ZOO AQUARIUM ASSOCIATION

AUSTRALASIAN SPECIES MANAGEMENT PROGRAM

Species Management

Captive Management Plan

CAPTIVE MANAGEMENT PLAN FOR KIWI

FINAL 2010- 2015

Draft circulated on NZ Fauna TAG listserve:	17/12/2010
Deadline for draft endorsement:	21/01/2011
Draft circulated to Kiwi Recovery Group:	26/01/2011
Deadline for KRG endorsement:	09/02/2011
Final circulated for CEOs endorsement:	10/02/2011
Final circulated to all:	03/03/2011

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1 Preface

This Kiwi Captive Management Plan (CMP) replaces the previous Kiwi CMP developed by the Kiwi Captive Management Advisory Committee, which covered the period 2004-2009. The 2004 CMP was due for review in 2009; however the decision to write a new document followed the publication of a new Kiwi Recovery Plan (KRP) in 2008 (Holzapfel *et al*., 2008). The need to establish a long-term population management strategy for captive kiwi in New Zealand was clearly identified in the new KRP.

This Kiwi CMP has been produced by the Kiwi Captive Coordinator in consultation with the Zoo Aquarium Association (ZAA NZ branch), the Kiwi Recovery Group and the New Zealand captive management community. The strategy was developed in a two day planning meeting with IUCN/SSC/CBSG (IUCN Species Survival Commission's Conservation Breeding Specialist Group) Australasia. The Kiwi Captive Coordinator's work in development of this CMP was funded by Auckland Zoo, with additional support from the NZ branch of the ZAA.

The document has a significantly different format to the previous CMP, with the aim of clearly illustrating the key issues, goals and resultant actions that are needed to deliver a viable and sustainable captive kiwi population well into the future. This 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 and transfer recommendations.

Captive management of kiwi in New Zealand is a cooperative effort between the Department of Conservation and the captive community. As with the previous CMP, the primary role for captive kiwi in the recovery of the species is through advocacy. The captive community makes a significant contribution to the national kiwi recovery effort through the extremely successful techniques developed for BNZ Operation Nest Egg™, which is now used in a large number of *in situ* kiwi conservation projects. Additionally, the captive managed Brown Kiwi population serves a number of purposes which may assist those working with wild populations in ways other than its acknowledged advocacy role.

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. 2009 Brown Kiwi Husbandry Manual), 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 production. Your support has been invaluable.

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Kiwi Captive Coordinator

Dr. Avi Holzapfel
Leader, Kiwi Recovery Group

Tony Billing
Chair, KCMAC

2 Introduction

This Captive Management Plan defines the scope of the managed population and sets the rationale for holding Brown kiwi (*Apteryx mantelli*) in captivity in New Zealand. This includes the primary focus of the population being for advocacy, with the supporting ability to use captive kiwi to support research and staff training, which directly benefits wild kiwi conservation. Ultimately the long term aim is to support targeted release and restoration requirements via the maintenance of a genetically and demographically robust population.

The document incorporates the reasons for the continued captive management of Brown Kiwi (as opposed to any other taxa); the need to create a single-provenance sustainable captive population by gradual 'phasing out' of Northland, Western and 'mixed provenance' birds and the direction to 'phase in' to Eastern provenance birds. It additionally, takes into account the requirements of the Kiwi Recovery Plan (2008-2018) which identifies the importance of the role that *ex situ* and captive management play in kiwi recovery.

'Captive management is coordinated through the Kiwi Recovery Group via the captive coordinator, and is supported by the professional association of captive institutions (Zoo and Aquarium Association; New Zealand branch – ZAA), and a captive management plan for kiwi (the previous CMP covering 2004-2009). *Ex situ* and captive management play an important role in kiwi recovery, in particular by enabling the development of skills in captive husbandry and tools such as BNZ Operation Nest Egg™. These provide opportunities to increase scientific knowledge of kiwi and advocate for the species and its conservation'.

Kiwi Recovery Plan, page 38. (Holzapfel*, et. al.,* 2008).
Link to Kiwi Recovery Plan

It is the intent of this CMP to set the strategic direction for the captive kiwi population held at New Zealand participating institutions for the next 10 – 20 year period; with this document covering the goals and actions for the programme for the next 5 years – 2010-2015. The next Captive Management Plan will be due in 2016 to cover the next 5 year period.

3 Executive summary

Goals of Brown Kiwi captive management

Vision	Captive management for kiwi is effective through a single provenance 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, provides a resource for recovery-directed training and research and fosters the capacity for escalation to a breed for release programme as required.
Captive management unit goals	• Transition captive population from Northland, Eastern, Western, and 'mixed' provenance Brown Kiwi to a single captive management unit of Eastern provenance Brown Kiwi.
Genetic goals	• Retain 90% of wild genetic diversity over 20 years • Ensure all offspring produced have an inbreeding threshold of below F = 0.125
Demographic goals	• Target population size 110 -120 over next 5 years • Move towards stable age structure
Recruitment goals	• Acquire 6 new Eastern founders through BNZ Operation Nest Egg™ over the next 5 years.
Husbandry & Management goals	• All holders meet the minimum standards defined in the Brown Kiwi Husbandry Manual. • Department of Conservation (DOC) Conservancy permitting process supports the consistent implementation of minimum husbandry standards. • To have sufficient kiwi breeding expertise to be able to support the programme goals.
Participant support goals	• Ensure that the captive management strategy meets both population goals and the display needs of participating institutions. • Maintain a shared understanding and support of the programme's goals. • Establish a network of expertise to support new or inexperienced captive institutions. • Ensure that holders are aware of the multiple roles that captive birds can contribute to species recovery.
Advocacy goals	• Develop key advocacy messages through the ZAA Education Specialist Advisory Group (SAG) in liaison with the National Mentor for Kiwi Advocacy (a member of the Kiwi Recovery Group). • Develop a programme wide evaluation process.
Ex situ Research & training	• Ensure that appropriate captive kiwi are made available for relevant research and training initiatives. • Research on captive kiwi is prioritised through Recovery Group direction.
Conservation Fund	• All participants in the programme are encouraged to contribute any institutional based conservation funding initiatives to the BNZ Save the Kiwi Trust.

4 Background

4.1 Taxonomy (taken from the 2008 Kiwi Recovery Plan)

Within both Brown Kiwi and Tokoeka, four geographically and genetically distinct forms can be distinguished: Northland, Coromandel, Western and Eastern Brown kiwi; and Haast, northern Fiordland, southern Fiordland and Stewart Island Tokoeka (Baker *et al*., 1995; Burbidge *et al*., 2003; Shepherd & Lambert, 2008). The other species show no such clear genetic variation along geographic lines (e.g. Herbert & Daugherty 2002), although a distinct North Island form of Little Spotted Kiwi became extinct in the late 1800s (Shepherd 2005).

4.2 Status in the wild (taken from the 2008 Kiwi Recovery Plan)

All kiwi taxa are threatened to varying degrees, as per the following table from the Kiwi Recovery Plan (2008):

Threat classification of Kiwi according to Miskelly *et al.,* (2008)

Taxon	Classification	Qualifiers*
Brown Kiwi (4 taxa)	Serious decline	HI, RF, CD
Rowi	Nationally critical	CD, RF, OL
Tokoeka		
Haast	Nationally critical	RF, OL, CD
Northern Fiordland	Gradual decline	HI, RF, DP
Southern Fiordland	Gradual decline	HI, RF, DP
Stewart Island/Rakiura	Gradual decline	HI, RF, DP
Great Spotted Kiwi	Gradual decline	RF
Little Spotted Kiwi	Range restricted	RC, HI

*Qualifiers are associated with each threat ranking, outlining the specific reasons for a particular ranking. CD: Conservation Dependent; DP: Data Poor; HI: Human induced; OL: One location; RC: Recovering; RF: Recruitment Failure.

Specific details in regards to agents of decline, threats, past management, current status and species recovery phases may be found on pages 11-17 of the 2008-2018 Kiwi Recovery Plan (Holzapfel, *et. al.,* 2008).

Brown Kiwi status in the wild

The total wild Brown Kiwi population in the North Island is estimated at 25,000 birds. Although mainland populations are declining overall, where active predator control or breeding management (BNZ Operation Nest Egg) are being undertaken numbers are increasing. Kiwi populations at unmanaged sites (i.e. populations without predator control or supplementation via BNZ Operation Nest Egg) are currently estimated to be declining at 2-3% per annum.

The latest estimates (Holzapfel, *et. al*., 2008) report that overall the wild Brown Kiwi population is still declining. Populations of Northland and Coromandel provenances are expected to increase over the next ten years (assuming current management efforts are maintained), however population decreases for western and eastern provenance Brown Kiwi at unmanaged sites will 'more than offset those gains'.

Specific details may be found in the 2008-2018 Kiwi Recovery Plan, (Holzapfel, *et. al.,* 2008)

4.3 History in captivity (taken from 2004 DOC CMP, updated to 2010)

1851 Female 'North Island' Brown Kiwi sent overseas to the Zoological Society of London (ZSL), lived for several years and produced eggs (Peat, 1990).

Before 1872 ZSL received several other live kiwi, including more 'North Island' Brown Kiwi, Southern Tokoeka, Little Spotted and Great Spotted Kiwi (Newton 1893).

1905 11 'Brown Kiwi' were received by ZSL from New Zealand (presumably wild caught). Barlow (ZAA, NZ) pers. comm.
1912 Wild-caught 'North Island' Brown Kiwi first appears on zoo stock sheets at Wellington Zoo.
1945 First 'North Island' Brown Kiwi chick hatched in captivity, Hawke's Bay Acclimatisation Society's game farm near Napier (Robson 1947).
1969 Pair of Little Spotted Kiwi received at Mount Bruce, from Kapiti Island. The pair lived on for several years and produced eggs.
1972 First 'North Island' Brown Kiwi displayed in nocturnal houses, Auckland Zoo and Otorohanga. First Little Spotted Kiwi chick hatched in captivity at Mount Bruce.
1974 First Great Spotted Kiwi arrived in captivity at Mount Bruce (Eason 1988).
1975 First partial artificially incubated 'North Island' Brown Kiwi egg hatched at Otorohanga. Artificial incubation was for the last few days before hatching (Peat 1990).
1976 Dummy egg with thermometer placed under a male 'North Island' Brown Kiwi, to determine incubation temperature, at Otorohanga.
1977 First artificially incubated full-term 'North Island' Brown Kiwi egg hatched at Otorohanga (Peat 1990).
1986 First partial artificially incubated Great Spotted Kiwi egg hatched at Otorohanga. Artificial incubation was undertaken after some 56 days natural incubation. Great Spotted Kiwi egg hatched at Mount Bruce (Eason 1988).
1988 Little Spotted Kiwi chick hatched at Otorohanga on 16th November.

1995 First release of sub-adult 'North Island' Brown Kiwi from wild-laid eggs brought into captivity ('Operation Nest Egg')
1995/6 First wild Rowi chicks raised in captivity and released to wild. Graham (DOC Franz Josef – Waiau Area Office), pers. comm.
1996/7 First wild Rowi eggs successfully incubated in captivity and chicks released to wild.

2001 First release of captive bred Brown Kiwi to a private reserve ('Warrenheip') October 2001 by Otorohanga Kiwi House/Society.
2004 First wild Haast Tokoeka egg artificially incubated and chick released to wild. Freer (DOC Haast Field Centre), pers. comm.
2007/8 First wild 'harvested' Great Spotted Kiwi eggs successfully incubated in captivity at Willowbank Wildlife Reserve and chicks released to the Paparoas. Shaw (DOC, West Coast), pers. comm.
2007/8 First wild Great Spotted Kiwi 'rescue' chick (Operation Nest Chick) reared in captivity at Willowbank Wildlife Reserve and released at Arthur's Pass. Shaw (DOC, West Coast), pers.comm.

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 SPARKS (ISIS) dataset (studbook) for the SSP/EEP programme which is currently managed at regional level, in a similar way as Brown Kiwi in New Zealand are managed by Suzy Barlow, via the ZAA in the Australasian region.

The SSP/EEP produced its first kiwi 'Master plan' (similar to the ZAA Annual Report & Recommendations) in 2009, and received five new Northland founders from the New Zealand programme in 2009. These birds 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.

	AZA/EAZA joint programme
Coordinator, institution, email	Kathleen Brader National Zoological Park, Washington, D.C., USA BraderK@si.edu
Management unit managed	**Species – Brown Kiwi**. Mixed provenance however predominantly Northland
Programme type	Joint SSP-EEP programme
Population Size	29.15.0 (29th October 2010 at 11 institutions)*
Planned Population Size	40.30.0 (October 2015)
Number of institutions in programme	10 (5 in SSP + 5 in EEP) + 1 in Japan
Studbook	Yes
GD	87% with a potential of 95% (data provided from 2009 does not include 5 new founders exported in 2009)
Inbreeding (F)	0.0302 (as for GD figure)
Programme status	All birds overseas included on EEP/SSP studbook including 1.1 at Osaka. However Osaka are not managing 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 the increased genetic diversity in the jointly managed overseas SSP/EEP managed kiwi population.

*NB Figures for numbers provided by K. Brader in 2010; however analysis of GD has not been provided since 2009. (the table above shows the lower GD which was true of the overseas population before the transfer of the 5 kiwi from Auckland Zoo in 2010).

5 Captive management strategy

Context

The captive community can provide a number of supporting tools for species recovery, including long term insurance, breed for release, advocacy, research/training and wild 'head start' management (e.g. Operation Nest Egg). Not all of these tools are useful to all species recovery programmes and it is the role of the Recovery Group to determine the appropriate tool for the appropriate taxon and appropriate situation. The existing Kiwi Recovery Plan identifies Operation Nest Egg as the most effective captive tool for the critically endangered kiwi taxa (Haast Tokoeka and Rowi) whilst a primary role of advocacy has been identified for the captive managed population of Brown Kiwi. Both Great Spotted Kiwi and Little Spotted Kiwi holdings are being phased out by natural attrition because other conservation programmes for these species are more effective than captive management, and captive management effort would be diluted by attempting to breed multiple species.

An effective advocacy programme requires a healthy, thriving population able to consistently fulfil display needs of contributing members. This is currently not possible because of a range of issues which are highlighted elsewhere in this document, the major issue being the fracturing of the current population into four separately managed groups. It is further compounded by 40% of the existing captive population being held on display in nocturnal facilities where breeding is unlikely. This effectively means that only 60% of the captive population is available for breeding and that these birds must support all display requirements. Any increase in 'display only' spaces (e.g. new or additional nocturnal houses) will need to be backed up by providing suitable off-display facilities.

This document lays out a strategy not only for delivering a high performing advocacy population, but also a population which has the potential to produce birds for wild supplementation in the future. Key to delivering this is the understanding and support of all programme participants. The programme will aim to support the goals of the Kiwi Recovery Plan (Holzapfel, *et. al*., 2008) by delivering on the captive work plan therein.

5.1 Rationale for Captive Management Unit Selection

The captive Brown Kiwi population was managed as a single management unit up until 1994 when DNA analysis showed that Brown Kiwi populations in the wild had far more genetic structuring than previously imagined, thus indicating very low levels of genetic mixing between provenances over the past 100,000 years (Burbidge, *et. al*, 2003). The splits between the various provenances were probably due to changes in sea-level, and tectonic and volcanic events (Burbidge, *et. al.,* 2003). The analysis showed that there was a mix of geographical provenances in captivity, and although most pairs came from the same provenance, some pairs came from different origins. Since about 1994, each provenance has been managed separately, resulting in 4 small and unsustainable (without massive founder input and increase in population size) populations of Northland, Eastern, Western and 'mixed' provenance captive kiwi in New Zealand. Current available captive space (~110) is sufficient to maintain only one taxon (species and provenance) effectively.

The following paragraphs outline the rationale for moving to a single population of Eastern provenance Brown Kiwi.

Rationale for selection of *Brown Kiwi*

There are a number of considerations in relation to the choice of maintaining Brown Kiwi in the New Zealand (and international) captive population. A decision matrix in regard to choice of taxa for captive management is presented below.

Key points considered include:

1. Wild status. Threat level as identified in Kiwi Recovery Plan.
2. Transition difficulty. This relates to the number of existing individual kiwi already in captivity; thus difficulty of replacing those birds.
3. Founder base. Relates to the existing numbers of 'founders' of each species in captivity. This is because the captive population should make the *least possible impact* on the wild population in terms of collection of founders for the captive population.
4. Ability to acquire new founders from the wild. This is considering obtaining birds from the least threatened populations via existing Operation Nest Egg in numbers that will support viable genetic diversity in a captive population.
5. The potential to contribute to wild release long term; based on number of opportunities for birds to be released to populations identified as needing supplementation, and the impact such releases would have on the total population of the taxon.

Kiwi taxon selection matrix

1 = best 4 = worst	Wild status	Transition difficulty	Founder base	Ability to acquire new founders from wild	Potential to contribute to wild release long-term	Total score (lowest = best)
Rowi	1	4	4	2	2[2]	**13**
Haast tokoeka	1	4	4	2	2[2]	**13**
Northern Fiordland Tokoeka	3	4	4	3	3	**17**
Southern Fiordland Tokoeka	3	4	4	3	3	**17**
Rakiura Tokoeka	3	4	4	3	3	**17**
Great Spotted Kiwi	3	3	3	2	3	**14**
Little Spotted Kiwi[1]	4	3	3	3	2	**15**
Brown Kiwi (all)	**2**	**1**	**1**	**1**	**1**	**6**

Wild status = most threatened (as per KRP) gets lowest score
Transition difficulty = number of existing birds in captive population; highest population = lowest score
Size of founder base (existing number of founders/potential founders in current captive population) = most founders = lowest score
Ability to acquire new founders from wild, (e.g. through Operation Nest Egg.) = most easily acquirable from existing projects gets lowest score
Potential to contribute to wild release long term = where most active number of projects where release would be possible are located = lowest score, but weighed by likely impact on the total population of the taxon (e.g. what impact would the release of 20 captive bred birds/year have.

[1] Although numerically the second rarest species, Little Spotted Kiwi have the lowest threat ranking (Near Threatened) because they are on a number of predator-free offshore islands, and one mainland sanctuary, and so must rank lowest here.

[2] Being the rarest taxa, Rowi and Haast Tokoeka would benefit most from the contribution of captive-*reared* offspring. As stated elsewhere (Holzapfel, *et.al*, 2008) Operation Nest Egg is the captive rearing tool allocated to these taxa.

Rationale for selection of *Eastern provenance* Brown Kiwi

As with the matrix developed to select Brown Kiwi for ongoing captive management in New Zealand, the matrix for selection of the most appropriate provenance to manage as a viable captive population is presented below.

Key points considered include:

1. Wild status. In the case of provenance selection; the focus was on the provenance of Brown Kiwi that is considered most threatened.
2. Transition difficulty. This relates to the number of existing individual birds already in captivity; thus the difficulty of replacing those birds (e.g. 38 Easterns in existing ~95 captive kiwi).
3. Founder base. Relates to the existing numbers of 'founders' of each provenance in captivity. The existing Eastern captive population is descended from the largest number of founders of any of the provenances, thus requiring fewer *additional* founders to meet programme goals.
4. Ability to acquire new founders from the wild. Taking into consideration which provenance kiwi are most likely to be obtainable through exchange of chicks (via Operation Nest Egg) from the greatest number of managed wild sites.
5. The potential to contribute to wild release long term; based on number of opportunities for birds to be released to populations identified as needing supplementation, and the impact such releases would have on the total population of the taxon.

Provenance selection for captive Brown Kiwi

1 = best 4 = worst	**Wild status**	**Transition difficulty**	**Size of Founder base**	**Ability to acquire new founders from wild**	**Potential to contribute to wild release long-term**	**Total score (lowest = best)**
Coromandel*	1	4	4	4	1	**14**
Northland	4	2	3	1	3	**17**
Western	3	3	2	3	3	**14**
Eastern	**2**	**1**	**1**	**2**	**2**	**8**

Wild status = most threatened (as per KRP) gets lowest score
Transition difficulty = number of existing birds in captive population; highest population = lowest score
Size of founder base (existing number of founders/potential founders in current captive population) = most founders = lowest score
Ability to acquire new founders from wild (e.g. through Operation Nest Egg) = most easily acquirable from existing projects gets lowest score
Potential to contribute to wild release long term = where most active number of projects where release would be possible are located = lowest score, but weighted by likely impact on the total population of the taxon (e.g. what impact would the release of 20 captive-bred birds/ year have).

*Although Coromandel is predicted to increase over the next 10 years, it is still by far the rarest of the four Brown Kiwi provenances, and is highly conservation dependent, with no 'insurance' population on islands or pest-free sanctuary, whereas Northland and Western have island populations free of predators and mainland sanctuaries. (Hugh Robertson, pers. comm.)

Moving the existing four single provenance management units to one Eastern management unit would have the least impact in terms of phasing for the existing captive population. Additionally it would make the least impact in terms of the much lower number of new founders that would need to be acquired from the wild. The number of DOC and community group projects working with Eastern birds provides many additional opportunities for future supplementation of small genetically isolated wild populations from a well managed captive population.

The preferred option for the captive programme is to **sustainably manage one provenance of Brown Kiwi** (planned population size is currently ~110 spaces). The preferred provenance would be Eastern. For specific details in reference to the genetic comparison between the captive provenance birds please refer to section 12, appendix II: Genetic Review.

5.2 Vision for the captive kiwi population in New Zealand

Our vision for this population is:

A single provenance 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, provides a resource for recovery-directed training and research and fosters the capacity for escalation to a breed for release programme as required.

5.3 Summary of current programme issues

The major issues facing the captive Brown Kiwi population group into five headings, which can be broadly defined as:

1. **Challenges to sustainable captive kiwi population management**

   Issues include the current situation of attempting to manage a population consisting of four sub-populations all being managed individually; the number of specimens being held in non-breeding situations on display, thus the requirement to phase into a one provenance Brown Kiwi population which meets best practice genetic and demographic goals over the long term.
   These are addressed in the 'Captive Management' and 'Population Management Strategy' sections of this CMP.

2. **Husbandry requirements** link to Kiwi Husbandry Manual

   Issues include ensuring all holders meet the minimum standards in the Brown Kiwi Husbandry Manual 2009; that DOC conservancy permitting processes support the consistent implementation of these standards (e.g. providing consistent wording, and meeting minimum standards as defined in the husbandry manual regardless of the size and nature of the institution); and that staff at participating institutions have sufficient kiwi breeding expertise to be able to support the genetic and demographic programme goals.
   These are addressed in the 'Husbandry and Management' section of this CMP.

3. **Participant/Institutional support for programme goals**

   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.
   These are addressed in the 'Stakeholder support' section of this CMP.

4. **Advocacy**

Issues include the need to agree a process which ensures that the kiwi conservation messages identified by the KRG and BNZ Save the Kiwi Trust are consistently delivered through participating institution advocacy programmes (allowing for a local flavour to the messages, including highlighting local problems and the contribution that the institution is making to kiwi conservation initiatives). It is important to develop a programme-wide evaluation process to assess the effectiveness of captive-based advocacy messages for kiwi. There is a need to explore the relative effectiveness of different advocacy approaches in terms of display and results achieved (e.g. kiwi encounter versus other).
These are addressed in the 'Advocacy' section of this CMP.

5. **Optimising the value of the captive kiwi population**

Issues include making kiwi available for appropriate research and training initiatives, for example, trialling predator trap designs/heights to ensure kiwi will not be at risk in the wild, teaching field workers how to fit radio-transmitters, or use of nest and faecal material for dog aversion training programmes. Research and training with captive kiwi should ensure that there is no detriment to the captive population and that recovery-directed research, as prioritised by the KRG, is supported.
These are addressed in the 'In-situ, research and training' section of this CMP.

6 Scope and Governance

6.1 Taxon information

Taxon	*Apteryx mantelli*
Common name	**Brown Kiwi**
Captive management unit	Species – Brown Kiwi Provenance – **Eastern**
TAG	New Zealand Fauna Taxon Advisory Group
Scope of managed population	Captive managed population in New Zealand institutions; *excludes BNZ Operation Nest Egg 'head start' chicks and those birds held under DOC rehabilitation permit.*
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. Population trend: decreasing
CITES listing	Not listed
Other relevant listings	'Serious Decline' (Conservation Dependent; Human Induced; Recruitment Failure); Hitchmough *et. al.,* 2007, Miskelly *et. al*., 2008.
Current ability to recruit from the wild	Good potential to recruit founders via BNZ Operation Nest Egg chicks of Eastern provenance

ASMP Species coordinator:		Suzy Barlow
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Document prepared by:	**Suzy Barlow**
Last updated:	December 2010
Studbook compiled by:	Suzy Barlow (August 2008 – current)
Scope of data:	Australasian (New Zealand)
Date first compiled:	1992 (by Tracy Johnson)
Data now current to:	24th November 2010
Frequency of Reporting	Annually in February/March each year

7 Programme administration

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

Programme management team

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Claire Travers	Kiwi Husbandry Manager, National Kiwi Trust at Kiwi Encounter	clairetravers@kiwiencounter.co.nz
Research contact	*To be sought in 2011*	

8 Scope of the kiwi captive management plan

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

One male Little Spotted Kiwi (estimate thirty-plus years old) and two female Great Spotted Kiwi (fifteen years old) remain in captivity at Otorohanga Kiwi House, and one female Great Spotted Kiwi remains at Willowbank Wildlife Reserve; these birds remain outside the scope of this managed programme and are considered as 'phase out' by natural attrition. Bevan and Lorraine Alexander in Arahura Valley (see 2004 Kiwi CMP) still maintain a single male Rowi injured in a trap twenty seven years ago, and male and female Rowi which were early Operation Nest Egg birds and did not adapt to the wild (these two birds have been with the Alexanders for over 10 years); a total of 3 birds. Shaw (DOC West Coast) pers. comm.

9 Population Management Strategy for Brown Kiwi

9.1 Genetic management strategy

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.

The current issue with the captive Brown Kiwi population in New Zealand is that none of the individual provenance populations have sufficient genetic diversity (or have been founded in appropriate numbers) to meet the ZAA accepted maintenance of a *minimum* of 90% of the wild founder genetic diversity. This is an historical, inherited problem, caused by the lack of scientific knowledge of the 'separate' genetic units within Brown Kiwi until 1994. Although the captive population has been managed as separate provenance pairs since the late 1990s, and the action to phase out 'mixed' provenance pairs was identified in the 2004 Kiwi Captive Management Plan, the population continues to be unsustainable. This is because three very small populations (Northland, Eastern and Western) are being attempted to be managed as individual populations, none with sufficient founders, and none in large enough numbers; and thus the captive population cannot function at optimum levels.

Additionally, the previous CMP identified the need to ensure each provenance held in captivity (Northland, Eastern and Western) was founded on the minimum of 20 founders, an action that required a large intake of new founders and has not been feasible during the 2004-2009 time periods. The planned population size cannot support three separately managed, viable, populations and meet display requirements.

The goal is to develop a single provenance population (with ~110 planned 'spaces') that is founded on the recommended minimum number of wild founders (20 individuals). The population will aim to equalise founder representation in the descendent population which will promote the long-term genetic health of the population by promoting retention of gene diversity. Thus it will be possible to establish a genetically viable population that is both sustainable in terms of providing birds for advocacy/display, and that has the ability to provide genetically appropriate kiwi to identified restoration/release sites as required.

The proposal to 'phase in' to Eastern provenance Brown Kiwi is based on the rationale outlined in section 5.1 'Rationale for Captive Management Unit Selection'. In order to transition the population, release of healthy kiwi, currently in captivity, which are not of the preferred Eastern provenance, will be utilised as a short-term strategy to move the population forward into a single, Eastern provenance population. This will be dependent on available release sites and appropriate genetics of individual specimens to available sites. Acquisition of new founder Eastern Brown Kiwi will be via BNZ Operation Nest Egg in liaison with the Department of Conservation, and will be staggered over time to stabilise the age-structure of the population. Consultation with relevant DOC staff occurred during the development of this plan, Rhys Burns (Technical Support Officer, DOC, East Coast-Bay of Plenty Conservancy) pers. comm. The acquisition strategy is covered in more detail in the 'Recruitment and Phasing Strategy' in section 9.4.

Genetic management strategy for Brown Kiwi

The goal is to maximise retention of founder genetic diversity. This will be achieved by the selection of breeding pairs being aimed at reducing the rate at which gene diversity is lost and inbreeding is accumulated within the population. 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

9.2 Demographic management strategy

Context

The available 'space' for the captive Brown Kiwi population is currently ~110 kiwi (planned space within the next 5 years as listed by all programme participants in November 2010). This number is considered to be sustainable in terms of managing a small population in captivity. Lees (CBSG Australasia) pers. comm. However the existing ~95 kiwi are being held in four *separately* managed populations (November 2010):

1. Eastern provenance - 38 individuals.
2. Western provenance – 32 individuals.
3. Northland provenance – 14 individuals.
4. 'Mixed' provenance – 7 individuals.

The goal is to aim for demographic stability of one provenance; with the captive management strategy being to 'phase in' to Eastern Brown Kiwi over the next 10-15 years. The existing captive population of Eastern provenance is small enough to be adversely influenced by demographic stochastity (random fluctuations in birth and death rate, and in sex ratio). Thus the aim of the demographic strategy is to gradually grow the population of Eastern Brown Kiwi beyond a size likely to succumb to these adverse affects (e.g. from a current population size of around 40 to fill the ~110 spaces). Additionally there is a need to stabilise the population age-structure in the short-term through strategic use of release, and in the long-term through management of annual birth rates.

Approximately 40% of the existing captive 'spaces' are allocated to display kiwi, the majority of which do not breed in nocturnal houses. Thus approximately 60% of the population must support all recruitment requirements, including those for the ~40% held in display-only facilities. In the future, any new institutions, or existing institutions, listing for new or extra kiwi 'spaces' must include off-exhibit space (as many off-exhibit spaces as on-exhibit spaces) to support the programme goals.

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 birds for existing advocacy displays. 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 if reproductive rates are lower than expected.

Demographic management strategy for Brown Kiwi

The number of breeding pairs each year/season will be determined with the aim of achieving planned numbers, avoiding unplanned recruitment, and, as required, providing kiwi for 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)
2. PM2000 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)

Implications of planned population size

If this transition was made only through breeding, the following table indicates the numbers of pairings and hatches that would be needed. This is modelled on the total population of Brown Kiwi, not with provenances separated. However, in reality the transition will be through a combination of release of 'over-represented' (in the captive population) kiwi, recruitment of new founders and breeding.

Table 5. 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):			110 (listed in Regional Census in November 2010)		
Growth rate required:	1.0443				
Average number per litter/ clutch:	1 (SPARKS dataset for Brown Kiwi)				
Probability that a pair breeds:	75 % (based on estimate from historical ARRs)				
	2011	2012	2013	2014	2015
Expected number of hatches needed:	13.2	15.3	16.09	16.64	16.89
Number of pairs required:	17.6	20.4	21.5	22.2	22.5

Note across all provenances there are currently 22 pairs established. However the 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.

9.3 Target population characteristics

Recruitment required *(collection from wild)*:	Yes
Rate of founder recruitment required to meet genetic goals	6 over the next 5 years to achieve target of 20 initial founders.
Source of new founders	Source from wild BNZ Operation Nest Egg™ chicks from Eastern restoration sites

9.4 Recruitment and 'phasing' strategy

Context

The aim of this captive management plan is to set the future strategy for the captive population and to gradually 'phase in' to a single provenance Brown Kiwi population. This will include the acquisition of new Eastern founders via BNZ Operation Nest Egg, captive breeding, and the release of healthy non-Eastern provenance kiwi at release sites agreed by the Kiwi Recovery Group, ensuring that the captive population is not compromised by this phasing and that display numbers are maintained.

The intent is to provide restoration sites with 'over-represented' captive bred Eastern Brown Kiwi ('over-represented' in the captive population in terms of mean kinship, but unrelated to restoration site birds) in exchange for BNZ Operation Nest Egg chicks which may be over-represented at their source site (e.g. if a large number of chicks are collected from one pair) but are unrelated 'founders' for the captive population.

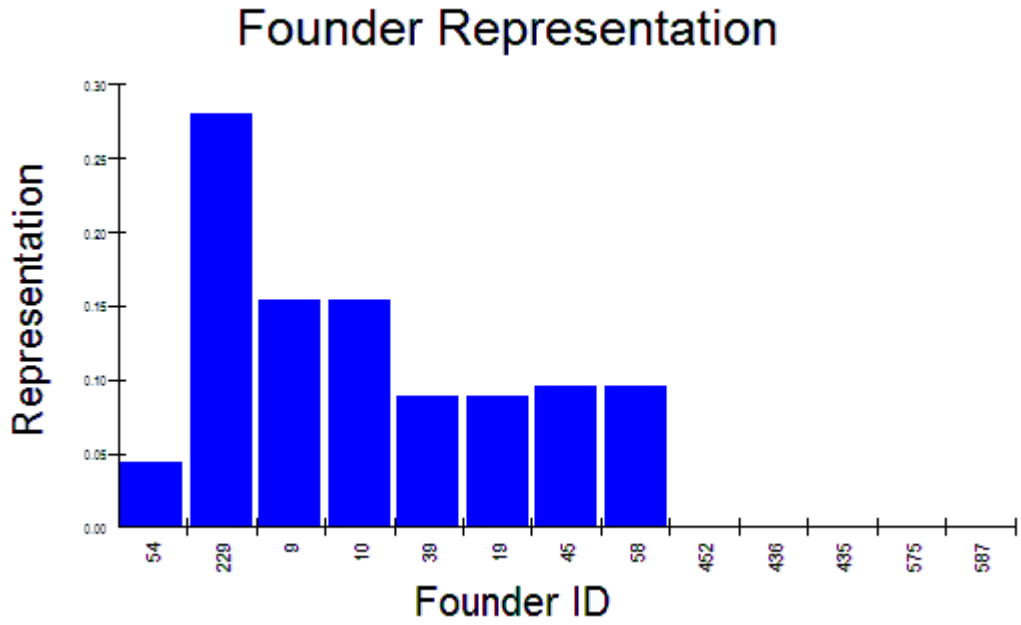
There will be a time-lag between founder acquisition from Eastern Operation Nest Egg eggs/chicks and release of those kiwi no longer required in the captive population (e.g. other provenance) kiwi. This is because the Operation Nest Egg chicks are unlikely to breed before their third year. Dependent on the results of annual breeding (as reported in the ZAA Annual Report and Recommendations in March each year), and the exhibit requirements of programme participants, gradual 'phase out' of all releasable Northland, 'mixed' provenance and Western Brown Kiwi will be recommended annually. This is to ensure no undue pressure is put on to the primary purpose of the captive population, which is for advocacy (e.g. no reduction in overall population size as required for display purposes).

'Phase- in' strategy

The existing Eastern Brown Kiwi captive population is currently founded on 8 birds (see 'Genetic Review' section 16, and the Graph 1, below, with an additional 5 birds not yet represented (too young to breed). This is a total of 13 Eastern Brown Kiwi. To meet international best practice by founding a captive population on a minimum of 20 founders to capture 98% of the genetic diversity recorded in the wild, (Frankham *et. al.,* 2002) this plan would aim to acquire a further 7 Eastern founders during the next 5 years (however an additional founder was ear-marked for the captive population during the final editing of this CMP, but has not yet entered the population; thus the plan indicates acquisition of six additional founders). In the longer term, there will be the requirement for periodic founder additions to maintain the genetic diversity of the captive population.

Acquisition will be via BNZ Operation Nest Egg (thus allowing chicks to be hatched and conditioned to captivity), in consultation and liaison with DOC, the KRG and the DOC East Coast – Bay of Plenty Conservancy. Founders will not be closely related to one another, nor to known captive Brown Kiwi, and will be sourced from sites identified with the stakeholders above. As founders will be acquired as eggs to be hatched in captivity, there will be a time lag before they commence breeding. Founder acquisition will be staggered to ensure founders are not in similar age classes.

Graph 1. Founder representation in the current Eastern provenance Brown Kiwi captive population (November 2010).



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 (2011)	2	Unrelated chicks 1 m. 1 f. to form future new pair – 1st priority to Auckland Zoo
3 (2013)	2	Unrelated chicks 1 m. 1 f.
5 (2015)	2	Unrelated chicks 1 m. 1 f.

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

'Phase-out' strategy

The aim is to secure the required number of kiwi for display, to release the non-Eastern provenance birds and expand the required provenance through a combination of breeding and acquisition of new founders (as outlined above). The short term tool for 'phasing out' of non-Eastern provenance Brown Kiwi will be through release. All releasable, non-Eastern birds will be released to KRG approved sites in liaison with DOC. This will be managed strategically to ensure display requirements are not compromised, and actioned through the Annual Report and Recommendations. The rate of release cannot be higher than the rate of breeding and acquisition of Eastern founders in order to keep the population stable.

Priority will be to remove releasable 'mixed' provenance and Northland birds from the captive population as there are lower numbers of these kiwi and they are not being bred. However, existing local release agreements, already endorsed by DOC, will be honoured.

Release to the wild should be guided by the needs of the wild population, for example where threats to birds in the wild have been controlled but where supplementation with captive bred birds may be the most effective way of providing unrelated genetics, particularly to small isolated wild populations.

As the Eastern population grows and breeding rates increase (as chicks reach breeding age), there will be gradual cessation of breeding of other provenance kiwi. At present, if all breeding of non-Eastern kiwi was stopped, there would be insufficient young kiwi to meet the programme requirements. Because of the fluctuations in birth and death rates these plans will need to be modified annually and remain fluid, with the CMP guiding the over-arching population strategy and the ARR detailing the 'on the ground' actions. It is anticipated that 'phasing out' of non-Eastern provenance kiwi will take at least 10 years. It is acknowledged that some injured, rehabilitated kiwi are not releasable and will remain in the captive population for the rest of their lives.

10 Husbandry and management

The standards referred to in this section are a summary of more complete husbandry information which is available in the Brown Kiwi Husbandry Manual 2009 (Fraser & Johnson, 2009). Please check the original document for any updates (a link to the original document is provided on page 12).

10.1 Behavioural and Reproductive management

To optimise behavioural welfare, the most appropriate way to hold captive Brown Kiwi is considered to be in a male/female pair. However, same sex chicks maybe held together until at least 3 years of age, and nocturnal display requirements may entail the management of 2 males (if they are gradually introduced – preferably pre sexual maturity). It is recommended that adult females are not housed together. Advice on the integration of individual kiwi is provided in the Brown Kiwi Husbandry Manual 2009 (Fraser & Johnson, 2009).

10.2 Reproduction

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

10.3 Artificial incubation

Eggs should be removed for artificial incubation according to the breeding male's experience. When a breeding pair has a history of egg breakages, eggs should be removed from the incubating male at no earlier than 30 days; for inexperienced birds (without a history of egg breakage) eggs should not be removed until 40 days for artificial incubation. Holders should consult with the Captive Coordinator in regards to the number of eggs removed for artificial incubation from a 'learning' male; before he is left to attempt incubation by himself (this will relate to the number of chicks hatched from the pairing each season).

For all other breeding pairs, which have a proven track record, males should be left to incubate naturally. These management decisions are made 'in house' by experienced staff, who adjusts their egg incubation regime based on the prior breeding behaviour/incubation record of each male kiwi.

Institutions without incubation facilities or experience should arrange to transfer eggs to a BNZ Operation Nest Egg facility for artificial incubation and rearing. Detailed information about the artificial incubation of kiwi eggs is available in the 2010 'Operation Nest Egg Incubation and Best Practice Protocols' (in prep.) and in the BNZ Operation Nest Egg™. Kiwi Egg Candling Workshop Study Guide (available from Suzanne Bassett, Oralis Ltd during the BNZ Save the Kiwi Trust kiwi egg candling course).

10.4 Methods of controlling breeding

There is a requirement to manage output from prolific breeding pairs (e.g. pairs that produce many more offspring than the population average). Options for releasing over-represented kiwi will be limited (e.g. to prevent the release of large numbers of siblings to one release site). Therefore, if it is not considered viable to split and re-pair two birds for welfare reasons, and they are genetically over-represented in both the captive population and at allocated release sites, breeding should be controlled as outlined in the Brown Kiwi Husbandry Manual 2009 (Fraser & Johnson, 2009).

Specifically if no chicks are required from kiwi already paired together any eggs laid should be replaced with artificial eggs, and the real eggs removed from the nest. Eggs should not be removed without an artificial egg replacing them, as an empty nest will encourage the female to keep laying. Repeated egg laying may negatively impact on the female's health (Fraser & Johnson, 2009).

10.5 Veterinary and health management (provided by Dr John Potter, NZCCM)

Full details of most of the conditions below can be found in *Kiwi First Aid and Veterinary Care* (Morgan 2008) which is available to all captive kiwi holders. Link to *Kiwi First Aid and Veterinary Care*

Preventative Medicine:

- Adult kiwi should be weighed at least twice a year, growing kiwi at least monthly to establish normal records.
- Faecal sampling for parasite examination should take place at least once every six months. Positive findings should be discussed with a veterinarian to determine what, if any, treatments are recommended.
- Food consumption should be monitored daily. It is best practice to weigh and record food eaten each day.

Health Issues:

- Traumatic injuries in legs from traps.
- Foreign body ingestion from metallic objects left in enclosures
- Reproductive disorders
- Parasite problems, and in particular coccidiosis
- Bacterial infections
- Neurological problems, sometimes associated with roundworm larvae.

General husbandry information (including diet, pre and post transfer veterinary screening for quarantine, etc) can be found in the Brown Kiwi Husbandry Manual 2009 (Fraser & Johnson, 2009).

10.6 Husbandry Issues / goals / actions

Context

At present there are a number of areas in which the captive programme is failing to model excellence in husbandry and welfare across all participating holders. These include some reluctance to standardise husbandry practice (e.g. in areas such as diet), low breeding rates in captive birds compared to the wild; smaller eggs and clutch size compared with the wild; low egg hatchability compared to Operation Nest Egg; husbandry issues in some nocturnal houses and the unreliable keeping and reporting of accurate animal records in some non-ISIS institutions.

Enforcement of husbandry standards:
There is no mechanism though which the captive programme coordinating body can enforce husbandry and welfare standards (the sole mechanism is through local DOC conservancy permits). ZAA NZ membership has not agreed to an over-arching zoo accreditation programme. The previous Kiwi Evaluation/Categorisation review requires follow-up.

Managing breeding rates:
The ability to control demographic stability relies on an ability to control breeding closely. At present, the current birth rate is derived from a relatively small number of pairs. Though the rate may be sufficient to maintain the desired population size, the loss of only a few key birds could place it below the required threshold. Maintaining genetic health requires an ability to control which pairs breed and contribute to the next generation, and the size of their contribution. Current factors preventing more pairs contributing to the birth rate include, young age, length of time taken for pairs to establish, delayed transfers, egg breakage (by inexperienced males), low egg fertility and female reproductive tract problems which have lead to the premature death of some female breeders.

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
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
Review 2009 Brown Kiwi Husbandry Manual and revise if required.	Captive coordinator + editing subgroup (Ian Fraser; Tony Billing)	During 2011	Revised 2011 Husbandry Manual is endorsed by all participating institutions and KRG	Likely to need additional resource to deliver this in 2011.
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	DOC conservancy permit process takes account of Brown Kiwi Husbandry minimum standards for captive kiwi.	
Survey holders for interest in a regular kiwi husbandry and breeding course directed at targeting key expert participants as potential contributors; as a	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.

way of disseminating regional expertise (e.g. Tasmanian devil model).				
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.

11 Programme participant support

Participant/ institutional understanding of programme goals

At this stage, the understanding of programme goals is variable across the fifteen different institutions holding Brown Kiwi. Some of the key issues are:

Culture of cooperative management is not embedded

An understanding of programme goals and requirements, and active support for them amongst holders is vital to a successful programme. The culture of participating in managed species programmes is in its early stages for many kiwi holders.

Ongoing conflict between fulfilling short-term display needs and meeting long-term programme requirements:

There is ongoing conflict between fulfilling short-term display needs and meeting long-term demographic and genetic population requirements. The former is important for advocacy in the short-term, the latter for advocacy and other conservation goals over the long-term. Thus there is a risk that participating holders may refuse to replace good nocturnal display birds with new specimens, which would make full implementation of the proposed changes difficult. Without a carefully developed strategy for phasing in the Eastern provenance kiwi and phasing out some of the existing kiwi, concerns will arise amongst holders about the future of their displays.

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
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 all appropriate programme documentation and provide information in relevant presentations. (e.g. personnel training)	Captive coordinator	2011	Paragraph appears in Annual Reports. Message is promoted in appropriate presentations.	
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.	

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.
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.	

12 Advocacy

Advocacy remains the primary goal of the captive kiwi population; however there is a lack of consistency in key advocacy messages and opportunities to promote kiwi conservation across all participating institutions. *In situ* conservation projects, particularly those run by community groups, are actively seeking ways to increase the advocacy opportunities of their projects, which may compete with captive facilities in terms of visitor experience with kiwi. 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.

Key Advocacy goals

Consistency in advocacy messages and evaluation across participating institutions:

The KRG identifies (though the National Mentor for Advocacy) key national and local advocacy messages for kiwi. These are not being utilised consistently across captive institution's interpretive and other media. Additionally there is no evaluation framework or feedback mechanism for captive-based conservation advocacy programmes, to ensure they are effective and to inform appropriate changes where they are not.

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?
Appoint an 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.
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 progamme.	Will need time allocation from member institution.
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

13 *Ex-situ*, research and training

Optimising the value of the captive kiwi population through utilising kiwi for recovery driven research/training:

There appears to be a need to align the needs for research by conservation practitioners on captive kiwi. There is acknowledged potential for using captive kiwi for research e.g. trialling pest animal traps or bait stations to assess risk to kiwi, and investigating species biology. This area of utility has not been fully explored and has often occurred at an *ad hoc* institutional level. Additionally there is demonstrated potential for using captive kiwi to train field workers and those working on community conservation projects e.g. in learning to fit transmitters, dog aversions training programmes, etc, which has not been fully explored and is not being actively recorded (where it does occur).

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
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.
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.
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.

13.1 Funding kiwi conservation initiatives

Participants in the captive programme are encouraged to contribute conservation donations to the BNZ Save the Kiwi Trust (www.savethekiwi.org.nz) which directs funding to support kiwi conservation initiatives across New Zealand, including much of the development of BNZ Operation Nest Egg, with annual funding rounds prioritised in accordance with Kiwi Recovery Plan objectives.

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15 Demographic Review

15.1 Demographic Goals

Target Population size = 110 -120 over the next 5 years	*Ensure persistence of population at planned size for20 years* *Stabilise age structure*

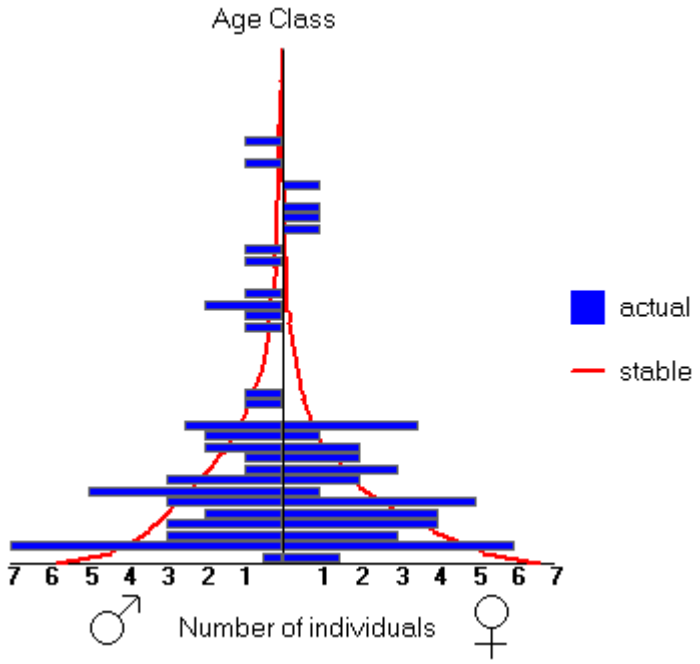
15.2 Tools for analysis

Package	*Version*	*Author, date*
SPARKS	1.54	ISIS, update 15.01.2004
PM2000	1.213	J.P Pollak, R.C. Lacy, J.D. Ballou. 2005. Chicago Zoological Society

15.3 Age structure and sex ratio

Data: **all provenance** living Brown Kiwi held by programme participants at 1st December 2010

Figure 1: Age Pyramid for living population.



Total Males = 48.0; Total Females = 45.0
Unknown Age Males = 2.0; Unknown Age Females = 3.0

15.4 Studbook data

Table 1: Overview of studbook data at 24th November 2010 (all provenance Brown Kiwi)

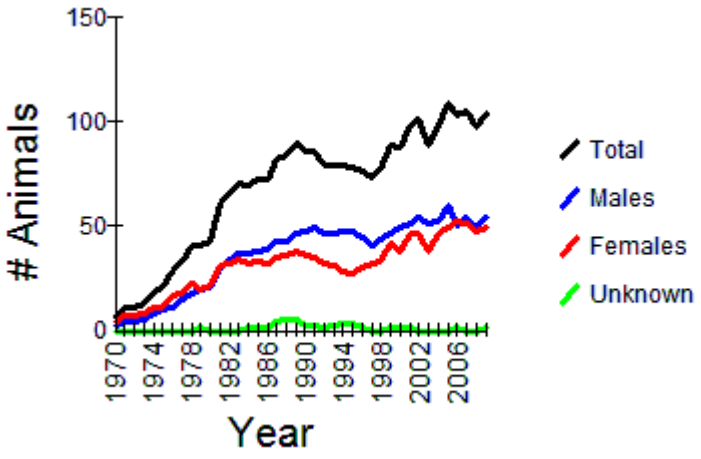
		Living Specimens		Total studbook	
		No. of specimens	**% of total living**	**No. of specimens**	**% of total**
Totals	Number of specimens	**93**	100%	**533**	100%
Sex	Females	44	47.3%	211	39.6%
	Males	46	49.5%	207	38.8%

		Living Specimens		Total studbook	
		No. of specimens	**% of total living**	**No. of specimens**	**% of total**
	Unknown	3	3.2%	115	21.6%
Birth dates	Known or Estimated	88	94.6%	482	90.4%
	Unknown	5	5.4%	51	9.6%

15.5 Annual census

Data restricted to all managed captive Brown Kiwi in New Zealand

Graph 1: Annual census of the captive population of Brown Kiwi (all provenances) 1st December 2010



15.6 Recent developments in the captive population by provenance

Data restricted to: All captive Brown Kiwi in the New Zealand captive managed population.

*Table 2. Developments in the captive population of Brown Kiwi (2006-2010): **Eastern provenance** (BOP) 2006 – 2010*

	2006-7	**2007-8**	**2008-9**	**2009-10**	**2010-10***	**Totals**
Population size at 1st April	37	43	47	41	43	
Acquisitions:						
Hatches	8	7	3	7	2	27
Captures from wild	0	1	0	0	0	1
Total acquisitions	**8**	**8**	**3**	**7**	**2**	**28**
Dispositions:						
Deaths (total no.)	0	2	3	2	5	12
(Neonatal deaths)	*(0)*	*(0)*	*(0)*	*(1)*	*(1)*	*(2)*
Releases	2	2	6	3	2	15
Total dispositions	**2**	**4**	**9**	**5**	**7**	**27**
Population size at 31st March	43	47	41	43	38*	

*Population size at 1st December 2010

*Table 3. Developments in the captive population of Brown Kiwi (2006-2010): **Western provenance (TAR) 2006-2010***

	2006-7	2007-8	2008-9	2009-10	2010-10*	Totals
Population size at 1st April	22	21	23	28	34	
Acquisitions:						
Hatches	8	6	6	7	4	31
Captures from wild	1	1	1	0	0	3
Total acquisitions	**9**	**7**	**7**	**7**	**4**	**34**
Dispositions:						
Deaths (total no.)	5	3	1	1	2	12
(Neonatal deaths)	*(2)*	*(2)*	*(0)*	*(1)*	*(1)*	*(6)*
Releases	5	2	1	0	3	11
Total dispositions	**10**	**5**	**2**	**1**	**5**	**23**
Population size at 31st March	21	23	28	34	33*	

* Population size at 1st December 2010

*Table 4. Developments in the captive population of Brown Kiwi (2006-2010): **Northland provenance (NLD) 2006-2010***

	2006-7	2007-8	2008-9	2009-10	2010-10*	Totals
Population size at 1st April	20	20	21	19	19	
Acquisitions:						
Hatches	1	0	2	1	0	4
Captures from wild	1	2	0	0	0	3
Total acquisitions	**2**	**2**	**2**	**1**	**0**	**7**
Dispositions:						
Deaths (total no.)	1	1	4	1	0	7
(Neonatal deaths)	*(0)*	*(0)*	*(1)*	*(0)*	*(0)*	*(1)*
Exports	0	0	0	0	2.3.0	2.3.0
Releases	1	0	0	0	0	1
Total dispositions	**2**	**1**	**4**	**1**	**5**	**13**
Population size at 31st March	20	21	19	19	14*	

* Population size at 1st December 2010

Table 5: Reproductive parameters from studbook data

Females	
Age range of possible reproduction (age of youngest and oldest animals recorded breeding)	2 yr, 11 mths–33 yrs 3 mths
Age range of peak reproduction (age classes for which median Mx value is exceeded)	7 - 33 yrs
Males	
Age range of possible reproduction (age of youngest and oldest animals recorded breeding)	2 yrs, 3 mths - ~36 years
Age range of peak reproduction (age classes for which median Mx value is exceeded)	11-32 yrs
Clutch fertility and mating success	
Percentage of attempted pairings successful (produce offspring when breeding recommended) – data from 2002-2009	47.5%
% fertile eggs (figures reported for eggs laid from 2002 -2009) – 216 eggs ~49 infertile (22%)	78%
Litter/clutch size	1-2
Interbirth interval (time between 1st and 2nd chick hatches)	16-19 days

15.7 Mortality

Table 6. Summary of mortality data from studbook

Females	
% juvenile mortality (females < 1 year old)	30%
Average life expectancy of adults *(mean age at death of animals surviving juvenile age classes)*	5 yrs, 3 mths
Maximum longevity *(age at death of oldest animal in studbook)*	22 yrs, 12 days
Males	
% juvenile mortality (males < 1 year old)	30%
Average life expectancy of adults *(mean age at death of animals surviving juvenile age classes)*	7 yrs, 14 days
Maximum longevity *(age at death of oldest animal in studbook)*	~ 44 years (wild caught)

15.8 Planned regional population size (all provenance Brown Kiwi)

Table 7. Current and planned holdings of programme participants

Holder	***Current***	***Current Provenance***	***Planned***	***Comment***
Auckland Zoo	1.2.0 (3)	1.2 (NLD)	4.4.0 (8)	Acquire ASAP
Hamilton Zoo	0.0.0 (0)	N/A	1.1.0 (2)	Follow DOC programme; acquire
Kiwi Birdlife Park (Queenstown)	2.2.0 (4)	1.1.0 (BOP) 1.1.0 (HYB)	3.3.2 (8)	Follow programme recommendations
National Aquarium of New Zealand	1.1.0 (2)	1.1.0 (BOP)	1.1.0 (2)	Follow programme recommendations
*National Kiwi Centre (Hokitika)**	*1.1.0 (2)*	*1.1.0 (NLD)*	*1.1.0 (2)*	*Follow programme recommendations*
Nga Manu Nature Reserve	1.1.0 (2)	1.1.0 (BOP)	1.1.0 (2)	Follow programme recommendations
Orana Wildlife Park**	6.6.0 (12)	2.2.0 (BOP) 4.4.0 (TAR)	6.6.0 (12)	Follow programme recommendations
Otorohanga Kiwi House	7.7.0 (14)	2.1.0 (NLD) 5.6.0 (TAR)	5.5.0 (10)	Follow programme recommendations
Paradise Valley Springs Wildlife Park	0.0.0 (0)	N/A	0.0.4 (4)	Acquire as available
Peacock Springs/Isaac Wildlife Trust	1.1.0 (2)	1.1.0 (TAR)	1.1.0 (2)	Follow programme recommendations
Pukaha – Mt Bruce	1.1.0 (2)	1.0 (NLD) 0.1 (HYB)	1.1.0 (2)	Follow programme recommendations
Rainbow Springs Kiwi Wildlife Park	10.7.2 (19)	6.5.1 (BOP) 4.2.1 (TAR)	8.7.0 (15)	Follow programme recommendations
Te Puia	2.2.0 (4)	2.1 (TAR) 0.1 (HYB)	2.2.0 (4)	Follow programme recommendations
Wellington Zoo Trust	4.1.0 (5)	3.0 (NLD) 1.1 (TAR)	4.1.0 (5)	Follow programme recommendations
Westshore Wildlife Reserve	5.4.0 (9)	5.4.0 (BOP)	6.6.0 (12)	Follow programme recommendations
Whangarei Museum and Heritage Park	2.0.0 (2)	2.0 (NLD)	2.0.0 (2)	Follow programme recommendations

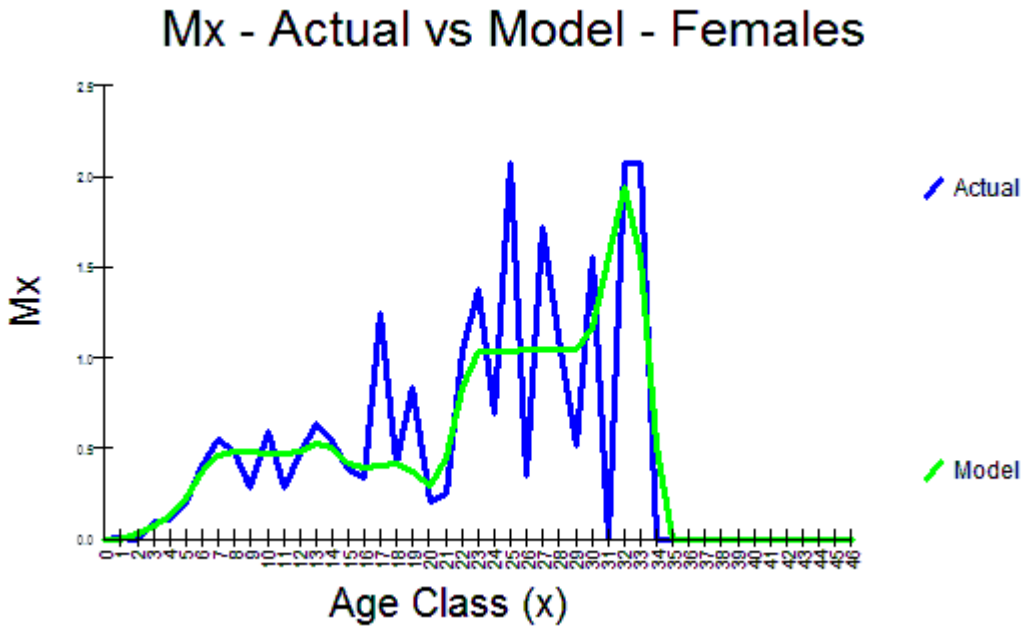
*Willowbank Wildlife Reserve**	*2.8.1 (11)*	*2.5.1 (BOP) 0.3 (HYB)*	*7.10.3 (20)*	*Follow programme recommendations*
TOTAL	**46.44.3 (93)**		**53.50.9 (112)**	

Taken from Online Census & Plan data, plus data from 2 non member holders from SPARKS dataset as at **24th November 2010**

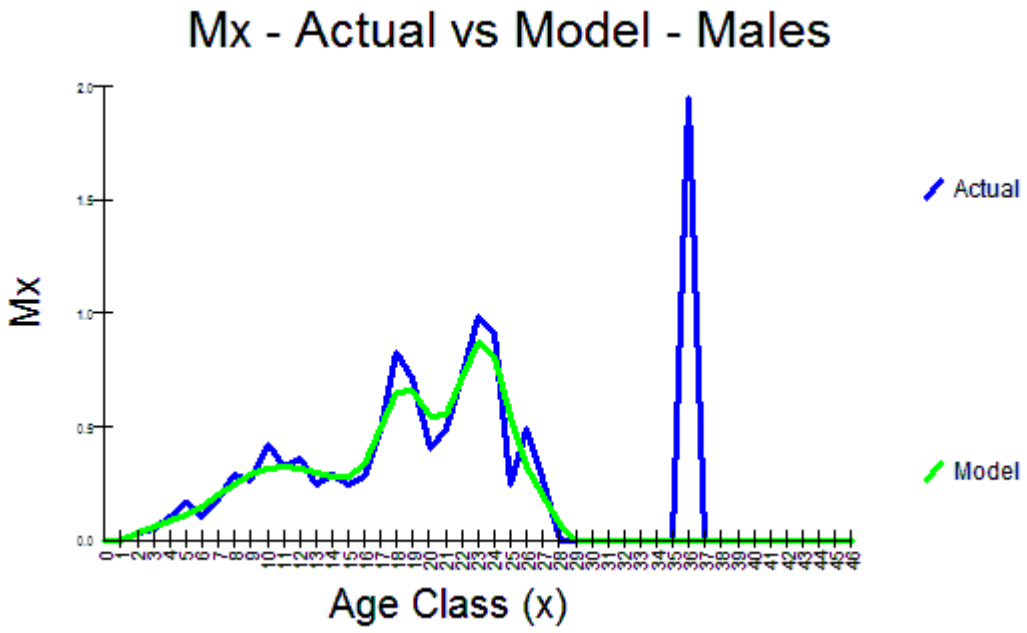
*Non ZAA NZ members. **1.1 held at Southern Encounter included in Orana Wildlife Park figures.

15.9 Life tables and graphs

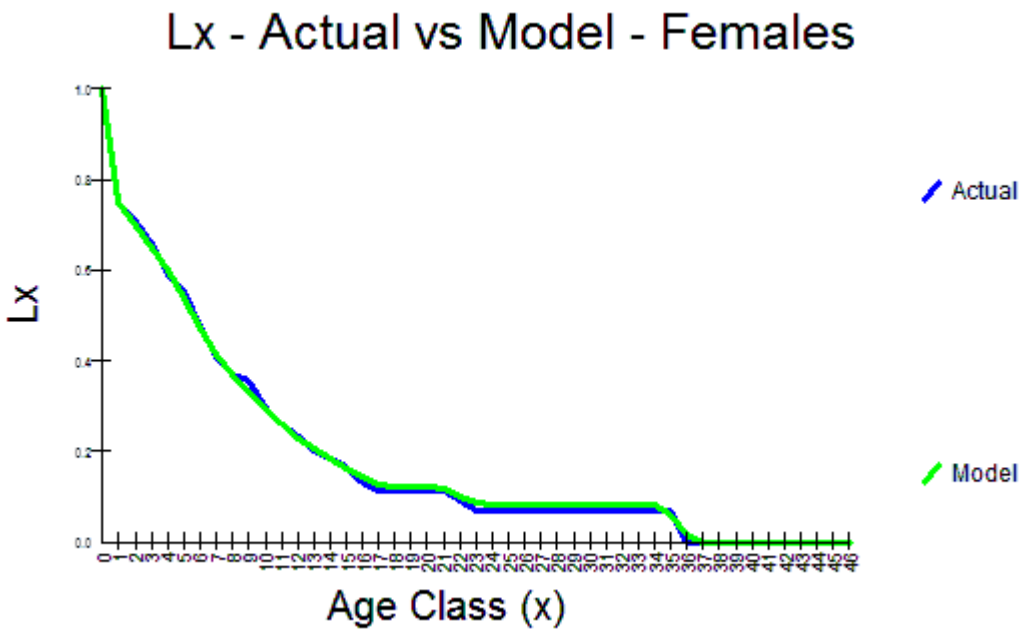
Graph 2: Age-specific fecundity in the captive population of female Brown Kiwi in the ZAA NZ captive population



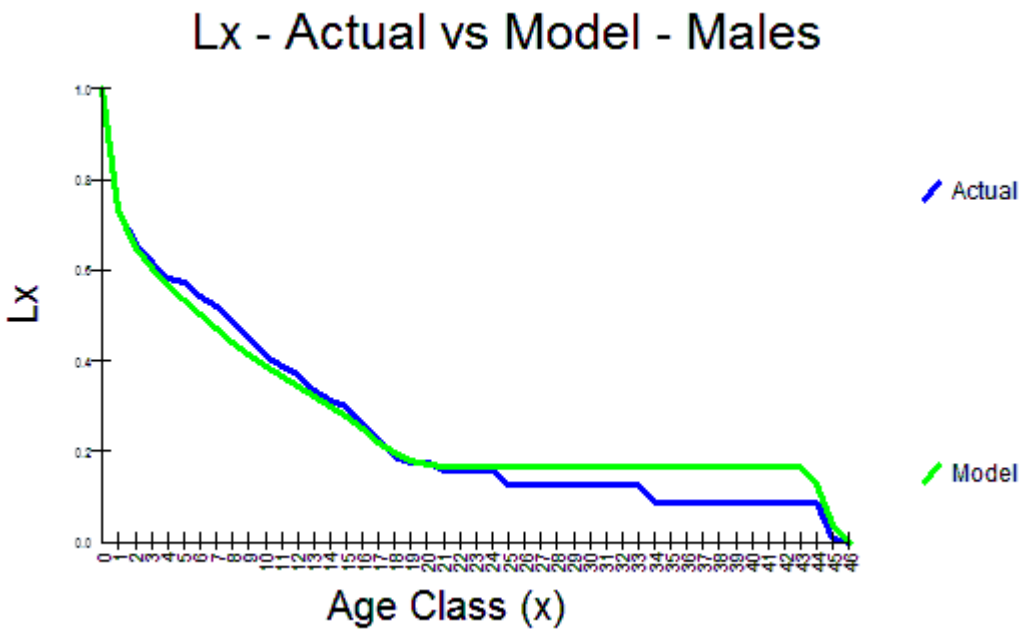
Graph 3: Age-specific fecundity in the captive population of male Brown Kiwi in the ZAA NZ captive population



Graph 4: Age-specific survivorship of female Brown Kiwi in the ZAA NZ captive population



Graph 5: Age-specific survivorship of male Brown Kiwi in the ZAA NZ captive population



16 Genetic Review

16.1 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

16.2 Tools for analysis

Package	*Version*	*Author, date*
SPARKS	1.54	ISIS, update 15.01.2004
PM2000	1.213	J.P Pollak, R.C. Lacy, J.D. Ballou. 2005. Chicago Zoological Society

16.3 Studbook data

Table 1: Overview of studbook data (all provenances) on 24th November 2010

		Living Specimens		Total studbook	
		No. of specimens	**% of total living**	**No. of specimens**	**% of total**
Origins	Captive born	77	82.7%	406	76.2%
	Wild born	16	17.2%	127	23.8%
	Unknown origin	0	0	0	0
Parentage	Parents known (identified by studbook no. or as 'WILD')	186	100%	1031	96.7%
	Parents unknown (listed as 'UNK')	0	0	35	3.3%

a) Eastern provenance

Post-reproductive animals:			
Females were considered post-reproductive at:	*34 years (as indicated by the SPARKS dataset)*		
Males were considered post-reproductive at:	*36 years (as above)*		
Animals at non-participating institutions: All Brown Kiwi in participating institutions, including birds at non-members, are included in this analysis as this is a Recovery Programme species (DOC).			
Additional animals excluded:			
Studbook no.	***Local ID***	***Sex***	***Reason removed from analysis***
81	R59182	F	'Te Kaha' Rainbow Springs – history of reproductive problems.
583	982 009105035552	M	'Ruha' Rainbow Springs – anaemic 'odd' ex BNZ ONE chick that has been held back on veterinary advice.

Pedigree assumptions

No. of gene drop iterations:	1000
Percentage of ancestry traced to founders:	100%
Data restricted to: Living animals held by all New Zealand captive holders at 24th November 2010	

*Table 3: Genetic summary of the descendent captive breeding population of Brown Kiwi at 24th November 2010 – **Eastern provenance***

	Current	***Potential***
Founders	8	5
Gene Diversity (fraction of source gene diversity retained)	0.8678	0.9545
Founder Genome Equivalents (FGE's)	3.78	10.99
Percent of potential gene diversity achieved (existing GD/ potential GD x 100)	90.91%	
Mean Inbreeding coefficient	0	
Range of Inbreeding coefficients	0	
Average Mean Kinship (MK)	0.1322	

b) Western provenance

Post-reproductive animals:			
Females were considered post-reproductive at:	*34 years (as indicated by the SPARKS dataset)*		
Males were considered post-reproductive at:	*36 years (as above)*		
Animals at non-participating institutions: All Brown Kiwi in participating institutions, including birds at non-members, are included in this analysis as this is a Recovery Programme species (DOC).			
Additional animals excluded:			
Studbook no.	***Local ID***	***Sex***	***Reason removed from analysis***
491	'Urenui'	F	Otorohanga; leg injury from wild, not suitable for breeding

Pedigree assumptions

No. of gene drop iterations: 1000
Percentage of ancestry traced to founders: 100%
Data restricted to: Living animals held by all New Zealand captive holders at 24th November 2010

*Table 5: Genetic summary of the descendent captive breeding population of Brown Kiwi at 24th November 2010 - **Western provenance***

	Current	***Potential***
Founders	7	0
Gene Diversity (fraction of source gene diversity retained)	0.8946	0.9199
Founder Genome Equivalents (FGE's)	4.74	6.24
Percent of potential gene diversity achieved (existing GD/ potential GD x 100)	97.24%	
Mean Inbreeding coefficient	0	
Range of Inbreeding coefficients	0	
Average Mean Kinship (MK)	0.1054	

c) Northland provenance

Post-reproductive animals:			
Females were considered post-reproductive at:		*34 years (as indicated by the SPARKS dataset)*	
Males were considered post-reproductive at:		*36 years (as above)*	
Animals at non-participating institutions: All Brown Kiwi in participating institutions, including birds at non-members, are included in this analysis as this is a Recovery Programme species (DOC).			
Additional animals excluded:			
Studbook no.	***Local ID***	***Sex***	***Reason removed from analysis***
463	05116	M	'Tahi' Wellington Zoo; above hock amputee
104	R25635	F	Otorohanga. Previous breeding problems; bird was caught as an adult 28 years ago.
429	'Koru'	F	Auckland Zoo. Used as a conditioned encounter bird.

Pedigree assumptions

No. of gene drop iterations: 1000

Percentage of ancestry traced to founders: 100%

Data restricted to: Living animals held by all New Zealand captive holders at 24th November 2010

*Table 7: Genetic summary of the descendent captive breeding population of Brown Kiwi at 24th November 2010 – **Northland provenance***

	Current	***Potential***
Founders	6	0
Gene Diversity (fraction of source gene diversity retained)	0.86	0.8947
Founder Genome Equivalents (FGE's)	3.57	4.75
Percent of potential gene diversity achieved (existing GD/ potential GD x 100)	96.12%	
Mean Inbreeding coefficient	0	
Range of Inbreeding coefficients	0	
Average Mean Kinship (MK)	0.1400	

17 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 (Leader signs off)	Dr. Avi Holzapfel	08/02/2011
New Zealand Fauna Taxon Advisory Group (TAG)	Andrew Nelson	24/02/2011
ZAA NZ Branch Committee (Chair signs off)	Stephen Standley	09/02/2011

This Captive Management Plan has been reviewed and endorsed by the *Director/CEO* of the following participating institutions:		
Institution	**TAG representative**	**Endorsement received (date)**
Auckland Zoo	Jonathan Wilcken	23/02/2011
Hamilton Zoo	Stephen Standley	10/02/2011
Kiwi Birdlife Park	Paul Wilson	23/02/2011
National Aquarium of New Zealand	Tony Billing	14/02/2011
Nga Manu Nature Reserve	Bruce Benseman	14/02/2011
Orana Wildlife Park	Lynn Anderson	28/02/2010
Otorohanga Kiwi House	Paul Stuart-Higgs	25/02/2011
Paradise Valley Springs Wildlife Park	Stuart Hamlett	21/02/2011
Peacock Springs/Isaac Wildlife Trust	Anne Richardson	25/02/2011
Pukaha – Mt Bruce	Chris Lester (DOC Area Manager)	23/02/2011
Rainbow Springs and Kiwi Encounter	Stewart Brown	25/02/2011
Te Puia	Peter Hatu	03/03/2011
Wellington Zoo Trust	Karen Fifield	14/02/2011
Westshore Wildlife Reserve	Tony Billing	11/02/2011
Whangarei Museum & Heritage Park	Dr. Joanna Cobley	02/03/2011

This Captive Management Plan has been reviewed and endorsed by the Director/CEO of the following non-member institutions:		
Non ZAA member institution	**Representative**	**Endorsement received (date)**
National Kiwi Centre, Hokitika	Terry Young	24/02/2011
Willowbank Wildlife Reserve	Michael Willis	02/03/2011 for Brown kiwi

This Captive Management Plan has been reviewed and endorsed by *nominated NZ Fauna TAG representatives* of the following participating institutions:		
Institution	**TAG representative**	**Endorsement received (date)**
Auckland Zoo	Ian Fraser	24/01/2011
Hamilton Zoo	Stephen Standley	18/01/2011
Kiwi Birdlife Park	Bridget Baynes	20/01/2011
National Aquarium of New Zealand	Kerry Hewit/Tony Billing	19/01/2011
Nga Manu Nature Reserve	Bruce Benseman	20/01/2011
Orana Wildlife Park	Lynn Anderson	19/01/2011
Otorohanga Kiwi House	Eric Fox	21/01/2011
Paradise Valley Springs Wildlife Park	Stuart Hamlett	21/01/2011

Peacock Springs/Isaac Wildlife Trust	Anne Richardson	18/01/2011
Pukaha – Mt Bruce	Rosemary Vander Lee	19/01/2011
Rainbow Springs and Kiwi Encounter	Steve Tregilgas/Claire Travers	21/01/2011
Te Puia	Peter Hatu	No response
Wellington Zoo Trust	Simon Eyre	19/01/2011
Westshore Wildlife Reserve	Tony Billing	19/01/2011
Whangarei Museum & Heritage Park	Elizabeth Adams	24/01/2011
This Captive Management Plan has been reviewed and endorsed by nominated representatives of the following non-member institutions:		
Non ZAA member institution	**Representative**	**Endorsement received (date)**
National Kiwi Centre, Hokitika	Kim McPherson	21/01/2011
Willowbank Wildlife Reserve	Kirsty Willis	Comment received(21/01/2011)