

## **CAPTIVE MANAGEMENT PLAN FOR KIWI**

### **FINAL 2018-2023**

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## 1 Preface

This Captive Management Plan (CMP) for Kiwi updates and replaces the 2011 Kiwi CMP (Barlow, 2011).

The 2018-2023 CMP has been produced by the previous Kiwi Captive Coordinator (2008-2018) in consultation with the Zoo Aquarium Association (ZAA), the Kiwi Recovery Group (KRG) and the New Zealand captive management community. The plan was developed over three days of review and planning with Caroline Lees of the IUCN/SSC/CPSG (IUCN Species Survival Commission's Conservation Planning Specialist Group) Australasia. The author's work in development of this document was funded by the ZAA NZ committee.

Captive management of kiwi in New Zealand is a cooperative effort between the captive community and the Department of Conservation (DOC) and the captive population will be supported by best practice population management that is valued by both kiwi holders and our stakeholders. The species will continue to be managed through the circulation of annual reports specifying breeding, transfer and release recommendations, developed in close consultation with kiwi programme participants and with the broader kiwi conservation community.

Separate to this captive managed kiwi programme, the captive community continues to make a significant contribution to the national kiwi recovery effort through the techniques developed as part of BNZ Operation Nest Egg™, (a head-start programme bringing wild eggs into captivity for artificial incubation and chick rearing for release back into designated wild sites). That programme does not come under the jurisdiction of the brown kiwi captive programme referred to herein.

We trust this document will provide clarity to both captive holders and the Department of Conservation in terms of the purpose, goals and strategies for management of captive kiwi in New Zealand. It is not the intent to replicate here, information provided in a number of kiwi management manuals/protocols now freely available (e.g. 2011 Captive Management Plan for Kiwi, Brown Kiwi Husbandry Manual, etc), and included in the reference section of this document.

We would like to acknowledge and thank the many people who have taken time to comment on this plan during its draft circulation.



**Suzy Barlow**

Previous Kiwi Captive Coordinator (2008-2018)



**Jess Scrimgeour**

Acting Leader, Kiwi Recovery Group (Department of Conservation)

## 2 Introduction

This Captive Management Plan (CMP) continues to build upon the strategic direction established in the 2011 Kiwi CMP; to create a sustainable captive population of Eastern region brown kiwi through expansion (by captive breeding and targeted introduction of new founders) of this population and gradual 'phasing-out' of remnant Northland, Western and 'mixed provenance/region' kiwi.

While advocacy remains the primary focus of the brown kiwi captive managed population, this population has supporting roles providing captive bred kiwi for targeted release to the wild and continuing to provide a resource for recovery-directed training and research. The programme will demonstrate best practice kiwi husbandry and welfare. Improvements in nocturnal house husbandry and management techniques, revision of the national captive kiwi diet and the roll out of ZAA member welfare accreditation have all occurred during the previous period and strongly support increased kiwi welfare.

One of the goals identified in the 2011 CMP was to build capacity to provide captive-bred kiwi for targeted release to the wild (reflected in the programme's vision statement). This capacity was built and is now being mobilised in support of the new national outcomes of achieving a 2% overall increase in kiwi abundance in the wild. The strategy and vision of the programme have been revised and adapted to accommodate this new role.

Brown kiwi that are part of this actively managed programme will continue to support recovery group approved research projects which directly benefit wild kiwi conservation. Research applications are reviewed and approved to ensure relevance to kiwi conservation and non-detriment to the breeding population in captivity.

This 2018-2023 CMP for Kiwi articulates closely with the 2018-2028 Kiwi (*Apteryx* spp.) Recovery Plan (Germano *et. al.*, 2018) and the previous jointly appointed ZAA/DOC captive coordinator (and author of this CMP) was a member of the Kiwi Recovery Group.

This document reviews the outcomes from the actions identified in the 2011 CMP (see Section 11 of this document) and sets new goals and actions for the programme for the next 5 years – 2018-2023.

### 3 Vision and goals summary

#### *Goals of Brown Kiwi captive management*

<b><i>Vision</i></b>	<p>Captive management for kiwi is effective through a single-region population of brown kiwi which is numerically self-sustaining, demographically stable and genetically healthy, maintained in facilities that model excellence in kiwi husbandry.</p> <p>The programme through which this population is managed is strongly supported and valued by all holders. It delivers key advocacy messages widely and effectively, has the capacity to provide captive bred kiwi for targeted release to the wild and provides a resource for recovery-directed training and research.</p>
<b><i>Population management goals</i></b>	<ul style="list-style-type: none"> <li>• Continue to transition the captive population to a single captive management unit of Eastern brown kiwi.</li> <li>• Maintain high levels of gene diversity and minimise inbreeding accumulation.</li> <li>• Maintain target population size and stable age structure.</li> </ul>
<b><i>Release goals</i></b>	<ul style="list-style-type: none"> <li>• Support DOC approved translocation plan for Western release/restoration sites.</li> <li>• Support DOC approved translocation priorities for Eastern release/restoration sites.</li> </ul>
<b><i>Husbandry management goals</i></b>	<ul style="list-style-type: none"> <li>• Ensure all holders have facilities that are 'fit for purpose' (including off-exhibit facilities)</li> <li>• DOC permitting process supports the consistent implementation of minimum husbandry standards (as documented in the Husbandry Manual).</li> <li>• Have sufficient breeding expertise, spread across enough participating institutions to be able to support the demographic and genetic goals of the programme.</li> <li>• Understand the triggers for and effect mitigation of behavioural, health and breeding problems experienced by kiwi in nocturnal houses.</li> <li>• Ensure all kiwi in the captive programme have the potential both to breed and to be released.</li> </ul>
<b><i>Participant support goals</i></b>	<ul style="list-style-type: none"> <li>• Ensure that the captive management strategy meets both population goals and the display needs of participating institutions.</li> <li>• Maintain a shared understanding of, and support for, the programme's goals.</li> </ul>
<b><i>Advocacy goals</i></b>	<ul style="list-style-type: none"> <li>• Ensure key advocacy messages are widely accepted and used.</li> <li>• Develop a programme wide advocacy evaluation process.</li> </ul>
<b><i>Ex situ Research</i></b>	<ul style="list-style-type: none"> <li>• To optimise the value of the captive kiwi population through utilising kiwi for recovery driven research.</li> </ul>
<b><i>Conservation Fund</i></b>	<ul style="list-style-type: none"> <li>• All participants in the programme are encouraged to channel institution-based conservation funding initiatives towards the Kiwis for Kiwi Trust and to support (via staff/shared expertise) local kiwi projects.</li> </ul>

## 4 Background

### 4.1 Taxonomy (taken from the Draft 'Kiwi (*Apteryx* spp.) Recovery Plan 2018-2028)

Kiwi have been classified into five species, all of which are endemic to New Zealand (see Table 1). They belong to a distinct family of ratite birds, the Apterygidae, which is generally placed in its own order, Apterygiformes (Germano, *et al.*, 2018), but sometimes grouped with other ratites and tinamous in the Struthioniformes (Germano, *et al.*, 2018).

Brown kiwi are a single species with four distinct regional populations in Northland, Coromandel, eastern North Island and western North Island (Weir *et al.*, 2016).

### 4.2 Status in the wild (taken from the Draft Kiwi Recovery Plan 2018-2028)

Table 1. Common, scientific, Māori names and current status for the five species of kiwi

Common name	Scientific name	Māori name	Current status*
Little spotted kiwi	<i>Apteryx owenii</i>	Kiwi pukupuku, kukupapata iti	At risk - recovering
Great spotted kiwi	<i>A. haasti</i>	Roroa, roa	Nationally Vulnerable
Tokoeka	<i>A. australis</i>	Tokoeka, tokoweka, roa	Haast tokoeka – Nationally Critical Rakiura tokoeka – Nationally Endangered N Fiordland tokoeka – Nationally Vulnerable S Fiordland tokoeka – Nationally Endangered
Brown kiwi	<i>A. mantelli</i>	Kiwi, kiwi a whenua toaroa	At risk - declining
Rowi	<i>A. rowi</i>	Rowi	Nationally Vulnerable

\*Assessment by Robertson *et al.*, (2017)

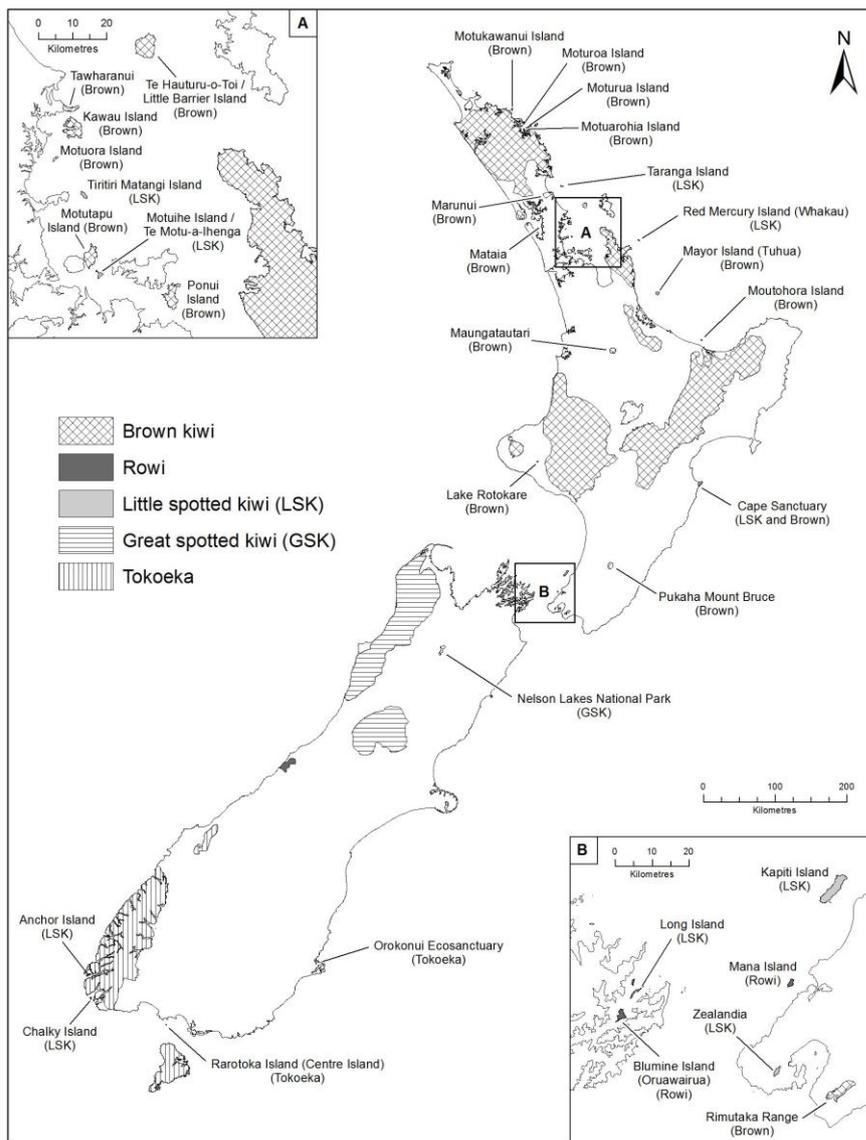


Figure 1: Current distribution of the five extant kiwi species in New Zealand (from the 2018 Kiwi Recovery Plan)

Specific details in regard to current status and changes in kiwi distribution and numbers may be found on pages 20-24 of the 2018-2028 Kiwi (*Apteryx* spp.) Recovery Plan (Germano, *et al.*, 2018).

### **Brown Kiwi status in the wild (from the draft Kiwi Recovery Plan 2018-2028)**

Although brown kiwi are still relatively numerous, with c. 25,000 birds in 2015 (Innes, *et al.*, 2015), the majority remain in sites with little to no management. These unmanaged populations are in decline due to predation of adults by dogs and ferrets (*Mustela furo*), and recruitment failure due to predation of chicks by stoats and cats. Landscape-scale (10,000+ha) mustelid trapping programmes and aerial application of 1080 have proven effective at reversing population declines, with annual growth rates of up to 11.3% per year being recorded (Robertson and de Monchy, 2012).

Within the brown kiwi group, Northland and Coromandel brown kiwi are receiving the most active conservation attention, mainly due to the larger number of active community projects in these geographic locations. Western and Eastern brown kiwi population estimates are believed to have declined over the 10-year period of the previous Kiwi Recovery Group (Germano, *et al.*, 2017); however new initiatives such as more broad-scale pest control being delivered by regional councils are creating landscape size predator free habitats. A new initiative from Kiwis for Kiwi ('Kiwis for Kiwi

Trust', previously known as 'BNZ Save the Kiwi Trust') to expand BNZ Operation Nest Egg™ with a focus on Western and Eastern birds commenced in late 2017. See [www.kiwisforkiwi.org](http://www.kiwisforkiwi.org)

### 4.3 History in captivity (please refer to the 2011 Kiwi Captive Management Plan)

### 4.4 Programmes in other regions

Since 2008, Brown Kiwi held in the USA and Europe have been managed by Kathleen Brader (National Zoo, Washington D.C.) in a joint Species Survival Program (SSP) in the USA and European Endangered Species Programme (EEP) captive programme. Kathleen maintains a ZIMS R3 (Species360) dataset (studbook) for the SSP/EEP programme which is currently managed at regional level, in a manner equivalent to that of Brown Kiwi in New Zealand, which are managed by a coordinator in the Australasian region.

The SSP/EEP produced its first kiwi 'Master plan' (similar to the ZAA Annual Report & Recommendations) in 2009 and produces these reports approximately once every 3 years. The most recent 'Master plan' produced in 2016 provided the data for the genetic statistics below.

Five "new" Northland founders were transferred to the US from the New Zealand programme in 2009. These kiwi were transferred by Auckland Zoo, with support from Ngati Hine. Details of the programme are provided below. The SSP/EEP and ZAA captive coordinators liaise regularly sharing studbook datasets, population management reports and husbandry information.

	<b>AZA/EAZA joint programme</b>
AZA studbook keeper	Kathleen Brader National Zoological Park, Washington, D.C., USA <a href="mailto:BraderK@si.edu">BraderK@si.edu</a>
AZA population advisor	Cara Groome Bryan AZA Population Management Center <a href="mailto:cgroome@lpzoo.org">cgroome@lpzoo.org</a>
Management unit	<b>Species – Brown Kiwi.</b> Mixed region however predominantly Northland
Programme type	Joint SSP-EEP programme
Population Size	33.15.0 (total 48 at 11 institutions as of 12 <sup>th</sup> January 2016)*
Planned Population Size	Target population is 75 kiwi
Number of institutions in programme	11 (6 in SSP + 5 in EEP) + 1 in Japan (not included)
Studbook	Yes
GD	86.24% with a potential of 95.98% (data provided from 2016 Masterplan report)
Inbreeding (F)	0.0594 (as for GD figure)
Programme status	All birds overseas included on EEP/SSP studbook including 1.1 at Osaka. However, Osaka are not managed as part of the programme and thus though tracked are a separate entity.
Other information	2.3 new ex BNZ ONE 'founder' birds (NLD provenance) were exported from Auckland Zoo to the USA in 2010, to support an increase in genetic diversity in the jointly managed overseas SSP/EEP managed kiwi population.

\*NB Figures for numbers provided by K. Brader in 2017; however, analysis of GD has not been provided since the last AZA Masterplan report as of January 2016. 33 males, 15 females and no unsexed kiwi.

## 5 Scope and Governance

### 5.1 Taxon information

Taxon	<i>Apteryx mantelli</i>
Common name	<b>Brown Kiwi</b>
Captive management unit	Species – Brown Kiwi Region – <b>Eastern</b>
TAG	New Zealand Fauna Taxon Advisory Group
Scope of managed population	Captive managed population in New Zealand institutions; <i>excludes BNZ Operation Nest Egg™ ‘head start’ chicks and those kiwi held under DOC rehabilitation permits.</i>
Current ASMP Programme	Conservation Programme
Planned ASMP Programme	Conservation Programme
Programme Partners	Department of Conservation, Kiwi Recovery Group
IUCN status	Endangered, (EN). A2bce+3bce+4bce ver 3.1 Population trend: stable.
CITES listing	Not listed
New Zealand Threat Classification System, DOC	‘At risk – declining’; Robertson <i>et al.</i> (2017)
Current ability to recruit from the wild	Ongoing ability to recruit founders as required via BNZ Operation Nest Egg™ chicks (Eastern brown)
ASMP Species coordinator:	<i>Todd Jenkinson</i>
Contact details: <i>Email:</i>	<a href="mailto:todd@zooaquarium.org.au">todd@zooaquarium.org.au</a>
<i>Phone:</i>	+64 223 229 622
Document prepared by:	<b>Suzy Barlow</b>
Last updated:	February 2018
Studbook compiled by:	Suzy Barlow (August 2008 – February 2018)
Scope of data:	Australasian (New Zealand)
Date first compiled:	1992 (by Tracy Johnson)
Data now current to:	February 2018
Frequency of Reporting	Annually in February/March each year

## 5.2 Rationale for captive management unit

The captive brown kiwi population was managed as a single management unit until 1994 when DNA analysis showed that brown kiwi populations in the wild had far more genetic structuring than previously known, (Baker *et al.*, 1995, Burbidge *et al.*, 2003). The splits between the various provenances/geographical regions (taxa) of brown kiwi were probably due to changes in sea-level, and tectonic and volcanic events (Burbidge *et al.*, 2003, Weir *et al.*, 2016). Their analysis showed that there were captive birds from three of the four geographical regions (all but Coromandel), and although most pairs came from the same region, some pairs came from different regions. From about 1994, each regional population was managed separately, resulting in four small and unsustainable populations of Northland, Eastern, Western and 'mixed' origin brown kiwi in captivity.

In 2011, the decision was taken to concentrate captive breeding on only one taxon of brown kiwi. **Eastern brown kiwi** was selected on the basis of a management unit matrix, as described in the 2011 CMP.

This decision was reconfirmed in 2017 and Eastern brown kiwi remains the sole focus of this captive management strategy.

**Rationale matrix for selection of brown kiwi in captivity can be found on page 9-12 of the 2011 Kiwi CMP**

## 5.3 Scope of this managed captive brown kiwi programme

This captive management plan includes kiwi which are held under DOC Standard Operating Procedure (SOP) Captive Management permit and are centrally coordinated through the Kiwi Captive Coordinator. It excludes 'head-start' wild Operation Nest Egg (ONE) eggs/chicks and individual kiwi held under DOC rehabilitation permits.

There are no remaining Little Spotted Kiwi in captivity (Jo Russell, pers. comm.) as at January 2018. One female Great Spotted Kiwi (16 years old) remains at Otorohanga Kiwi House. Two Great Spotted Kiwi, female "Mohua" estimated to be early 20s (grand-parenting permit) and male "Piki", hatched February 2015 (rehabilitation permit) remain at Willowbank Wildlife Reserve; these birds are outside the scope of this managed programme. Bevan and Lorraine Alexander in Arahura Valley (see 2004 Kiwi CMP) still maintain two Rowi: a male ('Albie') who was released but had to be recaptured, and a female ('Smiley'), rehabilitated, but with a damaged beak. These were early Operation Nest Egg birds and did not adapt to the wild. These two birds have been with the Alexanders for over 16 years. (Tim Shaw, pers. comm.)

There are between two and five Rowi chicks on rotational nocturnal exhibit (rotated seasonally) at the West Coast Wildlife Centre (WCWC) in Franz Josef under DOC exceptional circumstances. This was permitted under DOC due to the WCWC's investment in BNZ Operation Nest Egg™ for the critically endangered Rowi and Haast tokoeka kiwi taxa.

## 6 Programme administration

Documentation required	Frequency of reporting	Responsibility
Studbook maintenance ( <i>SPARKS dataset</i> )	<i>Updated monthly</i>	<i>Captive coordinator</i>
Planned frequency of recommendations:	<i>February/March annually</i>	<i>Captive coordinator</i>
Progress reported:	<i>Annually</i>	<i>Captive coordinator</i>
Programme review:	every 5 years with CMP	<i>Captive coordinator</i>

### Programme management team

Name	Institution	Email
Todd Jenkinson	Zoo & Aquarium Association NZ Fauna TAG Co-convenor (Birds) Kiwi Captive Coordinator	<a href="mailto:todd@zooaquarium.org.au">todd@zooaquarium.org.au</a>
Jess Scrimgeour	Department of Conservation Acting Leader, Kiwi Recovery Group	<a href="mailto:jscrimgeour@doc.govt.nz">jscrimgeour@doc.govt.nz</a>
TBA	TBA Engagement Specialist Advisory Group (ZAA)	TBA
Baukje Lenting	Wellington Zoo Vet advisor to NZ Fauna TAG	<a href="mailto:Baukje.lenting@wellingtonzoo.com">Baukje.lenting@wellingtonzoo.com</a>
Emma Bean	National Kiwi Trust, Rainbow Spring's Kiwi Encounter ZAA Kiwi husbandry advisor	<a href="mailto:emma.bean@rainbowsprings.co.nz">emma.bean@rainbowsprings.co.nz</a>
Hugh Robertson	Research advisor to the programme (DOC)	<a href="mailto:hrobertson@doc.govt.nz">hrobertson@doc.govt.nz</a>
Richard Jakob-Hoff	Research advisor to the programme (NZCCM, Auckland Zoo)	<a href="mailto:Richard.jakob-hoff@aucklandzoo.co.nz">Richard.jakob-hoff@aucklandzoo.co.nz</a>

## 7 Captive management strategy

An effective advocacy programme requires a healthy, thriving population able to fulfil the display needs of contributing members consistently. Over the next 5 years this programme will also need to have sufficient capacity to generate a more significant contribution of individuals for release to recovery group approved wild sites. Achieving all of these outcomes will require careful genetic and demographic management, high quality staff and facilities, best practice kiwi husbandry and care and effective delivery of key advocacy messages.

The role of the captive management programme is to support programme stakeholders to achieve these outcomes. The role of the captive management plan is to document agreed priorities for the 2018-2023 period and to provide a guide to stakeholders on their role in pursuing these priorities.

The captive management strategy therefore includes the following elements:

1. A VISION – that describes the ideal qualities of the programme.
2. CONTEXT – progress since 2011 and ISSUES for 2018-2023
3. GOALS aimed at addressing the programme issues
4. ACTIONS directed at delivering these GOALS.

Captive programme components can be neatly separated into seven main themes:

- Population Management (demographic and genetics).
- Release.
- Husbandry Management.
- Programme participant support.
- Advocacy.
- *Ex situ* Research
- Conservation initiatives.

The following section is separated into these individual themes with all population management-related graphs, tables and analyses listed in sections 9 and 10 of this document.

### 7.1 *Vision for the captive kiwi population in New Zealand*

#### **Our vision for this population is:**

Captive management for kiwi is effective through a single-region population of brown kiwi which is numerically self-sustaining, demographically stable and genetically healthy, maintained in facilities that model excellence in kiwi husbandry.

The programme through which this population is managed is strongly supported and valued by all holders. It delivers key advocacy messages widely and effectively, has the capacity to provide captive-bred kiwi for targeted release to the wild and provides a resource for recovery-directed training and research.

## 7.2 Summary of programme issues

As a result of progress since the development of the 2011 Kiwi CMP, most of the previously reported issues have been addressed. The majority of the issues that remain relate either directly, or indirectly to kiwi husbandry.

### 1. Challenges to sustainable kiwi population management

'Phasing-in' Eastern brown kiwi to create one management unit has gone well so far (see Figure 4, pg 20) and this continues to be the programme's management strategy. Remaining sustainability issues include: the increasing percentage of programme birds required for nocturnal house displays (increased from 40% in 2011 to 48% in 2018); random demographic challenges (such as some losses of breeding-age Eastern females and a skew in sex-ratio of male Eastern chicks); and managing high expectations in regards to kiwi availability for 'new' participant requests.

### 2. Release

Despite advocacy being the primary goal of the captive programme, 75 kiwi have been released to support wild sites since 2011. A key issue for management over the next 5 years will be understanding where, when and how many release birds can be accommodated at wild sites. This will require working closely with the Eastern 'taxon' group (DOC and local stakeholders) to develop confirmed release sites with approved DOC translocation plans in place; and working with DOC to develop a new Western multi-site translocation plan for the gradual release of remaining western birds from the captive population.

### 3. Husbandry requirements

Issues include the ongoing updating and review of the Brown Kiwi Husbandry Manual; sustaining staff kiwi husbandry expertise (and encouraging greater inter-institutional skill exchange); the ongoing management of the 'ZAA/Massey Kiwi Maintenance Diet' project; inspection/delivery of DOC permitting for captive kiwi facilities; ensuring sufficient off-exhibit space is maintained to support breeding; and ensuring that in future all programme kiwi are fit both for breeding and release (e.g. no holding of damaged, welfare compromised birds).

### 4. Participant/Institutional support for programme goals

All programme participants are actively supporting the programme goals and have increased support since 2011. One current issue is that not all facilities breed kiwi. Those that do may prefer to breed for release (now that there are increased needs/options for supporting targeted release to the wild), rather than supply the display needs of other facilities. This will need to be addressed.

### 5. Advocacy

The development of the 'Advocacy Messaging for Kiwi in Human Care' (DuBern, 2014) was a major step forward for the primary goal of a captive advocacy programme. There remain some issues around the consistency of uptake of this messaging by programme participants, and there is a need for the ZAA Engagement Specialist Advisory Group (SAG) to drive this process.

### 6. Optimising the value of the captive population

The development of a formal research application process has ensured that research utilising captive birds is well targeted and supports kiwi recovery. Ensuring that the research application process continues to occur will be an ongoing issue.

*The issues above are addressed in the 'Captive Management Strategy' section of this CMP.*

## 7.3 Population Management

### 7.3.1 Genetic Management Context

The importance of gene diversity to the success of wild populations is well documented (see Frankham *et al*, 2002). Without it, populations lose the potential to evolve in response to environmental change, have limited ability to survive exposure to new diseases or new variants of existing diseases, and suffer from the effects of inbreeding depression. Loss of genetic diversity happens continuously over time, more rapidly in small population than in large ones. In large populations (e.g. 1500 animals or more), the gradual loss of genetic diversity is offset by the addition of new genes via natural mutation. Although more gene diversity is always better, 90% of wild source gene diversity is the standard minimum threshold used in captive populations.

Review of the captive brown kiwi population in New Zealand in the 2011 Kiwi CMP identified that in order to maintain sufficient genetic diversity, targeted at a minimum of 90% of the wild founder genetic diversity the captive brown kiwi population needed to transition to a single management unit. Previously the captive population had been managed as 4 separate genetic units, none of which were large enough to reach the targeted genetic diversity for a ZAA conservation programme.

The strategic direction established by the 2011 Kiwi CMP was to focus on ‘phasing-in’ Eastern brown kiwi and gradually ‘phasing-out’ the remaining Western, Northland and ‘Mixed provenance’ kiwi. The goal remains to continue moving to a single management unit of Eastern brown kiwi founded on the recommended minimum number of wild founders (20 individuals).

The goal of transitioning to a single management unit of Eastern brown kiwi towards meeting best practice genetic and demographic goals over the long-term, will at times be in conflict with the goal of meeting display requirements in nocturnal houses. Thus, in the interim, a small number of Western birds may still need to be bred to ensure ‘back up’ young chicks that may be used in nocturnal houses as required.

Management of the population will aim to equalise the genetic representation of founders in the descendent population, promoting retention of gene diversity and as a result the long-term health of the population. A genetically viable population will carry value both in generating healthy kiwi for advocacy/display, and in providing genetically appropriate kiwi to identified restoration/release sites as required.

### Genetic management strategy

The overall aim of genetic management is to maximise retention of founder genetic diversity. This will be achieved by the preferential allocation of breeding opportunities to individuals less related to the wider population and therefore expected to carry rarer alleles. This strategy has been shown to reduce the rate at which gene diversity is lost and inbreeding is accumulated within populations. Wherever possible, pairs will not be established where the resulting offspring would be inbred to a level considered deleterious. Additional genetic support will be provided through the regular input of a small number of individuals from the wild. Optimal breeding pairs will be selected based on the following criteria (in order of importance):

- Males aged at least 2 yrs, females aged at least 3 yrs
- Low mean kinship values relative to the population average (individuals from genetic lines with the least representation in the current population, measured using mean kinship values)
- Similar mean kinship values between prospective pairs
- Avoiding inbreeding levels equal to or above  $F = 0.125$
- Acquiring new founders via Operation Nest Egg (ONE) as required

**Genetic targets:**

- Maintain a founder base of a minimum of 20 unrelated founders
- Supplement with between 2 and 6 new founders every 5 years if required
- Retain 90% of wild genetic diversity over 20 years
- Ensure all offspring produced have an inbreeding threshold of below  $F = 0.125$

**7.3.2 Progress since 2011:****Founder acquisition**

The proposal to ‘phase-in’ Eastern region brown kiwi was based on the rationale outlined in the 2011 Kiwi CMP (section 5.1 ‘Rationale for Captive Management Unit Selection’). In order to transition the population, release of healthy non-Eastern brown kiwi from the captive population was enacted as a short-term strategy, to move the population quickly towards a single, Eastern population. As planned, founder acquisition of Eastern brown kiwi founders from Maungataniwha, (Hawkes’ Bay), via ONE, occurred during the reporting period (2011-2017).

Acquisition of new founders via ONE (from known radio transmitted sires) continues to be considered the most appropriate way to bring new genetics into the captive population. These chicks are reared in a captive environment, thus conditioning them to captive management from hatch. This is considered preferable to any other way of acquiring new wild genetics and is currently considered best practice from a welfare perspective.

Ten chicks from different pairings, as identified through monitoring of wild male kiwi incubation and subsequent uplift of eggs for ONE from the large, extant wild population at Maungataniwha (Hawkes’ Bay,) were brought into the managed captive population to “grow-up” as new breeding founders - their status is as follows:

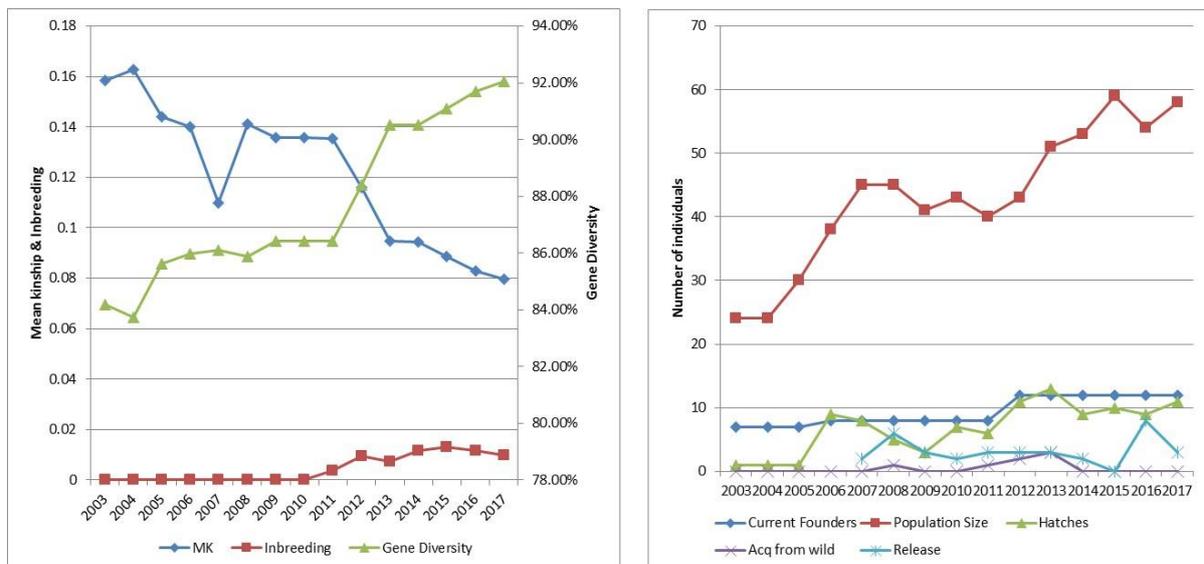
Studbook number	Sex	Hatched at Rainbow Springs	Current location and status
629	M	November 2011	Auckland Zoo - breeding
630	F	November 2011	Auckland Zoo - breeding
646	M	February 2012	Rainbow Springs - breeding
647	F	February 2012	Rainbow Springs - breeding
766	M	January 2013	Otorohanga – re-paired 2017
767	F	January 2013	Otorohanga – re-paired 2017
768	F	January 2013	Died April 2016
858	F	November 2017	Hatched Rainbow Springs
859	F	October 2017	As above
860	F	October 2017	As above

Agreement with the Forest Life Restoration Trust (Maungataniwha) to acquire a further 5 additional founders during the next 5-year period (of this CMP) has been reached. Chicks will be sourced from different incubating males at the wild site. Three female chicks were acquired in the 2017-2018 breeding season during drafting of this report (and have been included in the total of 10 acquired in the table above). Captive-bred Eastern brown kiwi are provided in return for this founder acquisition. In the longer term there will be a requirement for periodic founder additions to maintain the genetic diversity of the captive population. The number required will be determined by five-yearly reviews of founder representation in the descendent population.

## Captive breeding

Breeding capacity of Eastern brown kiwi has increased (documented in ZAA's "Annual Report and Recommendations" produced in February-March) and currently stands at ~15 pairs. During the previous period this was impacted by the losses of several female Eastern brown kiwi just as they reached breeding age (around 3 years of age); and a significant (but not statistically significant) skew in the production of male chicks from the current pairings.

Regardless, the Eastern population is gradually expanding to fill the captive space allocation and the descendent population genetic diversity is tracking at 93.12% (February 2018). Current projections indicate there should be no issues with achieving targets (dependent on ongoing breeding management).



**Figure 2: Eastern population genetic and demographic target progress showing progress from strategic direction set in 2011 CMP (from 2017 ZAA Annual Report and Recommendations)**

**A)** Mean kinship (MK), inbreeding coefficient (inbreeding) and gene diversity; **B)** number of current founders (successfully bred wild caught), population size, hatches and acquisitions from wild.

### 7.3.3 Challenges for 2018-2023

#### Issue: Shortage of Eastern region females of breeding age

There are two reasons for this:

##### a) Time lag between founder chicks arriving and reaching breeding age

Despite new founder acquisition being a relatively straightforward process, given the good relationship established between the captive programme and the large, wild site of Maungataniwha, there remains a time-lag between acquisition of ONE chicks and these birds reaching breeding age. Thus, new founders do not come 'on-line' immediately for breeding.

##### b) Loss of new founder Eastern females

The loss of new founder females, just as they reached breeding age – has hampered expansion of known founder representation in the descendent population. This has caused delays in plan implementation and has meant re-locating and re-pairing a number of genetically valuable birds to ensure they contribute their genes to the captive population.

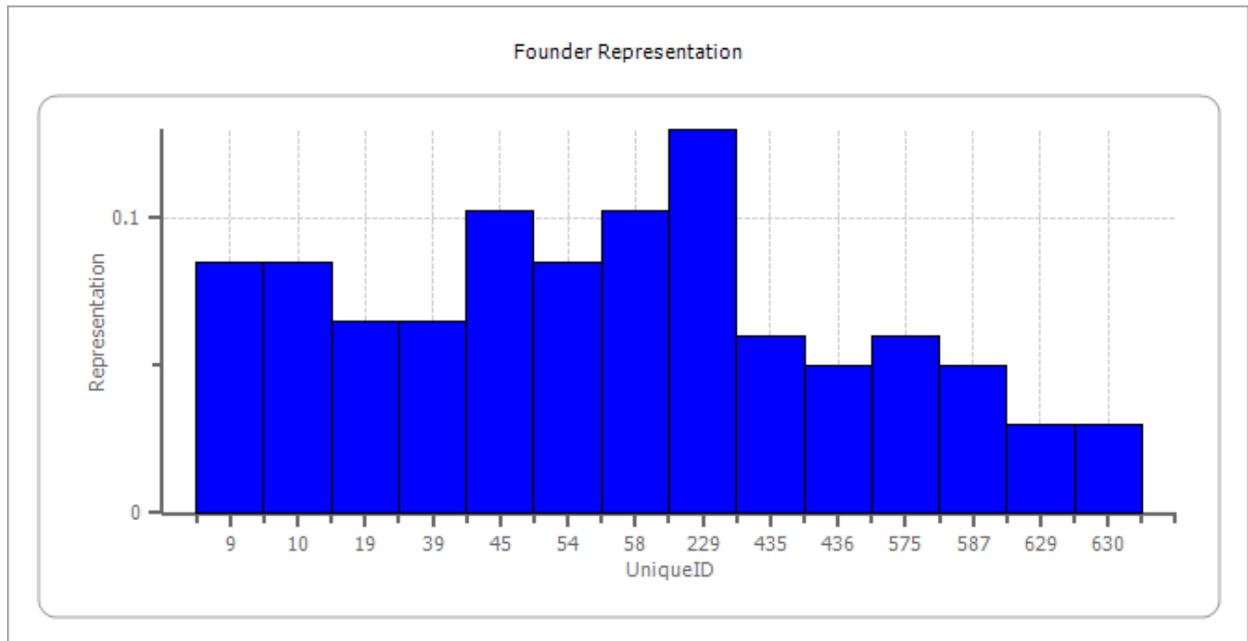


Figure 3: Founder representation in the current **Eastern** region Brown Kiwi captive population (February 2018).

The graph above illustrates over-representation of one founder (229), that was previously a prolific breeder in the captive programme. It also illustrates the low (but increasing) representation of new founders 435 – 630 in the population. The aim would be to equalise founder representation across the population (as far as possible).

#### 7.3.4 Demographic Management Context

The available ‘space’ for the captive brown kiwi population fluctuates between ~110-120 kiwi (planned space within the next 5 years as listed by all programme participants in February 2018). Based on past experience across a number of species, this number should provide sufficient space to support a relatively stable captive population. (Caroline Lees pers. comm.).

As outlined in the 2011 Kiwi CMP, the ~100 captive brown kiwi were previously being managed as four separate populations of Eastern, Western, Northland and “Mixed provenance” region brown kiwi. None of these populations were large enough to support a viable, sustainable captive population. Following the decision taken in 2011 to aim for demographic stability across the captive brown kiwi population, the captive management strategy proposed a strategic “phase-in” to **Eastern** brown kiwi. The aim of the demographic strategy is to gradually grow the Eastern brown kiwi population beyond a size where it could be adversely influenced by demographic stochasticity (random fluctuations in birth and death rate, and in sex ratio).

It is recognised that there are occasions when there are competing demands for brown kiwi bred in captivity. As the primary role of the captive population is species advocacy, priority will be given to maintaining a captive population that can provide kiwi for existing advocacy displays. The number of kiwi hatches required to maintain population size varies but is approximately 15 birds a year for current population targets (see section 9.10 ‘Implications of planned population size’). While it is anticipated that there will be enough breeding pairs to sustain the display (usually non-breeding) population, occasionally priority may need to be given to the establishment of new *breeding* pairs at the expense of new *display* pairs, especially where reproductive rates are lower than expected.

### Demographic management strategy:

The population size will be maximised by transitioning to a single captive management unit so that all available space is mobilised for Eastern brown kiwi. This will be done by reducing the breeding rate of Western brown kiwi and increasing the breeding rate of Eastern birds. This is a gradual process as young founder Eastern brown kiwi have to grow to breeding age before they can contribute to the population; and the need for replacement chicks in nocturnal houses is relatively frequent.

The number of breeding pairs each year/season will be determined with the aim of achieving planned numbers, producing kiwi for advocacy display and to support targeted release. The number of breeding pairs recommended each season will be selected with reference to:

1. available space (if the population is not at capacity)/and or release wants
2. PMx analysis of reproductive rate required to maintain zero population growth (if population at capacity)
3. number of kiwi needed for planned restoration/release sites (as identified annually) \*

### Demographic targets:

- Maximise population size (target >100).
- Maintain stable age structure.
- Generate harvest for release.

### 7.3.5 Progress since 2011

Significant progress has been made since 2011 with the “phasing-in” and “phasing-out” strategies outlined in the 2011 CMP. These include the cessation of any breeding of Northland and “mixed-provenance” birds, release of all non-target kiwi deemed “suitable” for release to DOC approved wild sites, and increased breeding of Eastern birds. Eastern brown kiwi now comprise 69% of the total captive population (February 2018). A limited number of Western brown kiwi pairs have been bred to provide additional young birds to meet nocturnal display requirements. A significant number of Western birds have been released since 2011, under a DOC multi-site translocation plan (see section 7.4.2 Figure 5 for numbers of kiwi released since 2011). Progress towards this goal has seen the reduction in holding of Northland, mixed region and Western brown kiwi and the increase of Eastern region birds since the 2011 Kiwi CMP, as illustrated overleaf.

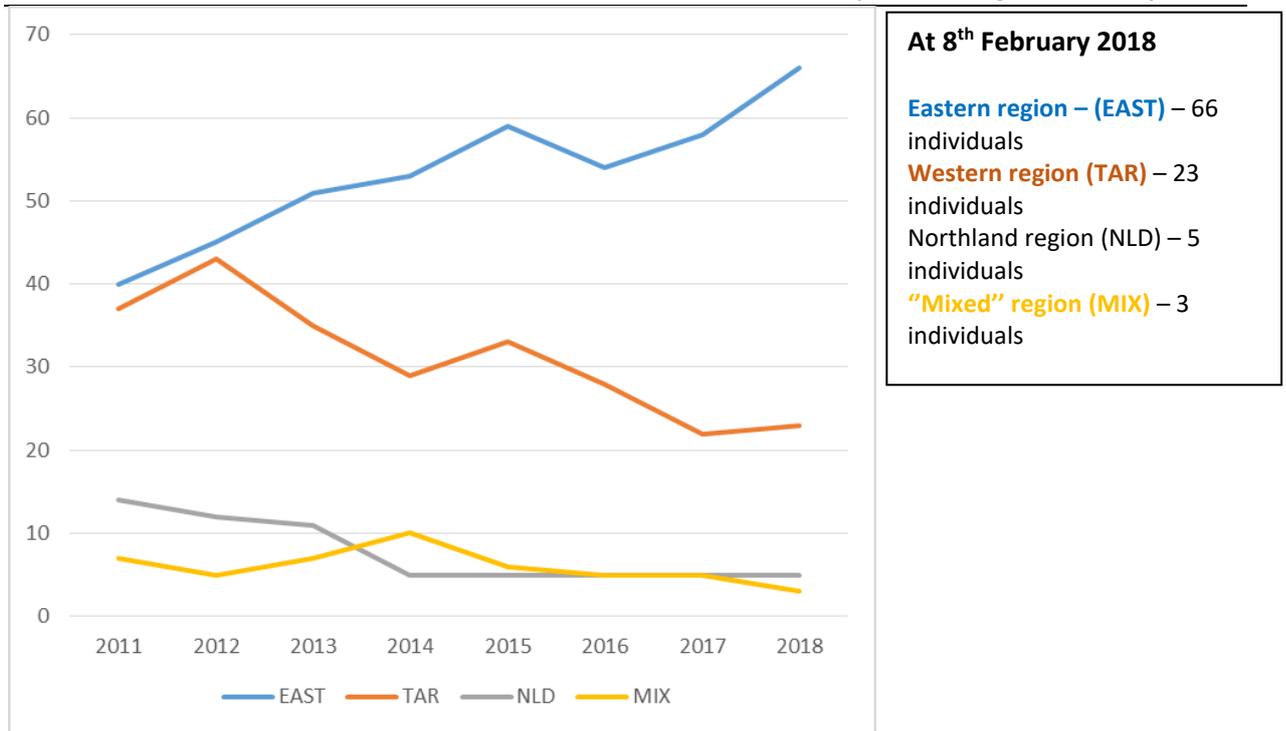


Figure 4: Numbers of each regional ‘provenance’ of brown kiwi in captivity from 2011 – February 2018, illustrating the gradual increase of the population of Eastern brown kiwi.

Note: The increase in the ‘mixed provenance’ numbers in 2013-2014 can be attributed to the inclusion of the ‘white kiwi’ brought with a ‘mixed-provenance’ mate from ONE to a nocturnal display, and breeding of ‘mixed provenance’ kiwi at a facility against recommendation for a phase-out population. Western kiwi numbers increased in 2016-2017 as more birds were required for nocturnal houses; a number of the total (adults) were released during 2017, since these figures (from the Annual Report and Recommendations) were recorded.

### Maintaining stable age structure

There have been no issues with maintaining a stable age structure in the captive population since 2011 and it is not anticipated that any issues will arise over the next 5 years (refer to section 9 ‘Demographic Review’ of this report for the age pyramid of the total captive population as at February 2018).

### 7.3.6 Challenges for 2018-2023

#### Issue: Captive space competition

Approximately 48% of the existing captive ‘spaces’ (up from 40% in 2011) are allocated to display kiwi, the majority of which are housed in reverse photo-period nocturnal houses. Nocturnal houses may not be conducive to kiwi breeding (see section 7.5.2 ‘Husbandry Management’ of this report). Approximately 52% of the population must therefore support all recruitment requirements, including those for the 48% held in display-only facilities.

#### Issue: Occasional breeding issues/Demographic stochasticity

Since 2011, three adult female Eastern brown kiwi died just as they reached breeding age, and this has been further confounded by a skewed sex-ratio (though not statistically significant) of male Eastern chicks hatching to date. This is not immediately resolvable.

#### Issue: Holders breeding or transferring against recommendations.

Despite strong uptake and endorsement by all programme participants of the 'Annual Report and Recommendations' each year since 2011, there have been a few instances of breeding against recommendations, and one case of mistaken identity for a released kiwi. All breaches of participant endorsed recommendations are reported the following season in the ARR, and 'purposeful' actions against the agreed strategy are reported to DOC.

### 7.3.7 Goals and actions

**Goal 1: Continue to transition captive population to a single captive management unit of Eastern brown kiwi**

**Goal 2: Maintain high levels of gene diversity and minimise inbreeding accumulation**

**Goal 3: Maintain target population size and stable age structure**

Action	Responsibility	Timeline	Measurable	Resource
Deliver ZAA Annual Report and Recommendations to action this strategy – report to DOC permitting any non-compliance	ZAA/DOC Captive Coordinator	Feb/March annually Ongoing	ARR endorsed and actioned by all stakeholders; ARR informs stakeholders in regards to breeding versus display	Active captive coordinator ensures breeding targets
Oversee acquisition of new Eastern founders via O.N.E. through Rainbow Springs from Maungataniwha	ZAA Captive Coordinator/Rainbow Springs	First 2-3 by February 2018; 2 <sup>nd</sup> 1-2 as required before 2022	Founders enter captive population and are set up for breeding	First 0.3 completed January 2018
Monitor male sex skew to report back on continuance or not in 2023	ZAA Captive Coordinator	Annually in ARR	Report on any further skew in male Eastern chicks in ARR	Active captive coordinator

## 7.4 Release

### 7.4.1 Context

In 2011 the primary role for the captive brown kiwi population was advocacy, with a caveat that the sustainable programme being established would be able to provide kiwi for targeted release at a future date.

Going forwards, as the captive population phases completely into Eastern birds there will be more opportunity to release birds to targeted wild sites. With the NZ government's recent target of reversing the 2% decline, nationally, in kiwi populations and turning it to a 2% increase, the captive population has the opportunity to start producing high quality, captive-bred birds for targeted release.

Captive-bred kiwi maybe grown to 3+ years of age in nocturnal displays, under the current strategy, (e.g. see section 7.5.2 Nocturnal House Displays) before being transitioned to outdoor enclosures for pre-release screening. Additionally, these birds are right at the commencement of breeding age and have the added bonus of being large enough to be 'stoat proof' (e.g. well over 1200g in weight) at release.

## 7.4.2 Progress since 2011

### Release of brown kiwi to wild sites

The ‘phasing’ strategies outlined in the 2011 Kiwi CMP included release of non-target, non-Eastern brown kiwi that were deemed suitable for wild release/to supplement wild populations that were under appropriate management. To this end the remaining releasable Northland (to Motukawanui, Cavalli Islands, Northland) and ‘Mixed region’ brown kiwi (to Rimutaka Forest Park and Pukaha-Mt Bruce hill-site), were released under DOC approved translocation plans.

A number of Western birds were released under a multi-site DOC translocation plan and a number of higher mean kinship Eastern birds were released to large Eastern wild sites (some in exchange for the acquisition of new wild founders for the captive programme). As can be seen from Figure 5 below, a total of 75 kiwi have been released to wild sites over the previous period.

There remain a small number of elderly/physically unsuitable/non-eastern brown kiwi in the captive population that cannot be released and these birds will be ‘grand-parented’ out of the population.

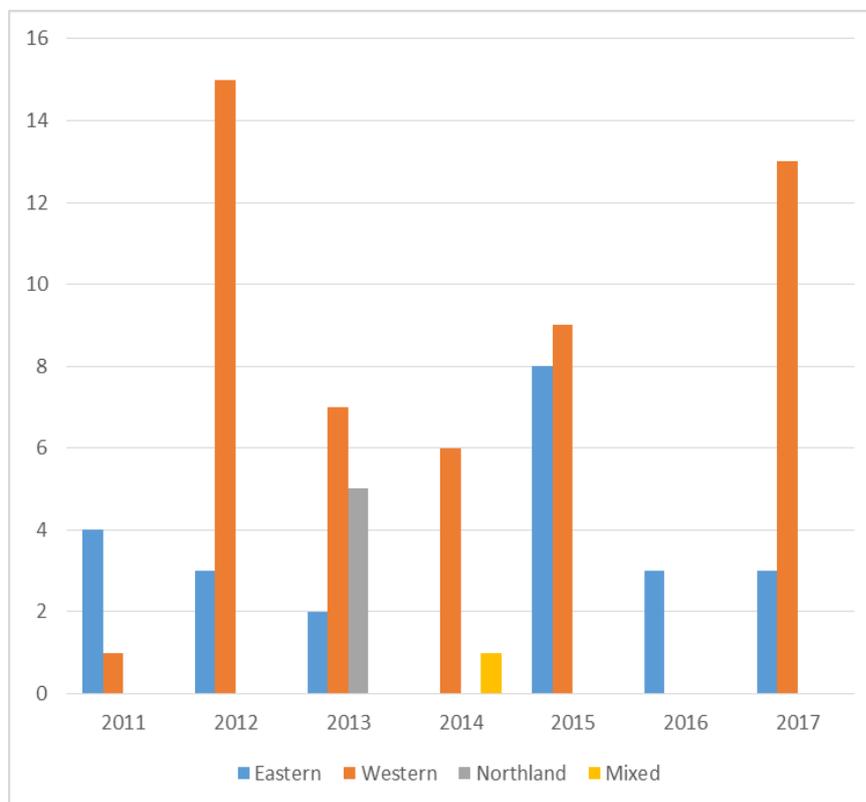


Figure 5: Illustrates number of Brown kiwi released to DOC approved wild sites 2011-2017 by “provenance” (a total of 75 releases to the wild)

### Development of principles for release of captive bred brown kiwi

In late 2017, the previous captive coordinator drafted guiding principles for the release of captive-bred brown kiwi. These closely reference the draft ‘Northland Brown Kiwi Translocation Strategy; Key Requirements for Translocation’ and underwent initial consultation with the Kiwi Recovery Group in November 2017. These DRAFT principles are included in Appendix I and will be finalised as a matter of urgency in 2018.

### 7.4.3 Challenges for 2018-2023

#### **Issue: Generate harvest for release**

Since 2011, releases to Eastern sites have not been managed as intensively as will be required going forward. While the captive population has been ‘phasing-in’ to Eastern brown kiwi since 2011 the strategy has been simply to release high mean kinship birds to large populations at wild sites (such as Cape Kidnappers and Maungataniwha), as numbers available for release have been limited. Additional requests from smaller population restoration sites (such as Otanewainuku) have been provided with only a small number of birds to prevent over-representation of captive founder lines at those smaller sites.

#### **Issue: Guidance from eastern taxon planning group**

Close liaison with the Eastern region ‘taxon group’ and DOC will be required, to identify, approve and confirm DOC release sites, set translocation plans in place and provide a clear understanding of where individuals for release should go (e.g. ensuring no flooding of small sites with over-represented genetic lines).

#### **Issue: Expiry of DOC translocation plan for western Sites**

While the ‘phasing-in’ to Eastern brown kiwi is progressing well, a number of genetically valuable eastern pairs are only just reaching breeding age. Thus, a small number of western birds (from the most valuable remaining genetic lines) will continue to be bred as ‘back-up’ kiwi to meet the display requirements of the programme. All these western birds are destined for eventual release, (anticipated during the next 5-year period).

The previous multi-site DOC Western brown kiwi translocation permit expired in November 2017. DOC is awaiting (via the Kiwi Recovery Group leader) the finalisation of this new Captive Management Plan for Kiwi, in order to develop a new translocation permit that allows for the remaining western birds (exact numbers can only be modelled in each Annual Report and Recommendations) to be released to multiple locations. There are some sites at which no more captive-bred western birds may be released (such as Maungatautari) as they have already received sufficient genetic input from the captive programme. The DOC western representative on the Kiwi Recovery Group is aware of this.

## 7.4.4 Goals and actions

**Goal 1: DOC approved translocation plan for western release/restoration sites**

**Goal 2: DOC approved translocation priorities for eastern release/restoration sites**

Action	Responsibility	Timeline	Measurable	Resource
Liaise with western taxon planning technical officer to ensure <b>new multi-site Western brown kiwi translocation plan</b> includes release of captive bred kiwi	Captive coordinator/DOC	2019/2020	DOC approved translocation plan in place	Active captive coordinator to DOC
Liaise with and advise DOC and <b>Eastern taxon planning group to support priority release sites</b> (and capacity) in eastern region	Captive coordinator/DOC	2019-2021	DOC approved priorities in place	Active captive coordinator to DOC
Ensure <b>DRAFT release principles</b> for wild release of brown kiwi (Appendix I of this document) are finalised and available to participants	Captive coordinator with Kiwi Recovery Group	By the end of 2018	Document endorsed and circulated	Active captive coordinator

## 7.5 Husbandry Management

### 7.5.1 Context

Documentation to support kiwi captive husbandry and best practice is now readily available from the DOC, 'Kiwis for Kiwi' and ZAA websites. Documents include the 'Brown Kiwi Husbandry Manual' (Fraser and Johnson, 2009, revised 2015), the 'Kiwi Best Practice Manual' (Robertson and Colbourne, 2003, revised 2017), the 'Operation Nest Egg Incubation and Chick Rearing Best Practice Protocols' (Bassett, 2012) and the Kiwi First Aid and Veterinary Care (Morgan, 2008) [Link to Kiwi First Aid and Veterinary Care](#) for veterinary care guidelines.

These documents amply outline best practice in kiwi care and welfare, yet there is no over-arching mechanism to ensure standards are met and maintained by all programme participants. Since 2013, DOC has included the requirement for captive facilities holding kiwi to meet the standards outlined in the 'Brown Kiwi Husbandry Manual' in their Wildlife Authority Permits; however, DOC permitting staff rarely inspect facilities to ensure these conditions are being met. Additionally, Zoo and Aquarium Association (ZAA) members must undergo welfare accreditation that specifically includes kiwi as one of their inspection species in New Zealand. Whilst both these initiatives are welcomed, there remains the need for facilities to be regularly reviewed, and to be open to undergoing review, in terms of kiwi facility and husbandry conditions. This issue is particularly relevant following any changes in key staff at kiwi facilities.

### 7.5.2 Progress since 2011

#### Nocturnal House Displays

Prior to 2011 it was assumed that to optimise behavioural welfare, the most appropriate way to hold captive Brown kiwi was in a male/female pair. For birds held in outdoor facilities in recommended breeding pairs this continues to be the assumption. However, since 2011, in response to observed symptoms of poor welfare in nocturnal houses (e.g. pacing, females becoming egg-bound) the programme has trialled a different approach. Pairs or single young kiwi (from previous season hatches) have been selected for display in nocturnal houses, replacing adult birds. Anecdotally, this appears to improve both activity/display levels, as chicks apparently adjust to reversed photo period more quickly than adult birds, and do not appear to develop stereotypic pacing that can occur once birds reach reproductive age. The use of chicks also reduces the risks associated with adult females becoming egg bound in nocturnal facilities. As the programme allows, kiwi chicks are removed from nocturnal houses at around 3 years of age, before the onset of adult behaviour, when they may be moved to outdoor facilities for breeding, or, released. Due to the success of these trials the future strategy will allow for chick placement in nocturnal houses (dependent on outcomes of annual population analysis).

Since 2011, some facilities have supported the programme by exhibiting single male chicks until they reach breeding age (at which point the coordinator identifies them for potential pairing in an outdoor breeding facility or for release depending on their MK value). Over the past 6 years there has been a male sex-ratio skew in Eastern chicks that has required some nocturnal facilities to display single male chicks (that 'grow up' in the facility from chick to 3 years of age). If this continues over the next 5 years other kiwi nocturnal houses may need to consider dividing their nocturnal houses to provide for displays of singleton males, while sex-ratios readjust.

#### Husbandry training

In the previous CMP (2011) there was an identified action to survey holders for interest in a regular kiwi husbandry and breeding management course. Action to be revisited with new coordinator in 2018.

### **'ZAA/Massey Kiwi Maintenance Diet'**

Major advances in the roll-out of a national standardised kiwi captive diet have occurred over the past 3 years. Following Charlotte Minson's (Massey University) review of wild kiwi diet composition and financial assistance from the ZAA NZ committee for the creation of an 'artificial' (but ultimately unpalatable) kiwi diet, the previous captive coordinator requested that the nutritional content of the recommended artificial diet be translated into a kiwi diet that could be easily created by captive holders from 'supermarket ingredients'.

The aims of this project were two-fold. Prior to having a nationally consistent diet it was a regular occurrence that birds transferred from one facility to the next would be faced with a different diet, and as a result birds frequently refused to eat (unless force-fed) for considerable periods post transfer. Since the diets varied extensively, there was also no guarantee that birds were being fed the most nutritionally appropriate kiwi diet and yet Charlotte Minson's PhD had already undertaken analysis of the required components for a nutritionally complete kiwi diet (based on wild data). Thus, the previous captive coordinator requested a 'supermarket' ingredient recipe that would meet the researched nutritional requirements of the birds and could be relatively easily made up with local ingredients at all captive facilities.

The resulting 'ZAA/Massey Kiwi Maintenance Diet' was rolled out nationally in 2016 and is being closely trialled and monitored to ensure uptake and the maintenance of general health/breeding parameters. Data are being collected by Claire Travers (private kiwi consultant) and Don Thomas (Massey University) with the aim of providing annual feedback to all holders.

### **Captive egg data annual reporting - established in the same format as for Operation Nest Egg (ONE) for direct data comparison**

Since the 2010-2011 kiwi breeding season, the captive coordinator has been collating annual egg data from all breeding facilities to provide a direct comparison with results from ONE. This data is presented at the end of the 'Annual Report and Recommendations' each season.

The format used to tabulate the data is identical to that used for ONE data collation and was developed in liaison with kiwi incubation experts at Rainbow Springs Nature Park (Rotorua). Thus, it is now possible to provide a comparison between data (i.e. egg infertility) from wild 'uplifted' eggs and captive laid eggs.

The mean over four seasons of DOA and infertile from ONE is 18.65% infertile. The mean over the same period (2012-2013 to 2015-2016 inclusive) for captive laid eggs is 22.8% infertile. Given that ONE eggs are not always brought in for incubation (e.g. infertile eggs candled in the field) and are taken from established wild breeding males (rather than 'created' captive pairings), the results are reasonably equitable. Many of the captive eggs are from newly created young (and inexperienced) pairs, and every egg laid is collated in the captive data.

### **DOC permit to hold 'Absolutely Protected Wildlife' – special conditions for kiwi**

With guidance from the Kiwi Recovery Group, the previous captive coordinator requested the inclusion of three 'special' permit conditions, specific to kiwi, in new DOC permits to hold 'Absolutely Protected Wildlife', under Schedule I of the Wildlife Act. Since 2013 these additional conditions have been included in all new DOC permits that include kiwi as part of the managed captive programme, including the condition that all captive holders must meet the minimum standards as incorporated in the 'Brown Kiwi Husbandry Manual'.

### 7.5.3 Challenges for 2018-2023

#### **Issue: Sustaining staff husbandry expertise**

There remains a recognised need for a national kiwi husbandry training course. This is a particular issue as staff turnover is relatively high among facilities holding captive kiwi, which presents challenges in sustaining expertise, particularly in the area of breeding management. This in turn can negatively affect the production of sufficient chicks to meet the needs of the programme.

#### **Issue: Off-exhibit holding space**

It remains critical that all holders have space for an equal number of birds off-exhibit as on-exhibit. This is to accommodate enforced separation, and transfer requirements in and out of a facility. The standard is that off-exhibit space is multi-purpose and should be outside (so that it can be used for breeding or pre-transfer/pre-release holding). Part of pre-release requirements remain (see Appendix I) that any birds exhibited in a nocturnal house are housed outside for a minimum of 30 days to adjust to changed photo-period pre-release.

#### **Issue: Ongoing management of the 'ZAA/Massey Kiwi Maintenance Diet' project**

This project is being overseen by Claire Travers (previously Rainbow Springs, now a private contractor) and Don Thomas (Massey University, ZAA NZ committee) with new diet data collated since 2016. The captive coordinator oversees delivery of the project and will be required to ensure data collation continues, with Don Thomas as lead in this roll. It is important that captive facilities have an expert contact person and receive feedback on the collated diet data.

In addition, the majority of kiwi that manage to find metal to ingest (even the tiniest piece despite ongoing metal detector screening of substrates) seem to be breeding age females. The previous captive coordinator compiled data for metal ingestion events over the past 5 years. National roll-out of the new kiwi diet in 2016 may alleviate some of these issues however results are as yet unknown, and this requires close monitoring.

#### **Issue: DOC permitting authority delivery (captive kiwi facilities)**

While the previous captive coordinator has effectively introduced additional kiwi specific conditions into the DOC permitting to hold Absolutely Protected Wildlife, (Schedule 1); there remain issues relating to effective delivery of these. Ideally, all facilities would receive DOC inspection at permit renewal. The captive coordinator has no influence over this process and higher-level intervention is required. (Note: not all kiwi holders are members of ZAA).

#### **Issue: Accommodating veterinary 'modified' kiwi in the captive programme that are unable to breed**

It is important that all kiwi held in the captive population have a purpose and can contribute to breeding at some stage in their life (whether in captivity or upon release). Holding injured or damaged birds that cannot breed for 'whole of life' in a nocturnal house is not considered best practice welfare. Every kiwi being held that cannot contribute to breeding at some life stage is detrimental to the overall goals of the programme and maintaining best practice welfare for captive kiwi.

## 7.5.4 Goals and actions

**Goal 1: Ensure that all holders have facilities that are ‘fit for purpose’ (including off-exhibit facilities)**

**Goal 2: DOC permitting process supports the consistent implementation of minimum husbandry standards (as documented in the Husbandry Manual).**

**Goal 3: To have sufficient breeding expertise, spread across enough participating institutions to be able to support the demographic and genetic programme goals**

**Goal 4: Understand the triggers for and effect mitigation of behavioural, health and breeding problems experienced by kiwi in nocturnal houses**

**Goal 5: All kiwi in captive programme have the potential both to breed and to be released.**

Action	Responsibility	Timeline	Measurable	Resource
Review and <b>update Brown Kiwi Husbandry Manual</b> (last completed 2015)	Captive coordinator oversees Kiwi Husbandry Advisor	During 2020 at latest	Kiwi Husbandry manual reviewed, updated and endorsed by all stakeholders	Time for coordinator and husbandry advisor to deliver
ZAA to support development of a <b>kiwi husbandry training</b> course for member staff working with kiwi	ZAA captive coordinator/ZAA NZ members/ ZAA executive office	Commence 2018 with aim to have course in place 2019-2020	At least one key staff member at every captive kiwi facility has participated in the course.	Funding and time to allow development of such.
Ensure <b>ZAA/Massey kiwi diet project</b> follow through	Captive coordinator with Claire Travers/Don Thomas	By 2019	Diet results are shared with all stakeholders	Time for this project to be completed
Communicate strategy of using <b>chicks to grow up in Nocturnal Houses</b> to all programme participants	Captive Coordinator to captive holders	Annually / Ongoing	Holders have a clear understanding of welfare implications and transfers implications	Captive coordinator time
Continue to communicate with all holders in regards to <b>providing off exhibit space</b>	Captive coordinator	Ongoing	All holders have suitable off exhibit holding	Coordinator time.
Ensure all kiwi holders are aware that birds must <b>be fit for purpose of programme</b>	Captive coordinator ongoing communication with holders and vets	Ongoing	No new injured/non-breeding birds are accepted into the captive managed population	Ongoing communication between captive coordinator/ vets/ captive holders
Initiate <b>studies of kiwi health and behaviour in Nocturnal Houses.</b> Contact Massey Uni in first instance.	Captive Coordinator/ Kiwi Recovery Group/ identified researchers	Commence 2018 – ongoing...	Evidence / publication in regards to implications of nocturnal houses on kiwi welfare	Request via research person on Kiwi Recovery Group/Massey University
Raise issue of <b>DOC permitting inspection</b> with ZAA NZ	Captive coordinator	Ongoing	Deficiencies in DOC permitting process discussed with ZAA NZ and deficiencies addressed	Resource – DOC – ZAA NZ

## 7.6 Programme participant support

### 7.6.1 Context

Issues include ensuring that the captive management strategy meets both the population goals and the display needs of participating institutions. It is important that all participants understand and support the rationale for holding a captive population, comprising a single taxonomic unit, which primarily ensures sustainability for display/advocacy. They also need to be aware of the multiple roles that captive birds can contribute to species recovery, of which breeding is only one.

### 7.6.2 Progress since 2011

All display needs were met in the previous period; the captive coordinator was able to respond in a timely manner where display birds needed to be unexpectedly replaced during the year. The quality of Nocturnal House displays was improved overall by the trial use of chicks to 'grow-up' on display (see section 7.5 Husbandry Management).

Implementation rate for the annual recommendations has improved over the past 6 years. Holders have strong support for the measures advocated in the programme reports. It is anticipated that this will continue provided there is ongoing clear and regular communication with holders.

### 7.6.3 Challenges for 2018-2023

#### Issue: Not all facilities breed kiwi

All stakeholders acknowledge the significant cost breeding facilities incur when rearing kiwi. Both breeding and display facilities play an important role in the advocacy of the species.

### 7.6.4 Goals and actions

**Goal 1: Ensure that the captive management strategy meets both population goals and the display needs of participating institutions.**

**Goal 2: Maintain a shared understanding of, and support for, the programme's goals**

Action	Responsibility	Timeline	Measurables	Resource
Deliver clear, consulted and endorsed Annual Report and Recommendations each February/March	Captive coordinator/ ZAA	March annually	Report is endorsed by members	Active captive coordinator
Proposed meeting at ZAA Conference Wellington May 2018 (or similar) for kiwi holders only to discuss breeding versus display	ZAA and individual programme participants	During 2018	Agreement to discuss annually and that all breeding facilities receive appropriate recognition	Requested meeting time (December 2017)

## 7.5 Advocacy

### 7.6.5 Context

Captive collections have an ongoing opportunity to showcase the issues facing kiwi conservation in the wild and to forge links with their local kiwi community conservation initiatives.

### 7.6.6 Progress since 2011

Over the last 6 years key advocacy messages have been developed in the “Advocacy Messaging for Kiwi in Human Care”, document written by Oliver DuBern (DuBern, 2014). The messaging was developed in liaison with the Kiwi Recovery Group and presented at Kiwi Hui and ZAA NZ conferences during the reporting period.

### 7.6.7 Challenges for 2018-2023

#### Issue: Non-captive conservation groups creating ‘close-up’ kiwi experiences

*In situ* conservation projects, particularly those run by community groups, are actively seeking ways to increase the advocacy opportunities of their projects, by creating ‘close encounters’ with ONE chicks and/or wanting to create captive ‘pens’ at their wild sites.

#### Issue: ZAA Engagement SAG needs to support kiwi advocacy messaging delivery

Despite the key advocacy messaging being widely disseminated, uptake has been limited across kiwi facilities. This needs to be reviewed and promoted by the ZAA Engagement SAG.

### 7.6.8 Goals and actions

#### Goal 1: Ensure key advocacy messages are widely accepted and used

#### Goal 2: Develop a programme wide evaluation process

Action	Responsibility	Timeline	Measurable	Resource?
Appoint a new Advocacy Coordinator (ZAA Engagement SAG)	Captive Coordinator request to ZAA Engagement SAG	During 2018	Appointed and active	Time
Engagement SAG to identify next steps in ensuring uptake of agreed advocacy messages	Captive Coordinator/Engagement SAG	2019-2020	Next steps identified by SAG	Support from participating institutions

## 7.7 *Ex situ*, Research

### 7.7.1 Context

There remains acknowledged potential for using captive kiwi for research, however it is important that research applications are coordinated centrally to ensure no detriment to the captive population and that recovery-directed research is prioritised.

### 7.7.2 Progress since 2011

A research proposal form has been developed and has been in use since 2012. The form is completed and submitted by the research proponent via the captive coordinator. Each proposal is evaluated by two experts; one in kiwi health and the other in national kiwi recovery. Approved projects may require ethics approval (to be obtained by the proponent). Following approval, the captive coordinator facilitates communication with the most appropriate captive facilities (e.g. research may negatively impact breeding pairs). Proponents whose projects are approved are required to report back on completion of their project.

### 7.7.3 Challenges for 2018-2023

#### **Issue: Ensure research application process continues to occur**

Programme participants require regular reminders that all research proposals must be directed to the captive coordinator for approval via the approved application process. This is to prevent *ad hoc* approaches to individual institutions and to ensure non-detriment to the captive programme goals.

### 7.7.4 Goals and actions

**Goal: To optimise the value of the captive kiwi population through utilising kiwi for recovery driven research**

Action	Responsibility	Timeline	Measurables
Continue ensuring programme participants are aware of, and use this process	All programme participants direct queries to the Captive Coordinator	Ongoing	All research results reported at completion of research projects

## 7.8 *Funding kiwi conservation initiatives*

### 7.8.1 Context:

Participants in the captive programme are encouraged to contribute conservation donations to the 'Kiwis for Kiwi Trust' ([www.kiwisforkiwi.org](http://www.kiwisforkiwi.org)) who direct funding to support kiwi conservation initiatives across New Zealand, including much of the development of Operation Nest Egg (ONE), with annual contestable funding rounds for community groups prioritised in accordance with Kiwi Recovery Plan objectives.

### 7.8.2 Goals and actions

**Goal: All participants in the programme are encouraged to contribute any institutional based conservation funding initiatives to the Kiwis for Kiwi Trust and to support (via staff/shared expertise) local kiwi projects.**

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## 9 Demographic Review

### 9.1 Demographic Goals

Target Population size = 110 -120 over the next 5 years

*Ensure persistence of population at planned size for 20 years*

*Stabilise age structure*

### 9.2 Tools for analysis

Package	Version	Author, date
SPARKS	1.6	Species360, 16.06.2013
PMx	1.4.2017	J.D. Ballou (National Zoological Park) R.C. Lacy (Chicago Zoological Society), J.P. Pollak (Cornell University), 2017.

### 9.3 Age structure and sex ratio

Data: **all provenance** living brown kiwi held by programme participants at 15<sup>th</sup> February 2018

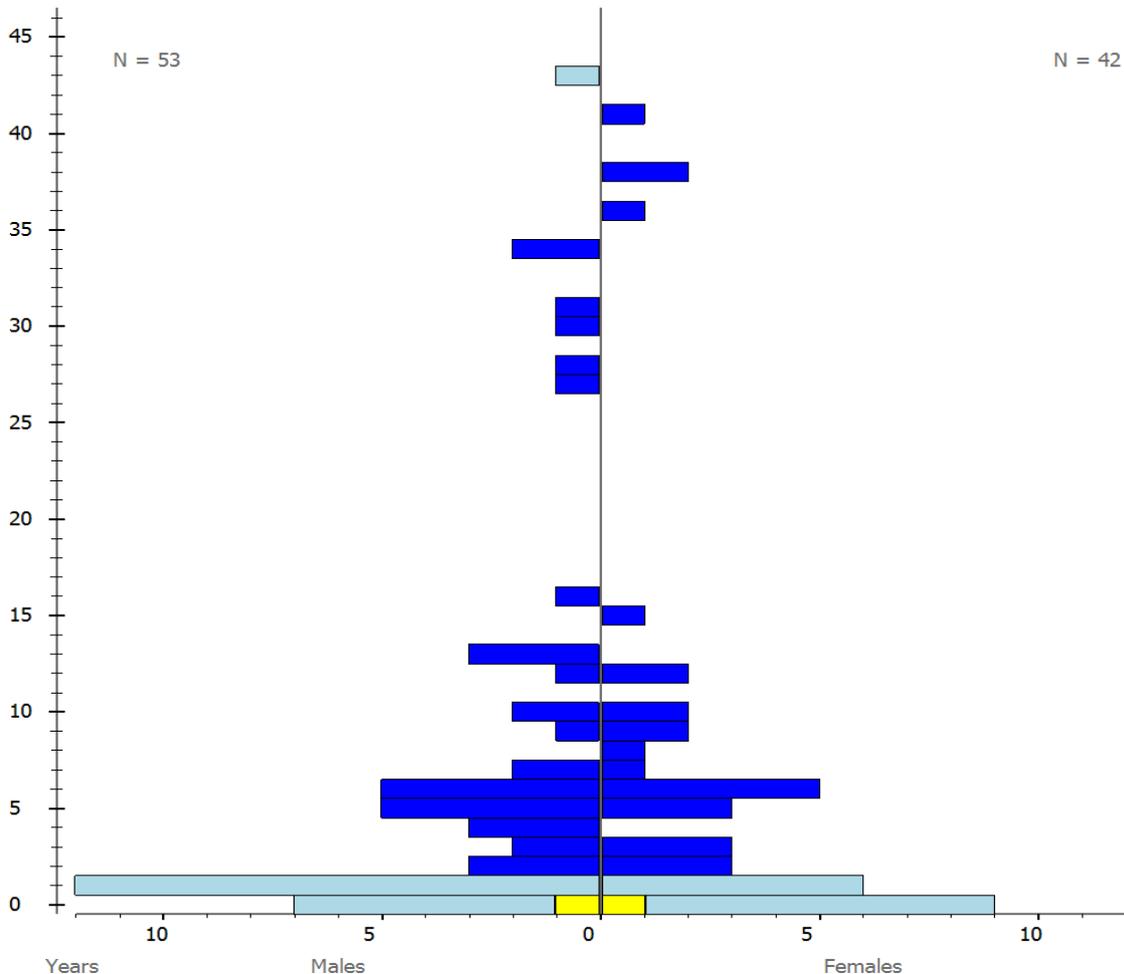


Figure 6: Age Pyramid for living population.

Total Males = 53; Total Females = 42

Unknown Age Males = 1; Unknown Age Females = 1

**9.4 Studbook data**

Table 2: Overview of studbook data at 15<sup>th</sup> February 2018 (all region brown kiwi)

		Living Specimens		Total studbook	
		No. of specimens	% of total living	No. of specimens	% of total
<b>Totals</b>	Number of specimens	<b>97</b>	100%	<b>789</b>	100%
<b>Sex</b>	Females	42	43.4%	300	38.0%
	Males	53	54.6%	294	37.0%
	Unknown	2	2.0%	195	25.0%
<b>Hatch dates</b>	Known or Estimated	92	95.0%	733	92.0%
	Unknown	5	5.0%	56	8.0%

**9.5 Annual census**

Data restricted to all managed captive brown kiwi in New Zealand

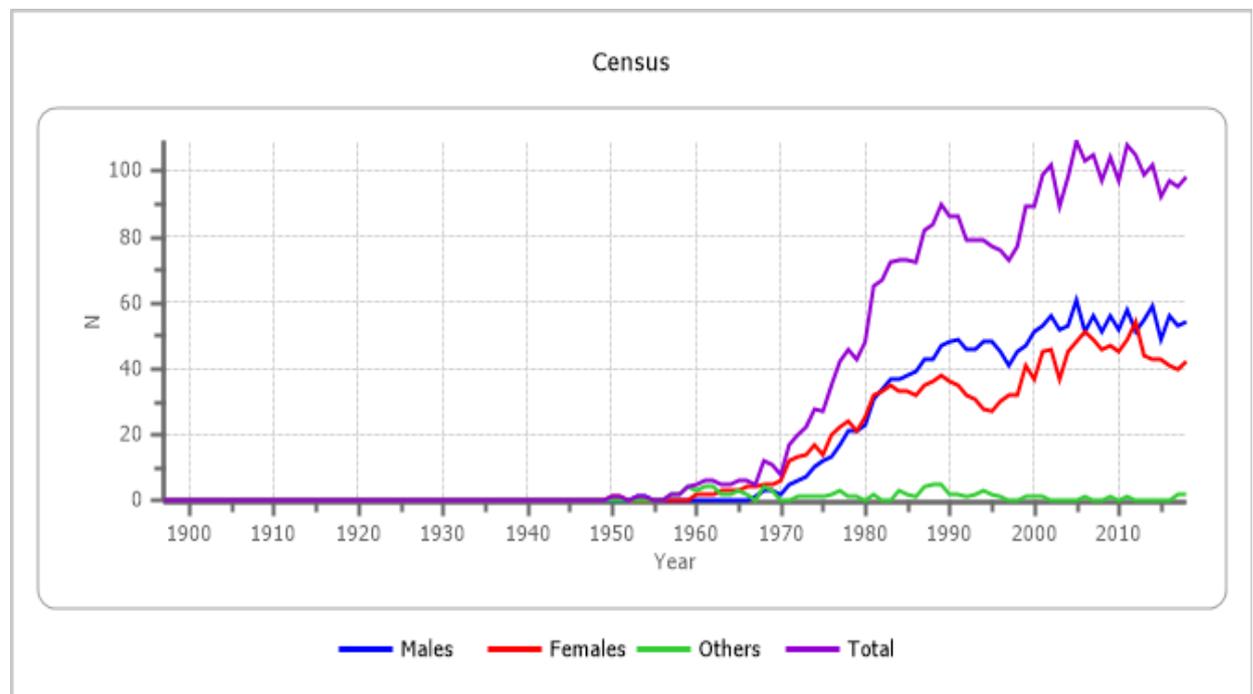


Figure 7: Annual census of the captive population of brown kiwi (all regions) 15<sup>th</sup> February 2018

## 9.6 Recent developments in the captive population by provenance

Data restricted to: All captive brown kiwi in the New Zealand captive managed population.

Table 3. Developments in the captive population of brown kiwi: **Eastern region (EAST) – 2013-2018**

	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	Totals
Population size at 1st March	51	52	59	54	58	
<b>Acquisitions:</b>						
Hatches	9	10	9	11	13	52
Founders from wild	0	0	0	0	(0.3***)	(3)
<b>Total acquisitions</b>	<b>9</b>	<b>10</b>	<b>9</b>	<b>11</b>	<b>13</b>	<b>52</b>
<b>Dispositions:</b>						
Deaths (total no.)	6	3	7	1.3	4	24
(Neonatal deaths)	(5)	(3)	(3)	(1.0)	(2)	(14)
Releases	2	0**	7	2.1	4	16
<b>Total dispositions</b>	<b>8</b>	<b>3</b>	<b>14</b>	<b>7</b>	<b>8</b>	<b>40</b>
Population size at 1st March	<b>52</b>	<b>59</b>	<b>54</b>	<b>58</b>	<b>66*</b>	

\*Population size at 15<sup>th</sup> February 2018

\*\*3 recommended releases to Otanewainuku had to be carried over to 2015 due to permit delays.

\*\*\*3 new founders ex ONE joined the programme slightly earlier than anticipated in December 2017 – show as captive hatches in SPARKS although as they came in as eggs.

Table 4. Developments in the captive population of brown kiwi: **Western region (TAR) 2013-2018**

	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	Totals
Population size at 1 <sup>st</sup> March	37	29	33	28	36	
<b>Acquisitions:</b>						
Hatches	7	9	6	3.2.4	1	32
Captures from wild	0	0	0	0	0	0
<b>Total acquisitions</b>	<b>7</b>	<b>9</b>	<b>6</b>	<b>9</b>	<b>1</b>	<b>32</b>
<b>Dispositions:</b>						
Deaths (total no.)	5	2	2	1.0	1	11
(Neonatal deaths)	(0)	(2)	(1)	(0)	(0)	(3)
Releases	10	3	9	0	13	35
<b>Total dispositions</b>	<b>15</b>	<b>5</b>	<b>11</b>	<b>1</b>	<b>14</b>	<b>46</b>
Population size at 1st March	<b>29</b>	<b>33</b>	<b>28</b>	<b>36</b>	<b>23*</b>	

\* Population size at 15<sup>th</sup> February 2018

Table 5. Developments in the captive population of brown kiwi: **Northland region (NLD) 2013-2018**

	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	Totals
Population size at 1st March	11	5	5	5	5	
<b>Acquisitions:</b>						
Hatches	0	0	0	0	0	0
Captures from wild	0	0	0	0	0	0
<b>Total acquisitions</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>
<b>Dispositions:</b>						
Deaths (total no.)	1	0	0	0	0	1
(Neonatal deaths)	(0)	(0)	(0)	(0)	(0)	(0)
Releases	3.2	0	0	0	0	5
<b>Total dispositions</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>6</b>
Population size at 1st March	<b>5</b>	<b>5</b>	<b>5</b>	<b>5</b>	<b>5*</b>	

\* Population size at 15<sup>th</sup> February 2018

Table 6. Developments in the captive population of brown kiwi: **Mixed provenance/region (HYB) 2013-2018**

	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	Totals
Population size at 1st March	8	10	6	5	5	
<b>Acquisitions:</b>						
Hatches	3***	0	0	0	0	3***
Captures from wild	0	0	0	0	0	0
<b>Total acquisitions</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>
<b>Dispositions:</b>						
Deaths (total no.)	1***	4	1	0	2	8
(Neonatal deaths)	(1)	(0)	(0)	(0)	(0)	(0)
Releases	1	1	1	0	0	3
<b>Total dispositions</b>	<b>2</b>	<b>5</b>	<b>2</b>	<b>0</b>	<b>2</b>	<b>11</b>
Population size at 1st March	<b>10</b>	<b>6</b>	<b>5</b>	<b>5</b>	<b>3*</b>	

\* Population size at 15<sup>th</sup> February 2018

\*\*1.1 acquired by Pukaha-Mt Bruce from their O.N.E. programme in 2011-2012 season – one 'white' and one 'brown' mixed region kiwi for display.

\*\*\*hatches against recs at Willowbank (2 DNS)

## 9.7 Reproduction

Reproductive cycle:	<i>seasonal (May – February)</i> (Robertson & Colbourne, 2003)
Social structure:	<i>pair</i>
Mating behaviour:	<i>monogamous</i> (Holzapfel, <i>et.al</i> , 2008)
Litter/clutch size	<i>1-2 eggs per clutch; up to 3 clutches per annum (Northland region)</i>
Interbirth interval	<i>When 2 egg these are laid 3-4 weeks apart</i> (Robertson & Colbourne, 2003)

The male brown kiwi incubates the egg/s for 70 to 80 days in the wild. Kiwi chicks hatch with a large internal yolk sac which is gradually absorbed over the first 10 days of life. Chicks are semi-precocial and stand upright at less than 6 hours old and walk freely by 1-2 days old. They are never fed by their parents in the wild and survive entirely off the stored yolk until they first venture from the nest at 5-7 days old. They leave the nest fully at about 1 week of age but can return daily for up to 6 weeks. Chicks leave the parental territory at 6-9 weeks (Robertson & Colbourne, 2003).

Table 7: Reproductive parameters from studbook data

<b>Females</b>	
Age range of possible reproduction (age of youngest and oldest animals recorded breeding)	2 yr, 5 mths – 40 yrs, 9 mths
Age range of peak reproduction (age classes for which median Mx value is exceeded)	8 - 42 yrs
<b>Males</b>	
Age range of possible reproduction (age of youngest and oldest animals recorded breeding)	2 yrs - ~42 years
Age range of peak reproduction (age classes for which median Mx value is exceeded)	6 - 41 yrs
<b>Clutch fertility and mating success</b>	
Percentage of attempted pairings successful (produce hatched chicks when breeding recommended) – data from 2012-2017 – 6 seasons reporting	51%
% fertile eggs (figures reported for eggs laid from 2012 -2017) 6 seasons captive data) – 367 eggs ~88 infertile (24%)	76%
Litter/clutch size	1-2
Interbirth interval (time between 1 <sup>st</sup> and 2 <sup>nd</sup> chick hatches)	16-19 days

## 9.8 Mortality

Table 8: Summary of mortality data from studbook

<b>Females</b>	
% juvenile mortality (females < 1 year old)	20%
Average life expectancy of adults ( <i>mean age at death of animals surviving juvenile age classes</i> )	8 yrs, 11 mths
Maximum longevity ( <i>age at death of oldest animal in studbook</i> )	~31 years*
<b>Males</b>	
% juvenile mortality (males < 1 year old)	20%
Average life expectancy of adults ( <i>mean age at death of animals surviving juvenile age classes</i> )	12 yrs, 1 mth
Maximum longevity ( <i>age at death of oldest animal in studbook</i> )	~ 44 years (wild caught)

\*Note there is a female Eastern brown kiwi breeding at 42 years of age (captive hatched 1976) at Westshore Wildlife Reserve

**9.9 Planned regional population size (all region Brown Kiwi)**

Table 9. Current and planned holdings of programme participants at 14/02/2018.

<b>Holder</b>	<b>ZAA member status</b>	<b>Current</b>	<b>Current Provenance</b>	<b>Planned</b>	<b>Comment</b>
Auckland Zoo <sup>^</sup>	Full	3.3.1 (7)	1.1.0 (NLD) 2.2.1 (EAST)	3.3.0 (6)	Follow programme recommendations
Butterfly Creek (Auckland)	Subscriber	1.1.0 (2)	1.1.0 (TAR)	2.2.0 (4)	Acquire for display Long term
Kiwi Birdlife Park (Queenstown)	Full	4.2.0 (6)	4.2.0 (EAST)	3.3.2 (8)	Follow programme recommendations
Kiwi North; Museum, Kiwi House & Heritage Park (Whangarei)	Full	1.1.0 (2)	1.1.0 (TAR)	1.1.0 (2)	Follow programme recommendations
National Aquarium of New Zealand	Full	1.1.0 (2)	1.1.0 (EAST)	1.1.0 (2)	Follow programme recommendations
National Kiwi Centre (Hokitika)	Non-member	1.1.0 (2)	1.1.0 (TAR)	1.1.0 (2)	No CPOS listing so left as plan same
Nga Manu Nature Reserve	Full	1.1.0 (2)	1.1.0 (EAST)	2.2.0 (4)	Follow programme recommendations
Orana Wildlife Park	Full	6.4.1 (11)	6.4.1 (EAST)	5.5.0 (10)	Breed according to programme recommendations
Otorohanga Kiwi House	Full	7.7.1 (15)	1.1.0 (NLD) 5.5.1(TAR) 1.1.0 (EAST)	8.8.0 (16)	Follow programme recommendations
Pukaha – Mt Bruce*	Full	1.1.0* (2)	0.1.0 (HYB) 1.0.0 (EAST)	2.2.0 (4)	Breed for display long term
Rainbow Springs Kiwi Wildlife Park	Full	6.8.0 (14)	4.6.0 (EAST) 2.2.0 (TAR)	5.4.0 (9)	Follow programme recommendations
Te Puia	Full	1.1.0 (2)	1.1.0 (TAR)	1.1.0 (2)	Follow programme recommendations
Wellington Zoo Trust	Full	3.0.0 (3)	1.0 (NLD) 2.0 (EAST)	3.0.0 (3)	Follow programme recommendations
Westshore Wildlife Reserve (under National Aquarium of NZ; holding facility is separate)	Full	7.6.0 (13)	7.6.0 (EAST)	4.4.0 (8)	Follow programme recommendations
Willowbank Wildlife Reserve	Associate	8.3.0 (11)	7.3.0 (EAST) 1.0 (HYB)	8.8.4 (20)	Continue advocacy, support breeding recommendations
<b>TOTAL</b>		<b>51.40.3 (94)</b>		<b>49.45.6 (100)</b>	

Data from Online Regional Census and Plan, updated studbook records and from one non ZAA members; as at 14 February 2018. Note Westshore is managed by National Aquarium, Napier, however the studbook and PMx treat the data separately – all kiwi are listed on CPOS under one facility (National Aquarium).

\* Note transfers in train at time of writing for one further mixed provenance male to transfer to Pukaha to meet display requirements (with 'white' female) and a female EAST to pair with young EAST male recently received (Feb 2018).

<sup>^</sup> Auckland Zoo information changed 8 May 2018 – updated information will not be reflected in population modelling.

National Kiwi Centre, Hokitika, is not a member of ZAA.

**9.10 Implications of planned population size**

The following table indicates the numbers of pairings and hatches that would be needed to meet the planned population size (not accounting for additional birds for release). This is modelled on the total population of Brown Kiwi, not with regions separated.

Table 10. Number of pairings and offspring required to meet population targets over next 5 years.

Current population size:	95				
Target population size in 5 years (life of this CMP):	108 (CPOS, 2018)				
Growth rate required:	1.0217				
Average number per litter/ clutch:	1 (SPARKS dataset for Brown Kiwi)				
Probability that a pair breeds:	75 % (based on estimate from historical ARRs)				
	<b>2018</b>	<b>2019</b>	<b>2020</b>	<b>2021</b>	<b>2022</b>
Expected number of hatches needed:	14.5	14.2	14.2	14.7	14.7
Number of pairs required:	19.3	18.9	19	19.6	19.6

Note across all provenances there were 19 breeding pairs (16 eastern and 3 western) established as at January 2018. However, some new pairs are not yet producing and some of the older pairs may need to be split as they are over-represented in the existing captive population. These actions will be outlined in the Annual Report and Recommendations each February/March.

**9.11 Life tables and graphs**

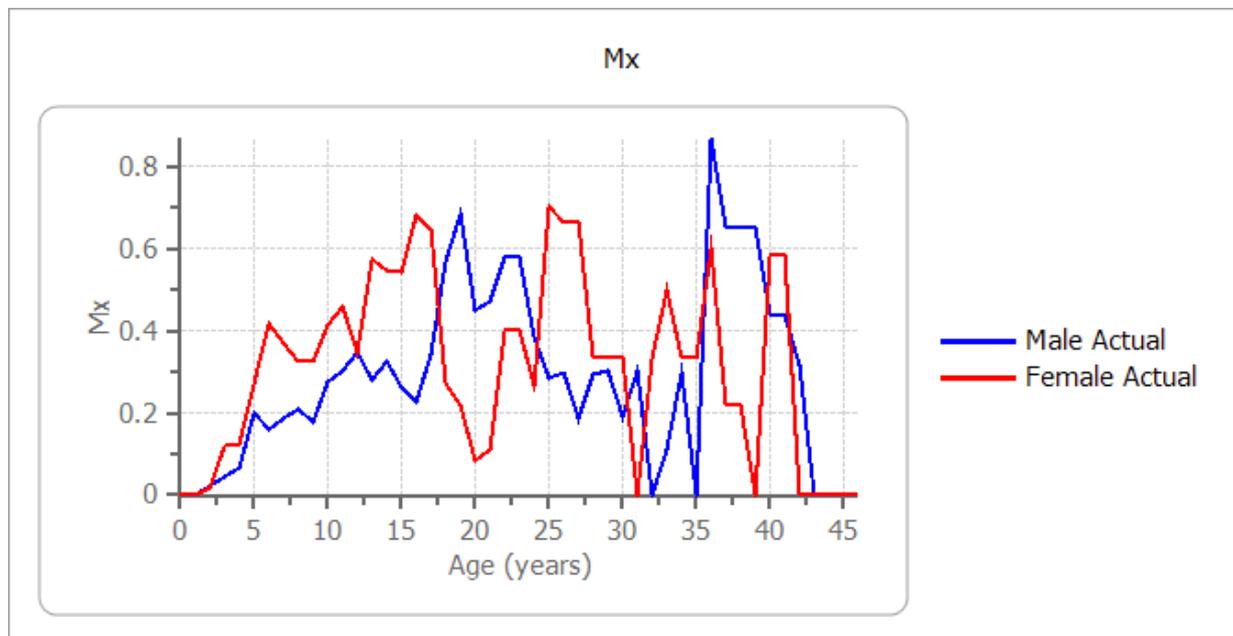


Figure 8: Age-specific fecundity in the total captive population of males and females brown kiwi in the ZAA NZ captive population

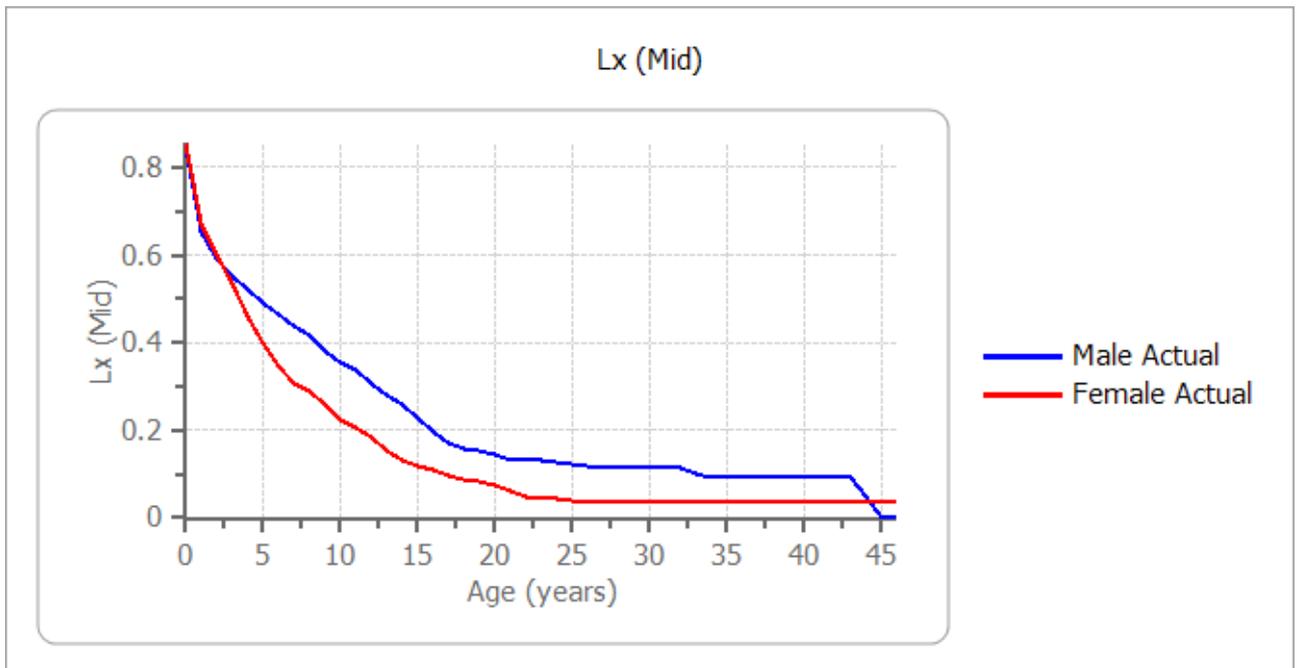


Figure 9: Survivorship in the total captive population of males and females brown kiwi based on records from the ASMP studbook

## 10 Genetic Review

### 10.1 Genetic Goals

Genetic Diversity: Retain 90% of the wild genetic diversity over 20 years  
 Preferentially breed birds with low and similar mean kinship values.  
 Ensure all offspring produced have an inbreeding threshold of below  $F = 0.125$

### 10.2 Tools for analysis

Package	Version	Author, date
SPARKS	1.66	Species360, 6 June 2013
PMx	1.4.2017	K.D. Ballou (National Zoological Park), R.C. Lacy (Chicago Zoological Society), J.P. Pollak (Cornell University). 2017.

### 10.3 Studbook data

Table 11: Overview of studbook data (all region brown kiwi) on 15<sup>th</sup> February 2018

		Living Specimens		Total studbook	
		No. of specimens	% of total living	No. of specimens	% of total
<b>Origins</b>	Captive hatched	73	75.3%	540	68%
	Wild hatched*	24	24.7%	230	29%
	Unknown origin	0	0	19	3%
<b>Parentage</b>	Parents known (identified by studbook no. or as 'WILD')	73	100%	770	93%
	Parents unknown (listed as 'UNK')	0	0	19	3%

\*this includes captive hatched wild sourced eggs brought in through Operation Nest Egg™ as new founders

Table 12: Kiwi excluded from analyses

Post-reproductive animals:				
Females were considered post-reproductive at:		39 years (as indicated by SPARKS dataset) (note there is known hatch date rising 42-year-old female currently breeding)		
Males were considered post-reproductive at:		42 years (as above). (Note a 42-year-old Western kiwi sired offspring at Rainbow Springs).		
Individuals excluded from genetic analyses:				
SB #	Local ID (and institution)	Sex	Reason removed from analyses (post-reproductive; non-participating or other)	
Eastern brown kiwi:				
81	'Te Kaha' 982 009104463740 (Rainbow Springs)	F	History of reproductive problems	
583	'Ruha' 982 00910503552 (Rainbow Springs)	M	Anaemic 'odd' ex-O.N.E. that was held back from release; to be used for display only on veterinary advice	

Table 13: Pedigree assumptions

No. of gene drop iterations:	1,000
Percentage of ancestry traced to founders (before pedigree assumptions are factored in):	100%
Number of parental assumptions required for analyses:	N/A
Data restricted to: living animals held by programme participants at 15/02/2018	

Table 14: Genetic summary of the descendent population of breeding **Eastern brown kiwi** at 15/02/2018

	Current	Potential
Founders	14	7
Gene Diversity (fraction of source gene diversity retained)	93.12%	97.35%
Founder Genome Equivalents (FGE's)	7.27	18.9
Mean Inbreeding coefficient	0.0075	
Range of Inbreeding coefficients	0 – 0.0625	
Average Mean Kinship (MK)	0.0688	

Table 15: Genetic summary of the descendent population of breeding **Western brown kiwi** at 15/02/2018.

	Current	Potential
Founders	7	0
Gene Diversity (fraction of source gene diversity retained)	87.54%	91.46%
Founder Genome Equivalents (FGE's)	4.01	5.85
Mean Inbreeding coefficient	0.0089	
Range of Inbreeding coefficients	0 – 0.25*	
Average Mean Kinship (MK)	0.1246	

\*Recorded as hatched and died in 1993

### Target population characteristic:

Recruitment required ( <i>collection from wild</i> ):	Limited requirement
Rate of founder recruitment required to meet genetic goals	4-5 over the next 5 years to achieve target of 20 founders. (3 arrived during draft of this CMP)
Source of new founders	Source from wild BNZ Operation Nest Egg™ chicks from large Eastern restoration sites

### Proposed rate of Eastern founder acquisition:

Year	Number of founders to acquire via O.N.E.	Source founder acquisition via Eastern taxon planning group
1 (2017-2018)	0.3	Unrelated chicks (this is known as wild sires are transmitted) 0.3 to grow up and replace females that died during previous CMP reporting phase.
3 (2020-2021)	2	Unrelated chicks 1 m. 1 f. if modelling shows as required.

(Priority placement will be to captive facilities with past consistent breeding records).

## 11 Review of progress with goals and actions set in the 2011 Kiwi CMP

This section provides review of progress with the programme goals and actions identified in the 2011 Kiwi CMP. For details of the underlying issues related to each goal and associated action see the 2011 CMP.

### 11.1 Husbandry goals and actions

**Goal 1. All holders meet the minimum standards defined in the Brown Kiwi Husbandry Manual (2009) by 2015.**

**Goal 2. DOC Conservancy permitting process supports the consistent implementation of minimum husbandry standards.**

**Goal 3. To have sufficient kiwi breeding expertise, spread across enough participating institutions to be able to support the demographic and genetic programme goals.**

Action	Responsibility	Timeline	Measurable	Resource	Status 2017
Revitalise Kiwi Evaluation / Categorisation exercise towards the aim of ensuring all holders meet Brown Kiwi Husbandry Manual minimum standards.	Captive Coordinator + DOC permit assessors appointed group (to include Tony Billing and potentially Brett Gartrell)	Commence 2011	Third party endorsement that all holders are meeting minimum standards across all facilities.	Will need resources to revisit facilities/form assessment group and develop criteria	Not considered a high priority (given ZAA Welfare Accreditation roll out), no resource to fund scheme.
Review 2009 Brown Kiwi Husbandry Manual and revise if required.	Captive coordinator + editing subgroup (Ian Fraser; Tony Billing)	During 2011 Done twice – last one in 2015	Revised 2011 Husbandry Manual is endorsed by all participating institutions and KRG	Likely to need additional resource to deliver this in 2011.	Brown Kiwi Husbandry Manual reviewed and updated twice during reporting period
Captive coordinator to follow up KRP action to ensure DOC kiwi holding permit includes meeting minimum standards.	Captive coordinator with KRG members (already a KRG action)	By 2012 additional permit conditions added to captive kiwi permits in 2013	DOC conservancy permit process takes account of Brown Kiwi Husbandry minimum standards for captive kiwi.	Captive coordinator time	New conditions incorporated in all DOC permits to hold captive kiwi from 2013. Done.

Survey holders for interest in a regular kiwi husbandry and breeding course directed at targeting key expert participants as potential contributors; as a way of disseminating regional expertise (e.g. Tasmanian devil model).	Captive coordinator + holders	2011 ZAA NZ branch (CMAG) conference to start.	Mandate to develop course or not.	Will need resource to develop and deliver course.	Drafted paper to ZAA NZ committee in 2016. Action to be revisited with new coordinator in 2018.
If holders agree to go ahead with husbandry training course (above), assemble team to progress course development and implementation.	Captive coordinator and expert husbandry team.	By 2012	First course delivered.	Course cost must be retrieved.	N/A

## 11.2 Participant/ institutional understanding of programme goals

**Goal 1. Ensure that the captive management strategy meets both population goals and the display needs of participating institutions.**

**Goal 2. Maintain a shared understanding of, and support for, the programme's goals.**

**Goal 3. Ensure that holders are aware that captive birds can play multiple roles in contributing to species recovery, of which breeding is only one. Also, that restricted breeding can play an important role in promoting population health when done strategically.**

Action	Responsibility	Timeline	Measurables	Resource	Status 2017
Craft and promote a suitable paragraph/page reinforcing the multiple roles of captive kiwi in kiwi recovery, and the value to managed programmes of non-breeding birds as well as breeding birds. Display prominently in	Captive coordinator	2011	Paragraph appears in Annual Reports. Message is promoted in appropriate presentations.		No longer required, participants happy to Receive chicks for Display only.

all appropriate programme documentation and provide information in relevant presentations. (e.g. personnel training)					
Survey holding and display needs of participating institutions and record each institutions response in the 2010 Captive Management Plan.	Captive coordinator	3 months to completion of CMP	Table of institutions current and planned display and holding facilities appears in 2010 CMP attachment.		Complete
Maintain regular communication and consultation with all kiwi holders (including at least one physical site visit to each holder every 3 years)	Captive coordinator	Annual and ongoing	Regular email and telephone contact maintained with all kiwi holders, additional to standard Annual Reporting requirements. At least 5 face to face visits (based on 15 holders).	Need to secure additional funding to deliver this for South Island institutions. NB. When possible visits are 'added on' to other work travel.	No funding or time for 3 day position to do this – job restructured during CMP time period.
Prepare a strategy for phasing in eastern provenance which takes account of participants display needs.	Captive coordinator	In CMP	CMP includes 'phase-in' strategy for eastern provenance and holders display needs are not compromised.  ARR includes specific transfers to meet strategy in February/March each year.		Good progress to date; only hampered by deaths of female founders brought in during this period

### 11.3 Key Advocacy goals

**Goal 1. Agree to a process which ensures that the KRG-identified kiwi conservation messages are consistently delivered through participating institution advocacy programmes.**

**Goal 2. To have a programme-wide evaluation process to:**

- a) Assess the effectiveness of captive-based advocacy messages for kiwi.
- b) Explore the relative effectiveness of different advocacy approaches in terms of display and results achieved (e.g. nocturnal houses versus other encounters).

Action	Responsibility	Timeline	Measurable	Resource?	Status 2017
Appoint a captive advocacy 'coordinator' from within ZAA NZ membership to liaise with the KRG BNZ-SKT 'National Mentor for Advocacy' (Wendy Sporle)	Captive coordinator / ZAA NZ members	By 2011	'Advocacy' coordinator approached and appointed.	Will need support from member institution.	Done – 'Advocacy Messaging for Kiwi in Human Care' Oliver Du Bern 2015
Ask Advocacy coordinator and National Mentor to work with kiwi holders to ensure their advocacy messages converge with key messages/help standardise key messages.	Captive Advocacy coordinator with all kiwi holders	Ongoing -	Key kiwi conservation messages are communicated to visitors across the programme.	Will need time allocation from member institution.	Was done, Advocacy mentor left zoo industry and unable to be replaced.
Propose to holders that in the remit of the 'Captive Advocacy coordinator' is the task of developing a programme-wide evaluation of captive advocacy effectiveness, and comparisons of the effectiveness of different kiwi advocacy approaches (e.g. nocturnal houses; 'kiwi encounters' etc)	Captive advocacy coordinator with support from all kiwi holders	Ongoing	Evaluation shows visitor uptake of key 'take home' kiwi conservation messages.	Potentially will need financial support/student project to evaluate	Need new Advocacy mentor/ Coordinator for programme

#### 11.4 Ex-situ, research and training

The goal is to optimise the value of the captive kiwi population to the species' recovery by:

1. Making birds available for appropriate training initiatives, for example training field workers how to fit radio-transmitters.
2. Targeting research on captive kiwi ensuring:
  - a) No detriment to the captive population
  - b) That recovery-directed research is prioritised.
3. That information gained from any research is disseminated to the captive community.

Action	Responsibility	Timeline	Measurables	Status 2017
Explore with holders and Kiwi Recovery Group, the current and future opportunities for using captive kiwi in recovery supported staff training and research (e.g. testing equipment).	Captive coordinator/Kiwi Recovery Group/captive holders	By 2015 (lifetime of this CMP)	Captive programme kiwi are made available and regularly used for recovery related training and research.  Done	Established formal process for assessing research applications that include KRG and ZAA vet input across all facilities.
Source and allocate a research coordinator to the kiwi management group (as defined in the CMP)	Captive coordinator / Vet SAG / KRG leader	Person identified during 2011	Captive research coordinator actively contributes to assessing proposed research.	Process established via Captive Coordinator with assessment by KRG and ZAA vet (as above).
Agree a mechanism for coordinating research on captive kiwi, which ensures no detriment to the captive population, and that recovery-directed research is prioritised.	Research coordinator (when appointed) with Captive coordinator	By 2015 (lifetime of this CMP).	There is a process for transparently evaluating proposals. A standard form (template) is created for research proposals which are submitted to the captive coordinator.	Mechanism agreed and implemented 2013 – ongoing.

## 12 Endorsements

This Captive Management Plan will be due for review in 5 years.

This Captive Management Plan has been reviewed and endorsed by the following bodies:		Endorsement received (date)
Kiwi Recovery Group (Acting leader signs off)	Jess Scrimgeour	7/6/18
New Zealand Fauna Taxon Advisory Group (TAG) Co-convenor Birds	Todd Jenkinson	12/4/18
ZAA NZ Branch Committee (Chair signs off)	Meg Rutledge	16/5/18
This Captive Management Plan has been reviewed and endorsed by the <i>Director/CEO</i> of the following participating institutions:		
Institution	TAG representative	Endorsement received (date)
Auckland Zoo	Richard Gibson (on behalf of Kevin Buley)	8/5/18
Butterfly Creek	John Dowsett	7/5/18
Hamilton Zoo	Perrin Sakamoto-Aish	6/6/18
Kiwi Birdlife Park (Queenstown)	Paul Wilson	10/4/18
National Aquarium of New Zealand	Kerry Hewitt	15/5/18
Nga Manu Nature Reserve	Matu Booth	20/5/18
Orana Wildlife Park	Lynn Anderson	9/5/18
Otorohanga Kiwi House	Jo Russell	11/5/18
Pukaha – Mt Bruce	Emily Court	11/5/18
Rainbow Springs Nature Park	Emma Bean	20/4/18
Te Puia	Mariana Te Rangi	20/4/18
Wellington Zoo Trust	Karen Fifield	21/6/18
Westshore Wildlife Reserve	Kerry Hewitt	15/5/18
Whangarei Museum & Heritage Park (Kiwi North)	Allie Fry	19/4/18
Willowbank Wildlife Reserve	Kirsty Willis	23/4/18
This Captive Management Plan has been reviewed and endorsed by the Director/CEO of the following non-member institutions (who have kiwi species on display):		
Non ZAA member institution	Representative	Endorsement received (date)
National Kiwi Centre, Hokitika	Terry Young	17/5/18
West Coast Wildlife Centre	Richard Benton	18/4/18

This Captive Management Plan has been reviewed and endorsed by <i>nominated NZ Fauna TAG representatives</i> of the following participating institutions:		
Institution	TAG representative	Endorsement received (date)
Auckland Zoo	Richard Gibson	8/5/18
Butterfly Creek	Rebecca Moyle	7/5/18
Hamilton Zoo	Catherine Nicholls	6/6/18
Kiwi Birdlife Park	Paul Kavanagh	10/4/18
National Aquarium of New Zealand	Kerry Hewitt	15/5/18
Nga Manu Nature Reserve	Matu Booth	20/5/18
Orana Wildlife Park	Lynn Anderson	23/4/18
Otorohanga Kiwi House	Jo Russell	20/4/18

Pukaha – Mt Bruce	Todd Jenkinson	12/4/18
Rainbow Springs Nature Park	Emma Bean	20/4/18
Te Puia	Mariana Te Rangi	20/4/18
Wellington Zoo Trust	Simon Eyre	6/6/18
Westshore Wildlife Reserve	Kerry Hewitt	15/5/18
Whangarei Museum & Heritage Park (Kiwi North)	Kevin Saxton	8/4/18
Willowbank Wildlife Reserve	Kirsty Willis	23/4/18
<b>This Captive Management Plan has been reviewed and endorsed by nominated representatives of the following non-member institutions:</b>		
<b>Non ZAA member institution</b>	<b>Representative</b>	<b>Endorsement received (date)</b>
National Kiwi Centre, Hokitika	Pip Clarke	19/4/18
West Coast Wildlife Centre	Lindsey Gray	18/4/18

## 13 Appendix I

### **DRAFT - Release locations for captive bred Eastern brown kiwi will be guided by the following principles:**

1. Releases will be undertaken only to approved DOC translocation plans and must meet DOC guidelines (therein) and best practice.
2. Release sites will have been subject to intensive, continuous predator control for 3 consecutive years prior to release and will have been audited by appropriate DOC personnel prior to receiving birds.
3. Release sites must be of sufficient size and suitability to sustain a kiwi population (500 ha under intensive management and opportunities adjacent for kiwi to disperse).
4. For releases to supplement existing wild populations (the most prevalent release type from captive bred kiwi), numbers will be limited to avoid over-representation of captive founder lines at any single site (depending on overall target population at receiving site).
5. Sufficient resourcing for all translocation/release requirements and phases, including planning, transfer, release, monitoring and post-release management will be available.
6. Only kiwi specifically identified for release by the Kiwi Captive Coordinator are to be released from the captive managed population. These will be identified in the 'Annual Report and Recommendations' or in response to interim recommendations as required.
7. Captive kiwi identified for release must spend a minimum of 30 days in an outdoor enclosure (if previously housed in a nocturnal house) to allow for adjustment to changed photoperiod pre-release.
8. Captive kiwi identified for release must undergo veterinary approved disease screening and treatment recommendations as outlined in the 'Disease Screening and Treatment Recommendations for Kiwi to be release from captivity' see Appendix II in this CMP.

## 14 Appendix II

### Disease Screening and Treatment Recommendations for Kiwi to be released from captivity

**(captive bred kiwi rather than Operation Nest Egg) (Kate McInnes and Kerri Morgan)** (from 'Operation Nest Egg Incubation and Chick Rearing Best Practice Protocols', Bassett, 2012 *modified by Kate McInnes 2012*) With input from Richard Jakob-Hoff.

Diagnostic faecal for parasitology	Treatment for coccidia:	Husbandry recommendations for coccidia	Treatment for helminths:	Cloacal swab for microbiology (Salmonella and Yersinia only)	Procedure if positive Salmonella or Yersinia	Blood smear for white blood cell count and haemoparasitology	Physical examination and body condition weight check
✓	>++ Baycox to avoid stress related disease issues upon release	Avoid build up of faeces and minimise transfer of parasites via equipment and people	Tapeworms (cestodes) no treatment*  Treat all other positives, recheck those with +++ and ++++ in 5 days after treatment before release	✓	Do not move bird or birds in contact. Isolate individual. Observe strict quarantine principles. Seek experienced veterinary advice	Complete blood count (including blood parasite exam) and serum biochemistry. If blood parasites found seek veterinary advice	Physical exam (including body weight). Ensure birds are in good body condition and show no signs of injury or disease.

Coccidia treatment indications:

- No treatment of birds with low burdens (+) of coccidia ensures natural vaccination without interfering in acquisition of immunity to coccidia.
- Moderate burdens (++) should be treated to reduce environmental contamination
- High burdens (+++ and ++++) should be treated to reduce morbidity/mortality of individual birds, as well as reducing environmental contamination
- Faecal sampling – overnight sample required (preferably between 3-7am) to account for circadian shed of parasites. Avoid pooling of samples. Preferably send multiple

samples to the lab. Highest score is most representative of actual burden.

NZVP scoring chart for coccidia (oocysts per gram): + 0-2,000; ++ 2,000-50,000; +++ 50,000-250,000; ++++ >250,000.

Therapeutics – check calculated dose rates with veterinarian if unsure. These are the recommended formulations for kiwi – there are others also which may be used (See Morgan 2008 p. 100).

\*Cestodes may be treated if high numbers are found and birds are clinically ill.