.

The population growth rate is generally considered a major predictor of extinction, and theoretical work has shown that environmental stochasticity and catastrophic events can drive populations to rapid extinction relatively independently of their size (Robert, *et al.*, 2015), for this purpose it is important to note that each site will have their own events that would need to be considered. The abovementioned models should therefore be used as a guideline only; it is recommended that a site would use site-specific data to determine their success.

Viable population size

Population Viability Analysis (PVA) has become a standard modelling tool for conservation that quantitatively assesses the threats faced by populations, their risks of extinction or decline, and the probability of population persistence over different temporal scales. One use of PVA's in conservation biology has been to estimate the Minimum Viable Population (MVP) size of species (Leech, *et al.*, 2008). The MVP is defined as the ecological threshold that specifies the smallest number of individuals in a species or population capable of persisting at a specific statistical probability level for a predetermined amount of time. Generally, the probability level is 90% for 100 years. The MVP effectively states the level of the population, after which any additional releases do not increase the rate of success of the project (Wolf, *et al.*, 1996).

Estimating the present and future carrying capacity of the habitat for the focal species is of first importance to defining targets of population viability and comparing the actual translocation success with these *a priori* targets in an adaptive management framework (Robert, *et al.*, 2015). Leech *et al.* (2008) estimated that at least 500km^2 of South Island beech forest would be needed to maintain a minimum viable kākā population size of 258 kākā (155 adults) (Innes, *et al.*, 2010). The MVP of kākā estimated by Leech *et al.* (2008) is at the lower bounds of estimates, but provides support to MVP's estimated from extinctions observed by Soule *et al.* (1988) that populations over 200 individuals are likely to persist long-term. However, if meta-populations are present and are linked with dispersing juveniles, the whole network may be viable even if the local populations are not (Leech, *et al.*, 2008).The South Island kākā programme for example considers populations to be viable when there are approximately 20 established breeding pairs, and when ongoing recruitment equals or exceeds mortality long term (Collen, 2010).

Issues

Issue 18.1: The breeding rate of kākā populations is low and highly variable, with no breeding occurring in some years (often consecutive) and considerable variation in the number of females attempting to breed in each season.

Issue 18.2: New release sites require predator control prior to participating in the kākā recovery plan.

Objectives and actions

Objective 18.1: To investigate options to increase breeding rates and success for kākā in the wild.

Objective 18.2: To promote predator control in proposed or new release sites.

5.1.19. Topic 19: Post-release monitoring

Translocations can become powerful experiments if they are monitored correctly, the monitoring can be particularly useful if accompanied by analysis or a manipulation of possible limitations or factors that caused decline (Innes, *et al.*, 2010). In general, it is now well recognised that the success of a project is directly related to the quality of the pre- and post-release monitoring of environmental variables and of follow-up observations on the released animals (Collar, 2006). Species translocations may result in population establishment, but long-term monitoring is required to demonstrate population persistence (Innes, *et al.*, 2010; Seddon, 1999).

White Jr. *et al.* (2012) found that many of the psittacine reintroductions have been poorly documented either methodologically and/or regarding long-term results, which in turn prevents measuring relationships between treatments and outcomes. For that purpose, they recommend that future psittacine reintroductions include not only a systematic and detailed documentation of all methods, but also a practical and effective plan for post-release monitoring that will provide information for assessing both short- and long-term results. This should be planned well in advance of any actual release event (Grajal & Sanz, 2002; IUCN/ SSC, 2013).

In the past, because of the lack of long-term monitoring of widespread native taxa in New Zealand, declines in formerly widespread taxa (such as kākā) have gone undetected to the point that they were endangered before the need for management intervention was identified (Monks, *et al.*, 2013). Going forward, project managers need to develop long-term monitoring protocols in which they gather key parameters reflecting the success of a relocation at previously specified time intervals (Fischer & Lindenmayer, 2000). Additionally, managers need to consider: (1) how to maintain consistent study design and sampling protocols over the long term; (2) the scale of any population change likely to be of concern; and (3) the most appropriate intervention if these trigger points are exceeded (Greene, *et al.*, 2010).

Where possible, monitoring should include census counts, sex ratios, adult/juvenile ratios, population change (births, deaths, immigration and emigration), breeding behaviour, nest data (e.g. clutch size, brood size, number of chicks fledged, fledging survival and nestling weights) and a constant re-assessment of threat factors and its management (Fischer & Lindenmayer, 2000; Collar, 2006; Moorhouse & Greene, 1998; IUCN/ SSC, 2013). Regarding census counts Greene *et al.* (2004) recommend that the best time for conducting counts should be immediately prior to the breeding season in October and November (at the latest), prior to 11am when kākā are more conspicuous.

Where captive kākā are used for re-establishment projects it is important that the captive coordinator is updated on the success or failure of the establishment of these birds, to allow the coordinator to capture this data in the species' studbook.

Issues

Issue 19.1: Due to the lack of long-term monitoring of widespread native taxa in New Zealand, declines in formerly widespread taxa (such as kākā) have gone undetected.

Issue 19.2: Only long-term monitoring can demonstrate population persistence and recovery.

Objectives and actions

Objective 19.1: To ensure that future kākā reintroductions include not only a systematic and detailed documentation of all methods, but also a practical and effective plan for post-release monitoring that will provide information for assessing both short- and long-term results.

5.2 Community relations and engagement

Recovery and protection of kākā relies on the interest, understanding and engagement of many sectors of New Zealand society, not just professional conservation organisations and ecologists. The education of the public about the plight of kākā and their conservation needs can present both opportunities and challenges. Realising these opportunities and challenges will have a strong influence on the outcome of this plan and the future of kākā in the wild.

5.2.1. Topic 20: Advocacy

Advocacy continues to be an important component of kākā protection projects throughout New Zealand, whether the project has been implemented by DOC, private groups, individuals, or a combination of these. Advocacy helps ensure broader public acceptance and buy-in, as well as actual support and funding. For the recovery programme to succeed, the public, communities and organisations need to understand the conservation issues facing kākā. Captive kākā institutions will be assisted in presenting high-quality advocacy plans. Advocacy is important for:

- Encouraging public participation in kākā protection activities and maintaining momentum
- Gaining local project support
- Raising a project's profile to increase its resources
- Acknowledging sponsors' contributions

- Sharing knowledge and best-practice methods
- Providing motivation and support from other groups, peers and specialists
- Reducing the direct human threats to kākā

Issues

Issue 20.1: There is a lack of understanding around the plight of kākā, and limited local and national advocacy to raise public awareness.

Objectives and actions

Objective 20.1: To promote kākā conservation by sharing knowledge and best management practices among all individuals, community groups and organisations concerned.

Objective 20.2: To promote positive attitudes to kākā re-establishment among the public.

5.2.2. Topic 21: Tangata whenua

Tangata whenua (iwi or hapū that has customary authority in a place) are recognised as key participants in the kākā recovery programme. Historically, tangata whenua have shared different views of kākā, where it used to be collected for both food and use in feather cloaks (O'Donnell & Rasch, 1991). Today the bird maintains a special taonga status. In many different areas, Māori and iwi have embraced the principles or kaupapa of native species protection and are actively involved in the protection of kākā (i.e. Poutiri Ao ō Tāne). By empowering tangata whenua to take on the role of guardians or kaitiaki of kākā, we can strengthen partnerships and maximise benefits to kākā populations throughout New Zealand. Opportunities need to be provided for information exchange, skill sharing, and direct and indirect involvement in kākā conservation. Tangata whenua involvement in the protection and preservation of kākā is welcomed and encouraged.

Issues

Issue 21.1: Tangata whenua have yet to be fully engaged in partnerships that provide mutual benefits for iwi and kākā, and that assist the kākā recovery programme.

Objectives and actions

Objective 21.1: To foster and develop relationships with tangata whenua, and encourage their involvement in all levels of kākā management.

5.2.3. Topic 22: Corporate sponsorship

Some species recovery programmes (i.e. kiwi, takahē and whio) benefit from corporate sponsorship. Kākā are an indicator species for the New Zealand forests, national sponsorship therefore would be beneficial for a variety of New Zealand native forest species rather than a single species approach. National sponsorship could support species recovery through sponsorship money and through the provision of information, resources, workshops and training. With the government's target to becoming predator free by 2050, there may be options available for corporate sponsorship in line with this target.

Issues

Issue 22.1: There is no national sponsorship programme for kākā.

Objectives and actions

Objective 22.1: To establish a national sponsorship agreement for kākā.

5.3 Research and innovative technologies

The recovery of kākā could benefit from research and technology that has been developed in the past, and will continue to be dependent on good scientific understanding and adequate tools. Current limitations include affordability and the scale of pest management, monitoring and small population management. In the past, a variety of research recommendations have provided some direction on required investigations on topics such as competitor and predator management, however more research needs to be completed to be able to fully support the re-establishment of kākā on the mainland. Current research is being carried out by universities, within DOC and through private enterprises.

5.3.1. Topic 23: Research planning

In the past, separate documents have been compiled listing several research and management recommendations for kākā in the wild and in captivity.

Issues

Issue 23.1: There is no nationwide coordination for kākā research or management.

Objectives and actions:

Objective 23.1: A coordinator needs to be appointed to oversee and manage past and future kākā management to aid in the species' recovery.

5.3.2. Topic 24: Genetics and taxonomy

The Kapiti Island kākā population is believed to have passed through a human induced genetic bottleneck (Sainsbury, *et al.*, 2006), which is common for island populations. Genetic bottlenecks may also have naturally occurred in the past in other areas around New Zealand. In the absence of a good understanding of their effects, management needs to apply a precautionary principle of minimising the risk of genetic bottlenecks occurring.

A basic requirement for recovery planning of any species is a good understanding of the actual identity of the species that need to be considered for recovery. Further research is required to validate, or negate, ongoing recognition of the two kākā subspecies (Sainsbury, *et al.*, 2006). Any further taxonomic work that is completed needs to be formally published.

<u>Issues</u>

Issue 24.1: The potential or actual effects of genetic bottlenecks on kākā populations (such as on Kapiti Island) have not yet been quantified but may be significant.

Issue 24.2: Kākā taxonomy is unresolved, leading to uncertainties about the status of the two subspecies.

<u>Objectives and actions</u>

Objective 24.1: To formally validate, or negate, the ongoing recognition of the two subspecies of kākā.

Objective 24.2: To maximise the genetic diversity of kākā within the bounds of natural rates of genetic exchange and to ensure that new populations are established with the best possible composition of founders.

5.3.3. Topic 25: Autecology and population dynamics

Issues

Issue 25.1: Baseline data on key parameters (mortality, recruitment, etc.) is lacking or is based on estimated data, which means that trend analysis, including detailed population modelling, is not fully utilised.

Objectives and actions

Objective 25.1: To ensure that robust population modelling is undertaken for all release sites prior to future reintroductions/ translocations to determine site specific requirements/ population options.

Objective 25.2: To increase our understanding of the ecology of kākā.

5.3.4. Topic 26: Pest management

While successful pest control technologies exist (e.g. trapping), they have associated high labour costs. This limits their applicability, as they need to be used over large areas to protect kākā populations. Stoat control on the mainland is required to reduce sex-skews caused by predation. Aerial 1080 applications prior to masting years needs to be tested as a large-scale tool for kākā conservation (these applications have already proven successful in Waitutu Forest (P. Gaze, 2017. Pers.comm)).

Issues

Issue 26.1: Existing technologies for pest control are labour intensive.

Issue 26.2: Predation (especially by stoats) has caused skewed sex ratios (in favour of males) in most mainland populations where pest control is minimal.

Issue 26.3: Kākā are episodic breeders with increased breeding activity during masting years. These in turn are linked to increased predator levels.

Objectives and actions

Objective 26.1: Large-scale stoat control is implemented prior to masting years in natural strongholds and at existing release sites.

Objective 26.2: To complete predator control in all release sites prior to reintroductions of North Island kākā.

5.3.5. Topic 27: Measuring success

Every re-establishment project should have some form of measuring success. In general, the success measures are very varied, due to the differences in opinion as to what constitutes "success". Factors which frequently compound the problem of objectively assessing results of reintroductions include poorly documented or inconsistent methodologies, insufficient post-release monitoring, and widely differing definitions – or no definition – of "success" (White Jr., *et al.*, 2012). Additionally, the danger of classifying a reintroduction as successful is that it implies an end-point beyond which further effort, in the form of new releases or monitoring, might be deemed unnecessary (Seddon, 1999).

Scott and Carpenter (1987) already called for an objective way to measure success specifying that project managers should: (1) ring or mark released birds; (2) ensure that captive-bred birds, however reared, can be distinguished from each other; (3) document the preparation of birds for different types of release (capture techniques, handling methods, holding cages, transportation procedures); (4) record release conditions; (5) record the release habitat and environment; (6) monitor the released birds at least to first breeding; (7) determine survival and breeding success by age and sex of birds reared and released under different regimes; and (8) document the use of medications (Collar, 2006). Unfortunately, there is still no uniform method for measuring success, however there has been an increase in publications reporting on success or failure of reintroductions. Reporting on psittacine reintroductions is however still minimal, with only five out of the 293 projects captured in the IUCN's Reintroduction Specialist Group book series reporting on Psittaciformes (two of which were on the same species and the remaining three were covered in one article) (Soorae, 2008; Soorae, 2010; Soorae, 2011; Soorae, 2013; Soorae, 2016).

Beck *et al.* (1994) considered a reintroduction project to be successful if the wild population subsequently reached at least 500 individuals which were free of provisioning or other human support, or where a formal genetic demographic analysis predicted that the population will be self-sustaining. The reintroduction itself may not have needed to be the sole factor contributing to population growth, additionally other measures may have been more instrumental in population recovery (Beck, *et al.*, 1994).

Whether a project is successful or not, it is crucial that all reintroduction attempts are fully documented. In a recent series of compendia of global reintroduction efforts for 184 taxa, 44% were considered either failures or only partially successful. In the case of psittacines, White *et al.* (2012) considered only 55% of 47 distinct efforts over the past 25 years as successful. With even lower success rates (26%) for animal translocations (White Jr., *et al.*, 2015). However, many failed reintroductions may not have been captured properly. To ensure future releases may become (more) successful, it is important data covering current and past releases is as detailed as possible.

Reintroduction success must be assessed over longer species-specific timeframes. Success criteria should also combine survival and reproduction- both fundamental parameters for population establishment and persistence (White Jr., *et al.*, 2013). From an ecological perspective, the establishment of a viable self-sustaining population is a key measure of success. When documenting release data, authors should clearly state their perspective and definition of reintroduction success. This data can in turn provide a method to measure the success of a reintroduction programme during the post-release monitoring stage (Fischer & Lindenmayer, 2000).

Seddon (1999) proposed that a reintroduction is comprised by a sequence of three objectives: (1) the survival of the release generation; (2) breeding by the release generation and their offspring; and (3) persistence of the re-established population, perhaps assessed through extinction probability modelling. Furthermore, Collar (2006) concluded that there are four causes of failure: (1) insufficient control of factors causing the original extirpation or decline; (2) insufficient numbers of birds available to form a viable released population; (3) insurmountable genetic problems; and (4) technical failures in conditioning birds or other procedures.

The factors associated with a minimal rate of early failure are distinct from the factors associated with longer-term persistence. Early failures are primarily associated with low growth rates, whereas long-term extinctions are related to a high probability of catastrophic events and a small population size (Robert, *et al.*, 2015).

It is important to note that all reintroductions should include an exit strategy in their plan, this not only allows for an orderly and justifiable exit (IUCN/ SSC, 2013), it also provides with a direction and objective of the reintroduction to measure its success against.

<u>Issues</u>

Issue 27.1: There is no uniform method for measuring reintroduction success.

Issue 27.2: Reporting on psittacine reintroductions is minimal.

<u>Objectives and actions</u>

Objective 27.1: To promote the development of a uniform method for measuring reintroduction success.

Objective 27.2: To ensure that all participants in kākā recovery fully document all reintroduction attempts.

Objective 27.3: To develop a clear exit strategy once the recovery plan has been finalised.

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Appendix I: Principles of species recovery: four phases of recovery action model

Research—identify cause and key agent(s) of decline

Where status, distribution, threats, and the means to recover the species are not well understood and where research to identify the cause and key agent(s) of decline is the focus of the plan. Identifying cause and key agent(s) of decline is a fundamental step in recovery of threatened species and, as such, must be adequately addressed in the recovery plan.

Security

Where urgent management effort is required to secure the species from extinction. Security from extinction in the wild is achieved when: • There is a viable population • Key agent(s) of decline have been identified and removed or mitigated • The population can recover given additional resources A population is defined as being viable when it is predicted to have a 95% probability of survival where: • There is an intrinsic ability to increase given additional management because the population is large or because recruitment = mortality; and • There is resilience against low and moderate level stochastic events over a 50-year time frame Management action may be undertaken with a knowledge of (and targeted at) the cause and key agent(s) of decline or undertaken in the absence of this knowledge and on the best advice on interim management from recovery experts. A 'salvage' operation maybe required in the latter situation (e.g. transfer the species to a suitable safe site). The prescription for managing the causal agents of decline is likely to follow an adaptive management approach in this phase. It may be appropriate to undertake the research and security phases at the same time.

Recovery

Where enough information exists on the status and distribution of a species, and the causal agent(s) of decline, to enable priority release sites to be selected. Management effort is instigated at these sites to achieve recovery of the species. This broader recovery phase involves establishing/enhancing multiple populations within their historic range, or at suitable sites and, where practical, maintaining genetic diversity.

Maintenance

Where the recovery plan goals have been achieved and the threat classification of the species has sufficiently improved, through implementation of recovery plan actions, management intervention can be reduced. The final, but ongoing, maintenance phase will involve sustaining gains made through all phases of recovery management by applying ongoing and appropriate monitoring and management at appropriate intervals and at key sites. These phases of recovery were developed from the model described by Jansen (2001) and from the 'Species Recovery Optimisation' project work.

Appendix II: Timeline for recovery actions for North Island kākā

Number	Objective	Action	Due date
Management			
1.1	To monitor naturally occurring kākā populations to determine whether additional management is required to support reversal of declines.		
1.2	To establish accurate sex ratios for sites around the North Island.		
1.3	To promote supplementation of female kākā in natural strongholds where active pest control is taking place.		
1.4	To investigate population parameters to determine whether populations can cope with (ongoing) harvesting for translocation purposes		
2.1	To ensure that the threat(s) that caused any previous extinction/ decline in the release sites have been correctly identified and removed or sufficiently reduced.		
2.2	To promote the fact that juvenile kākā need more anchoring to ensure they make their home range in the release area.		
2.3	To support mainland sites in their planning to advise on the most cost-effective pest-control methods.		
2.4	To encourage the participation of current predator-free areas in the recovery plan for North Island kākā.		
3.1	To review the current population status at each existing release site.		
3.2	To determine each site's supplementation requirements to enhance self-sustainability.		
3.3	To be proactive in planning for release permits if the captive programme is requested to provide birds for release.		
4.1	To ensure site pre-requisites for kākā re-establishments are published and made available to proposed or future sites.		
4.2	To conduct SWOT analysis for proposed or future sites, to ensure participation will be beneficial to the recovery outcomes.		
5.1	To complete SWOT analysis on recommended corridor sites to determine their possible contribution to the natural dispersal of kākā.		
6.1	Projects should be focussed on areas that will provide ample opportunity for reproduction, however it is important to consider that these 'sink' areas can be great corridors to support the entire population of North Island kākā.		
6.2	The chance of immediate dispersal could be mitigated by providing sufficient pre-release training and/ or supplementary feeding.		
6.3	To protect natural nest cavities from predators.		
6.4	To add sufficient artificial nest boxes to release sites when there are insufficient natural nest cavities.		
6.5	To ensure future release sites have sufficient natural food sources, thereby limiting the need to rely on supplementary feeding.		
7.1	To ensure that kākā management is undertaken to a consistent and high standard.		
8.1	To ensure that key supporting plans for kākā recovery contain up-to-date and relevant information.		

Number	*Objective*	*Action*	*Due date*
9.1	To provide security against disease dispersal, by following the strictest veterinary, quarantine and prophylactic methods.		
9.2	To complete full health assessments on selected birds, ensuring they are in good physical form without genetic, morphological or behavioural anomalies that reduce their chances for survival.		
9.3	Organisations/ individuals involved in the re-establishment of kākā follow the most recent guidelines to ensure stress or suffering is kept at a minimum.		
10.1	To promote anchoring/ soft-release techniques for wild-caught kākā.		
10.2	To coordinate the release of rehabilitated kākā to release sites.		
10.3	To ensure that the release area is as close to the source area as possible.		
10.4	To reduce the use of Kapiti Island kākā as a source for transfers to other areas (in the short-term). Where required, genetic considerations can still allow for use of the island's birds.		
10.5	To investigate cost-effective ways to ensure survival of wild-laid eggs and fledglings.		
10.6	To provide adequate genetic diversity to release sites by appropriately coordinating founder selection.		
10.7	To provide the captive industry with husbandry guidelines which demonstrate how to manage the breed for release birds.		
10.8	To develop a management plan which ensures an analysis on correct founder representation for each release site. This plan should also include "grandparenting" or potential release of over-represented founders.		
10.9	To advise against the use of hand-rearing North Island kākā chicks (especially when used for release).		
11.1	All birds should be assessed on their suitability prior to release.		
11.2	To sex all birds prior to release (to monitor sex-ratios on site).		
11.3	To promote long-term release planning, ensuring that the minimum number of birds required per site will be released over several years.		
11.4	To better protect female kākā on the mainland, ensuring their survival which in turn will provide better sex-ratios in the wild populations.		
11.5	To establish required sex-ratios for release sites thereby preventing "flooding" the sites with additional males.		
12.1	All released individuals should have clear identifiers to enable successful monitoring post release.		
13.1	To ensure release sites develop a plan to balance the sites requirements with natural parrot adjustment behaviour. This plan should demonstrate the intent to adjust release methods once an initial release has taken place.		
13.2	To check aviary designs are suitable for kākā reintroduction candidates.		
13.3	To promote (temporary) supplementary feeding methods for kākā.		
14.1	To promote long-term release plans where multiple small events are used.		
14.2	To ensure that (where logistically possible) releases are in line with the reproductive cycle of kākā when fledglings are naturally occurring in the wild.		
14.3	To encourage release sites to increase individual's survival success by releasing birds at dawn.		
15.1	To aim for catch rates that provide most benefit to kākā populations.		
15.2	To coincide pulsed management with the masting of kākā food species.		

Number	*Objective*	*Action*	*Due date*
15.3	To encourage the use of a variety of control methods, to limit pests becoming shy of certain types of control (e.g. traps) and actively avoid those control methods.		
15.4	To continue to investigate kākā proof pest control methods.		
15.5	To ensure that any 1080 control is planned prior to the main kākā breeding seasons.		
15.6	To advise the use of brodifacoum for initial removal of pests on mainland islands.		
15.7	To plan trap sites close to known kākā nests.		
16.1	To complete analyses for release sites to determine the impacts various competitor species may have on the re-establishment programme and which control methods would be most appropriate for the species.		
17.1	To reduce human-animal conflict at release sites by increasing awareness of kākā conservation via advocacy both pre- and post-release.		
18.1	To investigate options to increase breeding rates and success for kākā in the wild.		
18.2	To promote predator control in proposed or new release sites.		
19.1	To ensure that future kākā reintroductions include not only a systematic and detailed documentation of all methods, but also a practical and effective plan for post-release monitoring that will provide information for assessing both short- and long-term results.		
Community relations and engagement			
20.1	To promote kākā conservation by sharing knowledge and best management practices among all individuals, community groups and organisations concerned.		
20.2	To promote positive attitudes to kākā re-establishment among the public.		
21.1	To foster and develop relationships with tangata whenua, and encourage their involvement in all levels of kākā management.		
22.1	To establish a national sponsorship agreement for kākā.		
Research and innovative technologies			
23.1	A coordinator needs to be appointed to oversee and manage past and future kākā management to aid in the species' recovery.		
24.1	To formally validate, or negate, the ongoing recognition of the two subspecies of kākā.		
24.2	To maximise the genetic diversity of kākā within the bounds of natural rates of genetic exchange and to ensure that new populations are established with the best possible composition of founders.		
25.1	To ensure that robust population modelling is undertaken for all release sites prior to future reintroductions/ translocations to determine site specific requirements/ population options.		
25.2	To increase our understanding of the ecology of kākā.		
26.1	Large-scale stoat control is implemented prior to masting years in natural strongholds and at existing release sites.		
26.2	To complete predator control in all release sites prior to reintroductions of North Island kākā.		
27.1	To promote the development of a uniform method for measuring reintroduction success.		
27.2	To ensure that all participants in kākā recovery fully document all reintroduction attempts.		
27.3	To develop a clear exit strategy once the recovery plan has been finalised.		

Chapter 6 Conclusions and recommendations

6.1 Introduction

The overall aim of this thesis was to develop a detailed recovery plan for North Island kākā (*Nestor meridionalis septentrionalis*) in the North Island of New Zealand through assembling both published data on this species and through input from parrot experts and from managers of re-establishment sites. This aim was achieved by using an integrated approach: a stakeholder contribution survey (Chapter 2), a survey of kākā experts (Chapter 3) and a systematic literature review (Chapter 4).

The overall research objectives were 1) to investigate the success of re-establishment programmes globally with particular reference to species similar in biology and behaviour to North Island kākā; 2) to research and capture current availability of knowledge amongst experts on North Island kākā distribution, reintroductions and translocations; 3) to establish a long-term goal for North Island kākā re-establishment into the North Island of New Zealand and 4) to investigate and capture the current commitments and future expectations of release sites, governmental organisations and community groups.

The key findings from each of the chapters are described in the following sections. In addition to the key findings from the three chapters, the feedback and recommendations from the draft recovery plan are also described below.

6.2 Stakeholder contribution survey

The principle objectives of the stakeholder contribution survey included the capturing of past and current commitments and perspectives on kākā re-establishments from stakeholders as well as investigating future expectations of these stakeholders, with the aim to include these stakeholders in the draft recovery plan for North Island kākā.

The survey results demonstrated the different types of management practices that release sites apply to enable successful reintroductions in New Zealand. The results also revealed where there are overlaps, which can be utilised to develop standardised reintroduction management practices. The development of standards is highly recommended to ensure success of re-establishment programmes. Furthermore, there are a lack of uniform measures for rating the success of re-establishment programmes. Uniform guidelines on how to measure success of re-establishment programmes should be a priority for the global reintroduction community. This in turn will assist in determining the success or failure of projects and therefore the subsequent contribution or actions required to facilitate improved reintroduction success where required.

Furthermore, it is surprising that kākā do not feature more in current re-establishment projects. Being an indicator species for the New Zealand forests, it is recommended that this species be considered for more projects to allow determination of suitability of the forests for other species' reintroduction projects. Additionally, it is recommended that projects that are currently focussed on other species, should also consider adding kākā to their suite of species used for release. Where efforts are focussed on restoring an entire ecosystem, the release of subsequent species (apart from the main focus species) should be actively encouraged.

6.3 Kākā expert survey

The kākā expert survey had one principle objective which was "to capture expert knowledge on North Island kākā reintroductions and translocations" with the aim of creating a shortlist of factors that will determine the success or failure of kākā re-establishment projects.

The survey results demonstrate that the experts identified a large overlap of factors affecting success. The results also show that despite the complex aspects of a re-establishment, twenty experts can (without consultation with each other) create a thorough list of factors affecting success and reach consensus on the five most important factors. This method has proven to be a valuable tool in capturing expert information. It should be considered a regular method of capturing current views and experiences from people working on various species conservation programmes. This would reduce the loss of valuable data when people are no longer employed in their field of expertise.

6.4 A systematic literature review on global psittacine re-establishments

The systematic literature review had one objective, which was to investigate the factors that contribute to the success or failure of re-establishment programmes globally (for species similar in biology and behaviour to North Island kākā).

The review demonstrated that this systematic review appeared to be the first to cover re-establishment success of psittacines. Additionally, the majority of the articles were lacking detail in relation to the re-establishment projects and similar to the stakeholder contribution survey, it was hard to define “success” of re-establishment programmes.

In general, the factors that may affect reintroduction success include both ecological factors (i.e. habitat quality, genetics, or competition) as well as non-ecological factors. These include public relations and education, good team management, social factors, legal considerations and litigation costs, and long-term commitment to the reintroduction project.

6.5 Draft recovery plan

On the 25th July 2017, the draft version of the document “North Island kākā (Nestor meridionalis septentrionalis) recovery plan 2018 – 2028” was distributed for comment to thirty-one experts in the field of kākā conservation and/ or recovery specialists. The summary of the responses is listed in Table 6.1.

Table 6.1 Summary of responses post distribution of recovery plan. * 1 out of office until January 2018.

Type of response	Number of experts/ specialists
Distribution	31
Out of office	4*
Invalid email address	2
No longer employed at organisation	4
Unable to provide feedback	1
Initial response to ability to participate	10
Final responses received	6

The distribution list included individuals that in the previous surveys had indicated they would like to receive further information. Throughout the development of the recovery plan, I reverted to the individuals’ comments and decided to email the recovery plan to them for final comments. From the 31 I included in the list, some email addresses were no longer available, one person advised he felt he would not be the most suitable person to comment, a number were out of office for a long period (including one until January 2018) and some were no longer employed at the organisations. Some of the latter had a new contact provided in their email response, however when I emailed the new contacts some did not respond to my email.

Additionally, three out of the ten experts wishing to participate advised later they had significant time constraints which did not allow them to review the document by the proposed due by date.

In total six experts reviewed the draft recovery plan, their feedback was incorporated in the final version of the plan which will be sent to the Department of Conservation head office in Wellington.

6.6 Communication

Throughout the research for my thesis it became clear that there are aspects of re-establishment projects that require improvement. One of these aspects for example is communication. The findings from the surveys conducted as part of this research show that expert knowledge on re-establishment programmes is not shared widely. The information that is available is lacking detail, making it unsuitable for other recovery projects to utilise for their future planning. Furthermore, post-release monitoring details are not regularly reported on. It is recommended that for each re-establishment project a specific person is responsible for capturing data, analysis of these data and publication of the success or failure of the re-establishment effort. This in turn will support future recovery plans for the species in other areas, as well as assist in the planning of other species re-establishments around the world.

6.7 Cooperation

It is important for everyone involved in re-establishment projects in New Zealand to be aware that they are part of a bigger picture (metapopulation) of returning a species back to their historical range. This means that individual plans for success will need to be considered as part of a national plan. Collaboration between various parties on a national level, will not only facilitate the recovery of entire ecosystems, it also allows multiple species to benefit from these efforts. Cooperation between stakeholders can in turn reduce expenses as well as improve best practice techniques for a suite of species. Being an indicator species for New Zealand forests, kākā recovery can support conservation efforts for other New Zealand native species. The IUCN's Species Survival Commission promotes the inter-regional communication and collaboration in the interests of making best use of resources and experiences for attaining translocation goals and effective conservation (IUCN/ SSC, 2013). Globally, there is still a substantial improvement in cooperation required, considering data on re-establishment success or failure is not shared widely.

Armstrong & Mclean (1995) rightly laid stress on the importance of information exchange in improving the knowledgebase for translocation work. The benefits are "maximisation of the success of each project, minimisation of the damage each might cause, and a better understanding of the factors underpinning success or failure" (Collar, 2006).

The IUCN (1998) states that the principal aim of any reintroduction should be to establish a viable, free-ranging population in the wild, of a species which has become extinct in the wild. "Such a population should be established within the original range of the species and should require minimal long-term management". The IUCN guidelines emphasised that this "requires a multidisciplinary approach involving a team of persons drawn from a variety of backgrounds". Additionally, there should be provisions made for appropriate publicity and public awareness work (Collar, 2006). It would be beneficial for species' re-establishment programmes to participate in a knowledge/ data sharing exercise in the development phase of their project that not only includes their own personnel, but also includes experts from other projects, organisations and community representatives. This would be an ideal method to ensure all relevant information pertaining to the species is captured and everyone is aware of the goals for the species, rather than each site focussing on their own individual interests only.

6.8 Future recommendations from thesis

Being one of the most endangered avian groups in the world (White Jr., *et al.*, 2012; Munn, 2006; IUCN, 2017; Collar, 2000), Psittacine re-establishments need a more organised approach. Ideally, the IUCN's Reintroduction Specialist Group (RSG) could be tasked with compiling templates for capturing information on the entire re-establishment process (including planning, pre-release and post-release monitoring). These templates can ensure that all parties capture the same information, allowing for proper data analysis and comparisons in the future.

Besides capturing the information, data sharing should be prioritised by providing opportunities for sharing experiences. To support parrot conservation globally it should be considered that all future re-establishment projects are published in some form to allow research comparisons in the future. It is important to note that both successful as well as failed projects should be published to give a better picture on the reality of re-establishments.

There is no definition of re-establishment success that project managers can refer to when determining success or failure of their projects. Guidelines on how to measure success are therefore also required. These guidelines need to capture unambiguous definitions on re-establishment success, to ensure all projects are measured equally. Again, this could be initiated or distributed through the RSG.

With clear guidelines and templates in place, these practical steps might in turn increase the future commitments to psittacine re-establishment projects.

6.9 Future recommendations from recovery plan

The recovery plan has a large number of objectives which, after review by the Department of Conservation, need matching action items and responsible parties recorded in the timeline. To ensure there is an effective application of the recommendations (and action items) made in the recovery plan it is crucial to appoint a national kākā coordinator. The kākā coordinator should oversee and implement past and future kākā management to aid in the species' recovery.

6.10 Final remark

The recovery plan will serve as a tool for kākā re-establishment around the North Island of New Zealand. Furthermore, this thesis can be used as a base to encourage further research and collaboration of psittacine conservation efforts. The research completed demonstrates the current limitations in data sharing, and provides ideas on how this can be improved. It is our responsibility as stewards on this planet to ensure we provide species with the opportunity to thrive. More often are people required to step up to prevent extinction of species. Re-establishment efforts are increasing, however ultimately the aim of any successful re-establishment would be the establishment of a self-sustaining population. It is not until then that we should stop involving ourselves in the management of species such as kākā.

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Appendices

Appendix I: Global psittacine reintroduction projects

Common name	Taxonomic name	Country/ Region	Continent
Red-lored amazon	*Amazona autumnalis*	Costa Rica	North America
Yellow-shouldered amazon	*Amazona barbadensis*	Margarita Island	South America
Southern Mealy amazon	*Amazona farinosa*	Peru	South America
Hispaniolan parrot	*Amazona ventralis*	Dominican Republic	North America
Vinaceous amazon	*Amazona vinacea*	Brazil	South America
Puerto Rican parrot	*Amazona vittata*	Puerto Rico	North America
Hyacinth macaw	*Anodorhynchus hyacinthinus*	Brazil	South America
Blue and Gold macaw	*Ara ararauna*	Trinidad	South America
Great green macaw	*Ara ambiguus*	Costa Rica	North America
Green-winged macaw	*Ara chloroptera*	Peru	South America
Scarlet macaw	*Ara macao*	Costa Rica	North America
Illiger's macaw	*Ara maracana*	Brazil	South America
Military macaw	*Ara militaris*	Guatamala	North America
Chestnut-fronted macaw	*Ara severus*	Costa Rica	North America
Golden-capped conure	*Aratinga auricapillus*	Brazil	South America
Vasa parrot	*Coracopsis vasa*	Reunion Island	Africa
Spix's macaw	*Cyanopsitta spixii*	Brazil	South America
Yellow-crowned kākāriki	*Cyanoramphus auriceps*	New Zealand	Oceania
Orange fronted kākāriki	*Cyanoramphus malherbi*	New Zealand	Oceania
Red-crowned kākāriki	*Cyanoramphus novaezelandiae*	New Zealand	Oceania
Antipodes island parakeet	*Cyanoramphus unicolor*	New Zealand	Oceania
Ouvea parakeet	*Eunymphicus uvaeensis*	New Caledonia	Oceania
Orange-bellied parrot	*Neophema chrysogaster*	Australia	Oceania
Kākā	*Nestor meridionalis*	New Zealand	Oceania
Blue-winged macaw	*Primolius maracana*	Brazil	South America
Maroon shining parrot	*Prosopeia tabuensis*	Fiji	Oceania
Echo parakeet	*Psittacula eques echo*	Mauritius	Africa
Blue-throated parakeet	*Pyrrhura cruentata*	Brazil	South America
Thick-billed parrot	*Rhynchopsitta pachyrhyncha*	USA	North America
Kākāpo	*Strigops habroptilus*	New Zealand	Oceania
Rimatara lorikeet	*Vini kuhlii*	Cook Islands	Oceania
Blue lorikeet	*Vini peruviana*	French Polynesia	Oceania
Ultramarine lorikeet	*Vini ultramarine*	French Polynesia	Oceania

Appendix II: Guidelines for parrot reintroductions

Summarised from “Parrot re-introduction: towards a synthesis of best practice” by Collar (2006)

Long-term preparation:

- Create, finance and empower a task force of key players
- Maximise early publicity to ensure financial commitment
- Grow the captive stock fast to minimise the number of generations
- At all costs maximise genetic diversity among founders
- Invest in a comprehensive strategy of planting food-plants at site
- Anticipate dispersal over a greater range than history might suggest
- Consider a programme to reduce or exclude competition and predators

Pre-release preparation

- Build release cages large enough to maximise training capabilities
- Invest in major environmental enrichment or maximise leaming skills
- Ensure strenuous exercise, to maximise foraging and fleeing ability
- Give repeated predator-aversion training as in Whiley *et al.* (2005)
- Follow the soft-release model described above for Echo Parakeet

First release

- Select the optimal period for first release with special regard to food
- Establish a wild flock quickly (to maximise collective vigilance)
- Release as many birds as possible together or in quick succession
- Release a medley of age-class birds, but include established pairs
- Release established pairs first
- Hold back captive mates, initially, to act as lures to released birds

Later releases

- Time releases to coincide with wild fledglings
- Release birds at fledging age
- Release some single birds one at a time, to accelerate integration
- Release other groups of at least four, to allow for socialisation
- Rapidly decide between the two preceding strategies

Post-release arrangements

- Design feeding stations as for the kākā, but allow for visual contact
- Allow open-ended use of supplementary feeding
- Once breeding, foster young from nests to ensure all young fledge
- Find new release sites to increase the range of the species

Appendix III: Stakeholder contribution survey

This survey is used to compile current and past contributions to New Zealand native species re-establishment. The main aim of the survey is to assist in the compilation of a re-establishment plan for North Island Kākā, being an indicator species for forest birds it is the intention that the plan could become a guideline for other native species restoration projects.
Thank you in advance for your participation,
Tineke Joustra

ETHICS
"This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research. If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Dr Brian Finch, Director (Research Ethics), email humanethics@massey.ac.nz".

GLOSSARY
Release: Any form of intentional movement of living organisms where the primary objective is a conservation benefit.
Management Area: Land managed for conservation purposes.

CONSENT
1. Do you give consent to me using your answers to assist in the write up of a re-establishment plan for North Island Kākā?
o Yes
o No

DETAILS OF MANAGEMENT AREA
2. What is the full name of your Management Area?

3. Which of the below best describes your Management Area?
o Mainland
o Off-shore Island
o Peninsula
o Mainland Island
o Other (please specify):

4. What is the location of your Management Area?

5. What is the size of your Management Area (in ha)?

6. What best describes the landcover in your Management Area?
o Forest, indigenous
o Forest, exotic
o Exotic shrubland
o Native vegetation
o Farmland
o Urban
o Other (please specify):

7. Which species of trees can be found in your Management Area (select all that apply)?
o *Agathis australis* (Kauri)
o *Aristotelia serrata* (Wineberry/ Makomako)
o *Beilschmiedia tawa* (Tawa)
o *Carpodetus serratus* (Marbleleaf/ Putaputawētā)
o *Clianthus puniceus* (Kākā beak)
o *Coprosma* spp.
o *Cordyline australis* (Cabbage tree/ tī kōuka)
o *Cyathea* spp. (Tree ferns)
o *Dicksonia* spp. (Tree ferns)
o *Dacrycarpus dacrydioides* (Kahikatea)
o *Dacrydium cupressinum* (Rimu)

o *Dracophyllum* spp. (Dragon leaf)
o *Elaeocarpus dentatus* (Hīnau)
o *Knightia excelsa* (Rewarewa)
o *Melicytus ramiflorus* (Whiteywood/ Mahoe)
o *Myrsine australis* (Red Matipo/ Mapou)
o *Metrosideros* spp. (Rātā vines)
o *Nestegis cunninghamii* (Maire)
o *Nothofagus fusca* (Red Beech/ tawhai raunui)
o *Pennantia corymbosa* (Kaikōmako)
o *Phormium tenax* (Flax/ Harakeke)
o *Phyllocladus trichomanoides* (Tanekaha)
o *Pittosporum eugenioides* (Lemonwood/ Tarata)
o *Pittosporum tenuifolium* (Black Matipo)
o *Prumnopitys ferruginea* (Miro)
o *Prumnopitys taxifolia* (Mataī)
o *Podocarpus totara* (Tōtara)
o *Pseudopanax arboreus* (Fivefinger)
o *Rhopalostylis sapida* (Nikau)
o *Ripogonum scandens* (Supplejack)
o Schefflera digitata (Patē)
o *Solanum aviculare* (Poroporo)
o *Weinmannia racemosa* (Kāmahi)
o Exotic spp

8. Which best described the estimated average height of the trees in your management area?
o <5m
o 5m – 10m
o 11m – 20m
o 21m – 30m
o >30m

9. If any of the following tree species occur in your Management Area, when did you last observe a mast seeding year?

10. Do you have aviaries on-site to enable soft release of bird species?
o Yes
o No
o Not yet, but planned (specify timeframe):

11. What are the dimensions of the aviaries (per aviary please)?
Aviary 1: height x width x length (in metres)
Aviary 2: height x width x length (in metres)
Aviary 3: height x width x length (in metres)
Aviary 4: height x width x length (in metres)
Aviary 5: height x width x length (in metres)
Additional aviaries:

12. What materials are used for the aviaries?

13. Have any of your birds ever had any issues with possible environmental toxicity?

PEST CONTROL
14. What type of predator proof boundaries does your Management Area have?
o Natural boundaries (specify types e.g. river):
o Artificial boundaries (specify types e.g. fencing):

15. Do you complete pest control in your Management Area?
o Yes (please answer pest control questions)
o No

16. Do you have the ability to start pest control in your Management Area?
o Yes
o No (please specify):

o Unknown (please clarify):

17. How often do you complete pest control in your Management Area?
o Continuous
o Pulsed (specify frequency):
o Other (please specify):

18. Who manages pest control in your Management Area (select all that apply)?
o Department of Conservation
o Contractors hired by you
o Your own paid personnel
o Your own volunteer personnel
o Other (please specify):

19. What type of pest control do you use in your Management Area (select all that apply)?
o Ground control
o Trapping
o Bait stations
o Aerial control
o 1080
o Other (please specify):

20. If you use trapping, are these traps Kākā proof?
o Yes
o No
o Unknown/ Unsure

21. If you are using bait stations, are these Kākā proof?
o Yes
o No
o Unknown/ Unsure

22. Have you ever had any issues with Kākā getting into traps or bait stations?
o Yes
o No
o Unknown/ Unsure

23. What is/ are your target pest species in your Management Area (select all that apply)?
o Possum
o Rabbit
o Hare
o Deer
o Pig
o Goat
o Stoat
o Ferret
o Weasel
o Rat
o Mouse
o Cat
o Dog
o Exotic birds (specify species):
o Other (please specify):

ANIMAL RELEASE INFORMATION
24. What is your main target species for release?

25. How long have you been releasing this species in your Management Area?
o < 1yr
o 1yr – 4yr
o 5yr – 9yr
o Other (please specify):

26. How successful would you rate the release of this species and why?
o Excellent (e.g. self-sustaining population):
o Above Average (e.g. some breeding has been observed):
o Average (e.g. the majority of animals are still living):
o Below average (e.g. a large percentage has died):
o Poor (e.g. no survival):

27. Are you releasing any forest bird species besides your main target species?
o Yes
o No

28. If yes, which forest bird species do you release in your area? (select all that apply)
o Kiwi (specify species):
o Blue Duck/ Whio
o Weka (specify subspecies):
o Kereru (specify subspecies):
o Kākāpo
o Parakeet (specify subspecies):
o Cuckoo (specify species):
o Morepork
o Rifleman (specify subspecies):
o Whitehead
o Mohua
o Brown Creeper
o Warbler (specify species):
o Fantail (specify subspecies):
o Tomtit (specify subspecies):
o Robin (specify species):
o Silvereye
o Stitchbird/ Hihi
o Bellbird (specify subspecies):
o Tui (specify subspecies):
o Saddleback (specify subspecies):
o NI Kokako
o Kākā (specify subspecies):

29. What is the source of the forest birds for release (select all that apply)?
o Wild source, translocation adults
o Wild source, translocation chicks
o Wild source, translocation eggs
o Wild source, via Rescue/ Rehab
o Captive source
o Other (please specify):

30. Why was the decision made to select the above species (select all that apply)?
o Supplementation
o Re-establishment
o Trials for more endangered species
o Previous involvement through other sites
o Previous experience with the species
o Ease of acquisition of animals
o Other (please specify):

31. How successful would you rate the release of the forest bird species and why?
o Excellent:
o Above Average:
o Average:
o Below average:
o Poor:

32. How often do you release birds in your Management Area?
o Twice a year
o Annually
o Bi-Annually
o Other (please specify frequency):

33. On average how many specimens would you normally release per species?
o Single, small scale release (<10 specimens)
o Single, large scale release (<10 specimens)
o Multiple, large scale releases (>10 specimens)
o Multiple, small scale releases (>10 specimens)

34. What method of release do you use in your Management Area?
o Hard release
o Soft release with supplementary feeding
o Soft release without supplementary feeding
o Egg translocation
o Chick translocation
o Other (please specify):

35. If you use soft release, how much time do you give birds to acclimatise prior to release?
o < 1 month
o 1 – 2 months
o 3 – 4 months
o 5 – 6 months
o 7 – 8 months
o 9 – 10 months
o 11 – 12 months
o > 12 months (please specify):

36. Do you adjust soft release period once a core population has been established?
o Yes, decrease to (please specify):
o No (please specify why not):

37. Do you supplement feed after release?
o Yes
o No
o Not at this stage, but planning for future

38. What is the goal of your supplementary feeding?
o To encourage breeding in relative safety of release site
o To supplement food availability over winter months
o To support advocacy purposes (e.g. increase visitor experience)
o Other (please specify):

39. How long do you supplement feed after release?
o < 1 month
o 1 – 2 months
o 3 – 4 months
o 5 – 6 months
o 7 – 8 months
o 9 – 10 months
o 11 – 12 months
o > 12 months (please specify):

40. How many times do you supplement feed after release?
o Once a day
o Twice a day
o More than twice a day (please specify):
o Once every other day
o Once a week
o Other (please specify):

41. If you supplement feed after release, which food items do you use?
o Sugar water
o Bird pellets
o Fruit (please specify):
o Vegetables (please specify):
o Nuts (please specify):
o Other (please specify):

42. If you currently do not supplement feed, would you be in a position to do this in future to assist with release programmes/ simulate mast seeding?
o Yes
o No
o Unknown/ Unsure

43. Do you monitor any of the species released in your Management Area?
o Yes
o No
o Not yet, but planned for future (specify timeframe):

44. What methods of monitoring do you apply?
o Transmitters
o Transponders
o Banding
o Visual counts

45. Do you keep any of the below data on the species you release?

o Carrying Capacity	Yes/ No
o Census counts	Yes/ No
o Recruitment rates	Yes/ No
o Mortality rates	Yes/ No
o Adult Survival	Yes/ No
o Chick Survival	Yes/ No
o Fledgling Survival	Yes/ No
o Age of first breeding	Yes/ No
o Breeding success	Yes/ No
o Nest sites	Yes/ No
o Clutch size	Yes/ No

o Others (please specify):

46. Do you keep any of the abovementioned data for North Island Kākā?
o Yes
o No

47. Would you be willing to share any of the abovementioned data for the purpose of population modelling and/ or re-establishment purposes?
o Yes (contact details for data):
o No, because:

48. Do you complete disease screening on species in your Management Area?
o Never
o Opportunistically
o Prior to release
o Prior to transfer to your Management Area
o Other (please specify):

49. If disease screening takes place, who collects the samples?

50. If disease screening takes place, which laboratory completes the tests?

51. If disease screening takes place, what are the tests you complete (select all that apply)?
o Cloacal swabs for enteric pathogens (e.g. Yersinia, Salmonella, Chlamydia)
o Faecal samples (e.g. Coccidia, worm eggs)
o Blood parasites
o PBFD (Psittacine Beak and Feather Disease)
o Genetic testing
o Other (please specify):

NORTH ISLAND KĀKĀ

52. Are you releasing North Island Kākā in your Management Area?
o Yes, since (please specify year and total numbers released):
o No, but have in the past (please specify why this has ceased):
o No and not planning to (please specify why not):
o No, but planned for future (please specify rough timeframe):
o No, but may be interested

53. What is the source and number of Kākā for release (select all that apply)?
o Wild source, translocation adults (specify numbers):
o Wild source, translocation chicks (specify numbers):
o Wild source, translocation eggs (specify numbers):
o Wild source, via Rescue/ Rehab (specify numbers):
o Captive source (specify numbers):
o Other (please specify):

54. Is your Management Area suitable for North Island Kākā?
o Yes
o No (please specify why not):
o Unknown/ Unsure

55. Do North Island Kākā naturally occur in your Management Area?
o Yes
o No
o Unknown/ Unsure

56. If North Island Kākā naturally occur in your Management Area, please complete the below queries:
o Resident/ transient:
o Estimated census count (and which year):
o Frequency of sightings:
o Timing of sightings:
o Breeding behaviour observed:
o If breeding observed which years (if known) or the last year observed:
o Nesting behaviour observed:
o If nesting observed which years (if known) or the last year observed:
o Estimated sex ratio (M.F.U):

57. Are there any landowners near your Management Area that could be negatively impacted by Kākā releases (e.g. Orchards)?
o Yes (please specify why):
o No
o Unknown/ Unsure

58. Are there any aspects in the vicinity of your Management area that could negatively impact on Kākā once released (e.g. lead roofs, public feeding)?
o Yes (please specify what):
o No
o Unknown/ Unsure

59. If Kākā were to breed in your Management Area, would you be in a position to catch chicks for translocation?
o Yes
o No
o Unknown/ Unsure

CONCLUSION

60. What would your Management Area need to be able to participate in the re-establishment plan for North Island Kākā?

61. Would you be interested to receive a copy of the re-establishment plan that is due to be compiled by the end of 2016, and participate in a survey after receipt?
o Yes
o No

62. Do you have any other comments regarding this survey or information you may want to share?

Appendix IV: Expert survey

STAGE 1: FACTORS DETERMINING SUCCESSFUL KAKA RE-ESTABLISHMENT

Invitation:

Dear Kākā colleague,

As part of my Masters' thesis I am compiling data and opinions on Kākā re-establishment. I have previously circulated a survey for release sites in the North Island to determine what their past, current and future commitments are (not restricted to Kākā).

The overall aim of my thesis is to draft a re-establishment plan for NI Kākā, which could hopefully be used as a guideline for future NI Kākā planning. To assist with the writing of the plan, I have collated a list of approximately 30 experts in the field of Kākā re-establishment. I would like to invite you to participate in a three-stage questionnaire. The set-up will be as follows:

1) The first survey will only be 1 question: "In your professional opinion which factors determine successful Kākā re-establishment" For this question I would like you to list at least 10 (and a maximum of 15) factors that you feel are important. This could be ANY factor that you can think of.
2) I collate the responses I receive (hopefully you will all contribute to get a good representation of expertise).
3) The second survey will be a summary of the factors that have been identified and I will ask you to rate which you find has priority.
4) I will collate the responses (again hopefully you will all contribute to this section as well).
5) The last survey will simply be a Yes/ No answer to whether or not we have reached a consensus on the priority list that comes out of the collation of the second survey results.

All up this would only take a couple of minutes of your time, but will be tremendously helpful for my further research and potentially the future planning of NI Kākā. I hope I can count on your input. If you have any queries please feel free to contact me directly.

Many thanks in advance for your time and participation,
Tineke Joustra
Massey University

Survey question:

1. In your professional opinion, which factors (list 10 – 15 factors) determine successful kākā re-establishment? This could be any factor, e.g. related to environmental conditions, the birds used for release, origins of birds, disease, finance, etc.

STAGE 2: RATING OF FACTORS THAT AFFECT KAKA RE-ESTABLISHMENT

Invitation:

Dear kākā colleague,

First of all thank you to those of you who participated in the first survey. Your responses have been collated and summarised in 25 factors that determine successful kākā re-establishment.

This link is for part two of the three-stage survey. All up the survey should take 5 - 10 minutes of your time. There are four questions in this survey: the first three are for clarification of factors on what would realistically be sufficient for successful kākā re-establishment (e.g. how long should supplementary feeding continue after release).

The fourth and final question will ask you to rate the importance of the 25 factors that have been identified during the first survey. After completion of this survey I will compile the outcomes and circulate the final survey in approximately 2 weeks. The final survey will be a simple yes/no question to determine whether we can reach consensus on the most important factors that determine successful kākā re-establishment.

If you have any queries please feel free to contact me directly: tineke.joustra27@gmail.com. Again, thank you for your participation. Your feedback is very valuable to my research.

Tineke Joustra
Massey University

Clarification questions:

1. Predator control clarification: In your opinion, what is an acceptable level of predator control in the release area?

o No predator control
o Fully predator free
o Area free from stoats
o Area free from stoats and possums
o Area free from stoats, possums and rats
o Area has low levels of stoats
o Area has low levels of stoats and possums
o Area has low levels of stoats, possums and rats

2. Soft-release Clarification: In your opinion, how long should kākā remain in soft-release aviaries prior to release?

o < 1month
o 1 – 2 months
o 3 – 4 months
o 5 – 6 months
o 7 – 8 months
o 9 – 10 months
o 11 – 12 months
o 12+ months
o Other (please specify):

3. Supplementary Feeding Clarification: In your opinion, how long should kākā be supplementary fed after release?

o None
o < 1month after release
o 2 – 3 months after release
o 4 – 5 months after release
o 6 – 7 months after release
o 8 – 9 months after release
o 10 – 11 months after release
o 12+ months after release
o Continuous
o Other (please specify):

Survey question:

4. Please rate the level of importance of the below factors (25 in total)

STAGE 3: THE TOP 5 FACTORS DETERMINING SUCCESSFUL KAKA RE-ESTABLISHMENT

Invitation:

Dear Colleague,

Please find below the link to the final part of the three-stage survey. This survey will take 1 or 2 minutes and will close on Monday 8th August.

I would like to thank you all for your participation, your responses have been very informative, and will be immensely useful for my research thesis. A copy of the thesis will be sent to you upon completion. If you have any queries please feel free to contact me directly: tineke.joustra27@gmail.com

Many thanks,
Tineke Joustra
Massey University

Survey question:

1. Do you agree that the below five factors are the most important factors to affect successful Kākā re-establishment (factors listed in order of importance)?

1) Predator control (low levels of predators)

2) Managing cause of local extinction/ decline prior to release

3) Habitat suitable for Kākā (includes nest and natural food availability)

4) Sufficient number of birds released

5) Post-release Monitoring

o Yes
o No

2. Please feel free to leave any additional comments you may have:

Appendix V: Data extraction form

BIRD DATA COLLECTION

Author:	**Year:**
Title:	**Publication Type:** ○ Journal ○ Book ○ Other:
Citation:	**Source:** ○ Database search ○ Hand search
Verification of study eligibility: ○ Correct population (= Psittaciformes) ○ Relevance (= re-establishments) ○ Topic (= success/ failure) ○ Timeframe (> 1966 = last 50 years)	**Corresponding author's details:**
Date extracted: / /2016	**Author to be contacted:** YES/ NO
Species Common Name:	**Country of study:**
Taxonomy:	**Continent:**
IUCN listing: EX/ EW/ CR/ EN/ VU/ NT/ LC	**Island:** YES/ NO
DOC Threat listing: NA/ Other:	**CITES listing:** N/A/ I/ II/ III
Endemic species: YES/ NO/ UNKNOWN	**Episodic breeder:** YES/ NO/ UNKNOWN
Type of re-establishment: ○ Reintroduction (C -> W) ○ Translocation (W -> W) ○ Supplementation (C -> W / W -> W)	**Homing species:** YES/ NO/ UNKNOWN
Year of first release:	**Year of last release:**
Number of release events:	**Amount of birds released/ release event:**
Origin of birds: ○ Captive ○ Wild ○ Unknown	**Sex of birds released (M.F.U):**
Age category of birds released: ○ Juvenile ○ Adult ○ Juvenile and Adult	**Season of release:** ○ Spring ○ Summer ○ Autumn ○ Winter

ENVIRONMENT DATA COLLECTION

Size of Release area:	**Habitat type:**
Human population near release area:	**Main land use near release area:**
Species already resident in area: YES/ NO/ UNKNOWN	**Release area entirely fenced:** YES/ NO/ UNKNOWN
Disease prevalence in release area: YES/ NO/ UNKNOWN	**Predators in release area:**
PBFD Testing programme in place: YES/ NO/ UNKNOWN	**Predator Controlled:** YES/ NO/ UNKNOWN
Soft-release methods used: YES/ NO/ UNKNOWN	**Supplementary feeding after release:** YES/ NO/ UNKNOWN
Time kept in aviary prior to release:	**Breeding observed of released individuals:**
Mortality rates of released individuals:	**Survival rates of released individuals:**

PROJECT DETAILS/ SUCCESS RATING

Project Goals:	
Success Indicators:	**Major Issues Identified:**
Rating Project: o Highly successful o Successful o Partly successful o Failure o Unknown o Other:	**Major Issues Mitigated prior to Re-establishment:**
Reasons for rating:	