Captive management plan for kiwi

Apteryx mantelli, Apteryx rowi,
Apteryx australis, Apteryx australis 'Haast',
Apteryx haastii, Apteryx owenii

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Cover: A four-day-old kiwi chick in captive management. *Photo: © Tony Billing.*

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Preface

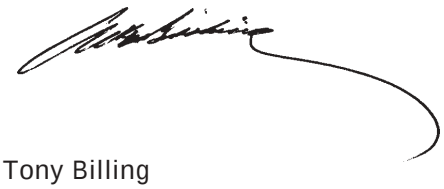
This Kiwi Captive Management Plan has been produced by the Kiwi Captive Management Advisory Committee in consultation with ARAZPA and the New Zealand captive industry. The plan aims to provide strategic and practical guidelines for holders of kiwi in New Zealand. There is further information relevant to captive management in the Kiwi Recovery Plan 1996–2006 (Robertson 2003), and we recommend that anyone with an interest in kiwi captive management also reads the recovery plan.

Captive management of kiwi in New Zealand is a symbiotic and co-operative effort between the Department of Conservation and the captive industry. In the past decade, we have learnt a considerable amount about the contribution that the captive industry can make to kiwi conservation in the wild, and to the management of kiwi in captivity. The successes of Operation Nest Egg are something that those involved in kiwi captive management can be rightly proud of—for without the support of the captive industry this programme would not be possible.

In contrast to other DOC published captive management plans, this plan does not contain a workplan or tasks to be achieved. Instead, a yearly workplan for kiwi holders (directing specimen transfers, pairings and releases) will be developed and released annually by the kiwi captive management co-ordinators in consultation with holders. The relevant workplan should be read in association with this document and the studbook analysis in Appendix 1. The 2002/03 workplan is included in this document in Appendix 2. Other tasks outside this workplan will be defined and carried out by members of the Kiwi Captive Management Advisory Committee, in consultation with the industry.

We hope that the publication of this document will assist the Department of Conservation and the captive industry to continue working together to make progress in kiwi recovery. We would like to take this opportunity to thank all those people who have commented on this plan during its production, and look forward to working with many of you in the future to improve the captive management of kiwi.

Paul Jansen
Kiwi Recovery Group Leader



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ABSTRACT

The current threat classifications of New Zealand's six kiwi taxa place them under the guidelines for 'Captive management of species absolutely protected under the Wildlife Act'. Policy guidelines dictate that kiwi will fall into category 1, which incorporates species where captive management forms an important part of recovery in the wild. In contrast to other DOC published captive management plans, this plan does not contain a workplan or tasks to be achieved. Instead, a yearly work-plan for kiwi holders will be developed and released annually by the kiwi captive management co-ordinators in consultation with holders. The Kiwi Recovery Group has determined a priority list for management action of kiwi populations based on the level of threat of extinction without management, distinctiveness, and effectiveness of current management proceedures. The plan assesses the current staus and knowledge of the existing kiwi populations, lays down goals and objectives, and a stategy for captive management. The plan will have a 10-year duration and will be reviewed five years after publication. A review of Appendix 2 (Demographic review of captive North Island brown kiwi) will be undertaken annually. Progress will be reported annually to the Kiwi Recovery Group meeting. Recommendations about captive management from the Recovery Group will be actioned by the Kiwi Captive Management Advisory Committee. Annual work-plans will be produced, as required.

Keywords: kiwi, *Apteryx mantelli*, *Apteryx rowi*, *Apteryx australis*, *Apteryx australis* 'Haast', *Apteryx haastii*, *Apteryx owenii*, New Zealand, captive management, biodiversity

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1. Introduction

1.1 TAXONOMY

Class:	Aves	
Superorder:	Palaeognathae	
Order:	Apterygiformes	
Family:	Apterygidae	
Species:	North Island brown kiwi	*Apteryx mantelli*
	Okarito brown kiwi/rowi	*Apteryx rowi*
	Southern tokoeka	*Apteryx australis*
	Haast tokoeka	*Apteryx australis* 'Haast'
	Great spotted kiwi/roroa	*Apteryx haastii*
	Little spotted kiwi	*Apteryx owenii*

The North Island brown kiwi population has been split into four sub-populations, each of which shows high levels of genetic variation. For management purposes, the populations are:

- Northland
- King Country–Taranaki–Wanganui
- Bay of Plenty–East Coast–Hawkes Bay
- Coromandel

The southern tokoeka population has also been split for management purposes, the populations are:

- Northern Fiordland
- Southern Fiordland
- Stewart Island

1.2 CONSERVATION STATUS

All six taxa of kiwi are threatened (Hitchmough 2002). Okarito brown kiwi/rowi[1] are classified as Nationally Critical with the Conservation Dependent, Recovering, Recruitment Failure, and One Location qualifiers. Haast tokoeka is classified as Nationally Critical with the Recruitment Failure and One Location qualifiers. North Island brown kiwi is classified as Seriously Declining with the Human Induced and Recruitment Failure qualifiers. Great spotted kiwi/roroa and southern tokoeka are classified as Gradually Declining with the Human Induced and Recruitment Failure qualifiers. The little spotted kiwi is classified as Range Restricted with the Recovering and Human Induced qualifiers.

Archaeological finds and historical evidence show that all species of kiwi were once more widespread than they are today. In the North Island, brown and little

[1] Listed in Hitchmough (2002) under the tag name *Apteryx* (Okarito).

spotted kiwi were found in the Tararuas, Mount Hikurangi and the Kaimanawas, among other places. In the South Island, all four species of kiwi were present when Europeans arrived. Little is recorded about the historical presence of kiwi on offshore islands. Today, overall reports indicate a decreasing kiwi population on the mainland, especially in southern Northland, the Bay of Plenty, western Waikato, Hawke's Bay, and the West Coast.

Of the six taxa, only the little spotted kiwi was increasing in 1996, following several successful transfers to predator-free offshore islands (Colbourne & Robertson 1997). Radio-telemetry studies at a number of unmanaged sites indicate that North Island brown kiwi are declining at a rate of 5.8% per year, mainly due to intense predation of young kiwi in the first six months by stoats and cats (McLennan et al. 1996). Because the main agents of decline are widespread, it is likely that all mainland kiwi taxa are declining at a similar rate, except perhaps at high altitude in the South Island.

1.3 PRIORITY LISTING OF KIWI IN RELATION TO LEVEL OF THREAT

The Kiwi Recovery Group has determined that the following is the priority list for management action based on the level of threat of extinction **without management**, distinctiveness, and effectiveness of current management (most threatened first):

1. Haast tokoeka
2. Okarito brown kiwi/rowi
3. Great spotted kiwi
4. Little spotted kiwi
5. Fiordland West tokoeka (= south)
6. Fiordland East tokoeka (= north)
7. Coromandel North Island brown kiwi
8. Western North Island brown kiwi
9. Bay of Plenty/East Coast North Island brown kiwi
10. Stewart Island tokoeka
11. Northland North Island brown kiwi

While this list clearly directs the need for management of these populations, the requirement for captive husbandry is further determined by the need of each taxon and population to have close order management techniques developed. The priority technique for development is Operation Nest Egg (O.N.E.) for those species most at risk, and those for which little is known about their nature, breeding, and/or their juvenile life stage. It is not intended that any new taxa be held permanently in captivity.

Okarito brown kiwi/rowi have had an extensive period of development of O.N.E., and this technique is well proven as a successful technique for expanding this population quickly.

Haast tokoeka, in contrast (but based on limited data), show all the signs of low productivity and poor recruitment, yet there is currently no confirmed close order technique for their management. This species is a priority for refining O.N.E and potentially captive breeding methods.

Fiordland tokoeka, though numerically still quite strong, are not well studied or understood. While not an immediate priority, this taxon may require close order management in the future.

Very little is known about the great spotted kiwi with regard to its breeding and juvenile life stage. Like the Haast tokoeka, this species is considered to be exceptionally wary and possess particular problems in regard to close order management. While great spotted kiwi are not the highest priority for immediate action, there could be several years of experimentation involved prior to developing effective captive hatching and rearing techniques for these birds.

There is reasonable confidence that O.N.E. techniques for North Island brown kiwi are applicable to all populations with a high chance of success. North Island brown kiwi have been in captivity for several decades and the husbandry of captive adult birds is well advanced.

Little spotted kiwi have expanded rapidly on predator-safe offshore islands and do not require captive husbandry or captive close order techniques.

1.4 REPRODUCTIVE BIOLOGY

Kiwi reproductive behaviour varies widely between (and perhaps within) taxa. The details below for the North Island brown kiwi are taken from Heather & Robertson (1996).

Birds are most vocal in winter and spring. During courtship, a pair often remains together for hours, making loud grunts and snuffling sounds. The male and female of a pair usually feed separately at night but spend about 20% of days together. Pairs are monogamous and persist throughout the year and between years.

Most eggs are laid between June and September, with rowi laying as late as February. Birds lay 1–2 white eggs (125 × 78 mm, 430 g) in either a burrow or hollow log, or sometimes under dense vegetation. In two-egg clutches, the eggs are laid 4–6 weeks apart. Incubation is generally by the male, and the incubation period can range from 70–100 days. Incubating birds develop a brood patch.

The chick hatches fully feathered and remains in the nest for about a week before venturing out unaccompanied. Usually it returns to the nest for several weeks but may stay away for the odd day. Chicks seem to stay close to their natal territory for at least 6–9 months before dispersing to find a vacant territory. Growth continues for at least 24 months.

Incubation times, who incubates, growth rates, and other factors relating to reproductive biology can vary widely between taxa.

1.5 HISTORY OF KIWI IN CAPTIVITY

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

Before 1872
Zoological Society received several other live kiwi, including more North

Island brown kiwi, Southern tokoeka, little spotted and great spotted kiwi (Newton 1893).

1912 Wild-caught North Island brown kiwi first appeared on zoo stock sheets, 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, 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, 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 16 November.

1995 First release of sub-adult North Island brown kiwi from wild-laid eggs brought into captivity (O.N.E.).

O.N.E. involves taking eggs or young chicks from the wild, raising them in captivity, and then returning them to the wild as sub-adult birds, when they are more successful at coping with most introduced predators. The first release of captive-reared chicks took place in 1995 and has been highly successful: the chicks have coped well with the transition (Robertson 2003). Released birds heavier than 1 kg are less likely to be killed by a stoat or a cat, but released birds must still be managed (in terms of advocacy and pest control), especially when they can be reached by domestic dogs and ferrets.

The O.N.E. programme includes North Island brown kiwi and Okarito brown kiwi/rowi. This programme has involved 10 holding institutions, selected according to *how near they are to egg collection sites, existing facilities, and available expertise.*

1.6 PRESENT CAPTIVE KIWI POPULATIONS

1.6.1 North Island brown kiwi

As at February 2003, there were 145 North Island brown kiwi held in captivity: 106 in New Zealand institutions and 39 overseas. The two largest populations were at Westshore (15 birds) and Willowbank (22 birds). See Appendix 3 for a full list of New Zealand holders of North Island brown kiwi.

1.6.2 Great spotted kiwi

As at January 2003, Otorohanga had one male and two female great spotted kiwi. The Alexanders (Arahura Valley) had one female great spotted kiwi.

1.6.3 Little spotted kiwi

As at January 2003, Otorohanga had two male little spotted kiwi.

1.6.4 Okarito brown kiwi (rowi)

As at January 2003, the Alexanders (Arahura Valley) had two male and two female rowi[2].

1.7 MORTALITY AMONG CAPTIVE KIWI

Boardman (1998) described recorded causes of mortality in captive birds. He identified ingestion of foreign bodies, egg-related peritonitis, yolk sac retention and infection, septicaemia, cryptococcosis, aspergillosis, coccidiosis, visceral gout, avian TB, steatitis, and (suspected) biotin/pantothenic acid deficiency, goitre, and lipidosis. Jakob-Hoff (2001) outlined the basic wildlife health profile for North Island brown kiwi, including summaries of physical and physiological parameters, clinical pathology, disease susceptibilities, and documented pathogens and diseases of wild and captive kiwi.

Birds have also died as a result of aggressive exchanges and poisoning. Annual mortality rates among captive birds are between 5–10% in the past five years, which compares with rates of around 3–8% annual mortality in wild birds.

Despite improvements in artificial incubation techniques for kiwi eggs, it is still rare for eggs to hatch when artificially incubated from point of lay. Data on egg fertility and embryo mortality (from Bassett & Potter 1998) are summarised in Appendix 4.

1.8 CAPTIVE MANAGEMENT POLICY

The current threat classification of the six kiwi taxa mean that they fall under the guidelines for Captive Management of Species Absolutely Protected Under the Wildlife Act (DOC 2003). Policy guidelines dictate that kiwi will fall into category 1, which incorporates species where captive management forms an important part of recovery in the wild.

In cases, such as the kiwi, where captive management has been identified as an important component of a threatened protected species recovery strategy, there should be 'close integration between *ex situ* and *in situ* programmes, with captive management designed to support programmes aimed at conserving the species in the wild' (DOC 2003). The holding of category 1 species must be either for:

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[2] These are injured or rescued birds that are unsuitable for release in to the wild.

- Producing stock for re-introduction in to the wild, or
- Providing an insurance where the risk of loss of the protected species in the wild is judged to be significant, or
- Salvaging of the last wild survivors of a protected species or a key population which cannot currently be maintained in the wild, or
- Providing individuals for research or development of techniques designed to assist conservation of threatened protected species in the wild. (This includes research using analogue species.)

2. Context, goal, and objectives of kiwi captive management

2.1 CONTEXT OF CAPTIVE MANAGEMENT

2.1.1 Kiwi recovery plan

The long-term goal of kiwi recovery, as stated in the 1996–2006 Recovery Plan (Robertson 2003) is:

- To maintain, and where possible, enhance the current abundance, distribution and genetic diversity of kiwi.

The following excerpts from the recovery plan directly involve captive breeding as a requirement for achieving this goal. Note that all aspects of the recovery plan have implications for captive management, and that birds in captive populations will benefit from outcomes in addition to those listed below.

Topic 1—Tangata whenua

Objective—Iwi are involved at all levels of kiwi research and management in an interactive way and in a way appropriate to all parties' commitments and expectations under the Treaty of Waitangi, taking particular note of the requirements of the Ngäi Tahu Claims Settlement Act 1998.

Action 1.3: Ensure that the Department acts in synergy with tangata whenua to maintain open communication about, and involvement in kiwi management and research, welcoming and respecting contributions from tangata whenua. (Priority 1)

Accountability: Kiwi Co-ordinator, Operations and Planning (Conservancies, Kiwi Co-ordinator, Research and Monitoring, SRU).

Topic 2—Communities

Objective—Communities are empowered to protect kiwi by the sharing of knowledge and best management practices amongst all individuals and organisations concerned with this protection.

Action 2.5: Encourage captive-breeding institutions to present accurate information on kiwi and their conservation. (Priority 2)

Accountability: External Relations Division (Conservancies).

Topic 6—Maximising productivity of wild-laid eggs in captivity

Objective—Tools are developed to maximise productivity of wild-laid eggs in captivity.

Action 6.1: Undertake research to identify the social systems of all kiwi, especially their incubation regimes. (Priority 1)

Accountability: Kiwi Co-ordinator, Research and Monitoring (SRU).

Action 6.2: Develop *ex situ* egg and chick handling protocols to maximise productivity and minimise disease risk. (Priority 1)

Accountability: Kiwi Co-ordinator, Research and Monitoring (SRU, captive-rearing institutions, Conservancies).

Action 6.3: Monitor the fate of captive-reared chicks released into the wild and establish locally appropriate protocols to maximise survivorship. (Priority 1)

Accountability: Kiwi Co-ordinator, Research and Monitoring (Conservancies).

Action 6.4: Determine the average annual egg production, recruitment and survival of adult females with and without egg-cropping. (Priority 3)

Accountability: Kiwi Co-ordinator, Research and Monitoring (SRU).

Action 6.5: Assess the genetic diversity of the captive-reared wild kiwi. (Priority 1)

Accountability: Kiwi Co-ordinator, Research and Monitoring (SRU).

Topic 7—Captive breeding

Objective—Captive institutions produce surplus kiwi progeny for release.

Action 7.1: Develop and adopt a captive management plan for kiwi. (Priority 1)

Accountability: Kiwi Co-ordinator, Operations and Planning (captive-rearing institutions).

Action 7.2: Refine kiwi husbandry techniques, especially to reduce mortality of adult females and chicks. (Priority 2)

Accountability: Kiwi Co-ordinator, Operations and Planning (Conservancies, SRU).

Action 7.3: Assess health status of birds in captivity and in the wild to identify health normals and successful treatments for sublethal diseases. (Priority 2)

Accountability: Kiwi Co-ordinator, Research and Monitoring (SRU, captive-rearing institutions, Conservancies).

Action 7.4: Bring further taxa into captivity to establish husbandry protocols for all taxa. (Priority 3)

Accountability: Kiwi Co-ordinator, Operations and Planning (SRU, captive-rearing institutions).

Action 7.4: Determine what, if any, captive breeding programme is required for release into the wild, and identify kiwi captive breeding targets. (Priority 3)

Accountability: Kiwi Co-ordinator, Operations and Planning (SRU, captive-rearing institutions).

2.1.2 Long-term management of kiwi in captivity

At this stage, captive populations of the three management units of North Island brown kiwi being held in captivity need to be managed separately. Hybrids will be progressively replaced by pure provenance birds. Where possible, O.N.E. birds will be used. Long-term captive populations for other kiwi taxa will be established only if North Island brown kiwi are not suitable as an analogue for all kiwi taxa.

2.2 GOAL OF CAPTIVE MANAGEMENT

The goal of this captive management plan is to contribute to the conservation and maintenance, in the wild, of the six taxa of kiwi.

2.3 OBJECTIVES OF CAPTIVE MANAGEMENT

To achieve the goal of captive management, a number of objectives need to be achieved during the life of this plan. These are set out below.

- Develop and maintain skills through all institutions to be able to deliver a surplus of any kiwi taxon.[3]
  Outcome: Skills exist to breed any taxon in captivity.
- Use the skills held by the institutions to produce a surplus of pure provenance kiwi for release, for the best advantage of kiwi populations in the wild.
  Outcome: Wild kiwi populations established or enhanced.
- Develop and deliver current information about the plight of kiwi and how people can help to conserve them.
  Outcome: More people actively participate in the protection of kiwi and the broader New Zealand natural ecosystem.
- Provide opportunities to increase scientific knowledge of kiwi.
  Outcome: An increased knowledge of kiwi.

Achieving the objectives of the captive management plan will relate directly to performance of the actions listed in Topic 7 of the Kiwi Recovery Plan (Robertson 2003).

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[3] These skills will be developed and maintained through breeding of North Island brown kiwi.

2.4 TIME FRAME OF CAPTIVE MANAGEMENT PLAN

This captive management plan will have a 10-year duration and will be reviewed five years after publication. A review of Appendix 2 will be undertaken annually.

Progress will be reported annually to the Kiwi Recovery Group meeting. Recommendations about captive management from the Recovery Group will be actioned by the Kiwi Captive Management Advisory Committee. Annual work plans will be produced, as required.

3. Captive management strategy

The paragraphs in this section outline the strategies that will be taken to achieve the objectives of this captive management plan. Individual strategies may work towards achieving multiple objectives.

3.1 GENETIC MANAGEMENT

The captive populations identified for long-term captive management are to be managed to maintain at least 90% of the genetic variability found in the corresponding wild populations. This is to be achieved through selectively breeding for optimal gene diversity within the captive population, and periodically introducing new founders from wild populations. Genetic management strategies to be used are as follows:

- Where captive breeding is required, breeding from birds determined to be genetically suitable through pedigree analysis. Under current methodology this involves preferentially breeding from birds with low and similar mean kinship values that will produce offspring not inbred, or inbred to a level less than F = 0.125.
- Where new founders are to be added to the captive population, that these represent a random sample from the relevant wild populations.

The captive populations will be managed to ensure pure birds of each management unit of North Island brown kiwi will be available for release into the wild, should this be required.

3.2 LONG-TERM CAPTIVE POPULATIONS

Ten pure pairs of each of the three provenances of North Island brown kiwi existing in captivity are required in the next 10 years as a starting point for each captive population. This should be achieved from within current stock capabilities, or by incorporating ‘rescue’ or O.N.E. birds into the captive

population, as they become available. This should be a managed process, including phasing out of 'hybrid' birds and the return of any surplus birds of known provenance to the wild.

The three provenances currently in captivity are considered adequate analogues for the Coromandel provenance, and birds of that taxon will not be brought into captivity unless managed populations are demonstrated to be in decline.

3.3 RESEARCH

3.3.1 Captive management issues

The mortality rate of captive adult kiwi is higher than that of wild adults, despite the absence of predators in captivity. Captive-reared birds are often smaller than wild birds from the same provenance, so too are their eggs. Research is therefore needed on the nutrition and diets, physical and physiological parameters, clinical pathology and disease susceptibilities of captive versus wild birds.

Other key research questions relevant to captive management are associated with improving reproductive management techniques. The success of O.N.E. depends on reliable incubation and rearing techniques. The long-term viability of captive populations will depend on the ability to breed from captive adults. Such reproductive techniques are poorly known in some kiwi taxa.

3.3.2 Operation Nest Egg

Techniques for hatching and raising Okarito brown kiwi / rowi and North Island brown kiwi are already well known. However, Haast tokoeka, Southern tokoeka and great spotted kiwi have not yet been reliably hatched and raised in captivity, and are the highest priority for such research.

DOC will set priorities for O.N.E. research work programmes, and will invite captive institutions to be involved on the basis of criteria that will be set out in those programmes. Holding of any kiwi from taxa involved in such research is likely to be for the duration of such research only.

3.3.3 Adult breeding

There are currently no plans to establish long-term captive populations of taxa other than the North Island brown kiwi. Captive breeding in this species has been well established. However, this plan aims to ensure that captive breeding capability exists for all kiwi taxa. Haast tokoeka, Southern tokoeka, Okarito brown kiwi/rowi and great spotted kiwi have not been regularly bred in captivity, and therefore these taxa are the highest priority for adult breeding research.

DOC will set priorities for adult breeding research work programmes, and will invite captive institutions to be involved on the basis of criteria that will be set out in those programmes. Holding of any kiwi from taxa involved in such research is likely to be for the duration of such research only.

3.4 COLLECTION FROM THE WILD

No collection from the wild of North Island brown kiwi will occur for captive management purposes, except for O.N.E. and injured birds. Other taxa will be collected for O.N.E and will be maintained in captivity long enough to establish techniques to raise and maintain in captivity. The other taxa will be released if North Island brown kiwi are a suitable analogue.

3.5 BIRDS HELD ABROAD

It is recommended that a separate management plan be developed for the population of kiwi held abroad. The aim of such a plan would be to ensure that the population remains viable without requiring excessive, on-going supplementation from New Zealand. It is not envisaged that captive kiwi held abroad will return to New Zealand, because of disease risks.

4. Programme administration

The Kiwi Captive Management Advisory Committee consists of the following members:

Joint Captive Co-ordinators	Tracy Johnson Ian Fraser	Kiwi Management Services ARAZPA
Husbandry Advisor	Murray Potter	Massey University
Wild Population Management Advisor	John McLennan	Landcare Research
Kiwi Recovery (Research) Co-ordinator	Hugh Robertson	Department of Conservation
Kiwi Recovery (Operations and Planning) Co-ordinator	Paul Jansen	Department of Conservation
Diet Advisor	Don Thomas	Massey University
Captive Advisor(Committee Chairman)	Tony Billing	Westshore Wildlife Reserve
Small Population Management Advisor	Ian Fraser	ARAZPA

Other people may be drawn in to advise as the need arises.

5. Contingency plan

This section sets out the measures to be taken if kiwi die in captivity, along with some other requirements that may be suitable for inclusion in permits to hold kiwi.

5.1 GENERAL REQUIREMENTS

- All birds in captivity must be permanently identifiable, i.e. sexed, measured and banded by a DOC officer (or authorised staff member). Accurate records must be kept pertaining to their history in captivity.
- Kiwi and all enclosures in which they are held, and all records pertaining to kiwi, shall be made available for inspection at all reasonable times by DOC officers.
- Vet services and facilities are to be made available at all reasonable times and all records of vet treatment must be kept and made available to DOC officers if requested.
- Issues of quarantine and disease in captivity should be addressed according to the existing protocols in the Kiwi Best Practice Manual.
- Please note that kiwi (alive or dead), and any parts thereof including feathers and eggs may only be disposed of as directed by your local DOC Area Manager. Kiwi may be repossessed by DOC at any time.

5.2 KIWI DEATHS

Any deaths of kiwi in captivity must be notified to the local DOC Area Manager immediately, and should also be notified to the kiwi captive management co-ordinators (Tracy Johnson) within two working days of the deaths occurring.

The body of any dead bird should be immediately placed in cold storage (do not freeze), and sent to an appropriate veterinary or laboratory facility for a complete necropsy. Recommended providers for kiwi necropsy can be found in the Kiwi Best Practice Manual. A 'Kiwi Deaths' data sheet should be completed. Copies of any documentation relating to the death (e.g. autopsy results, kiwi deaths data sheet) should be sent to DOC and to the kiwi captive management co-ordinator(s). Please refer to the Kiwi Best Practice Manual (section 9) for more information on dealing with dead kiwi. After necropsy, the body should be deep frozen and returned to your local DOC office.

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Appendix 1

SUMMARY AND ANALYSIS OF NORTH ISLAND BROWN KIWI STUDBOOK DATA

This section is based on the format of a Captive Management Plan for level 1a (intensive genetic management) programs in the Australasian Species Management Program (ASMP) as administered by the Australasian Regional Association of Zoological Parks and Aquaria (ARAZPA) (Lees & Wilcken 2002).

Taxon

Taxon (scientific name)—*Apteryx mantelli*

Common name—North Island brown kiwi

TAG—NZ Fauna TAG

Taxonomic concerns—None

Captive management unit—Currently divided into four provenance populations: Northland, Taranaki, East Coast / Bay of Plenty, Coromandel. Several hybrid birds currently in captive population.

Scope of managed population—Captive population in New Zealand institutions (excluding O.N.E. birds)

Statement of purpose

See Section 2.2 of this document.

History in captivity

See Section 1.5 of this document.

Programs in other regions

Although 41 (22.13.6) North Island brown kiwi are held in overseas institutions, mostly in Europe and the United States, there are no overseas species management programs for kiwi. As time allows (but before December 2004), genetic and demographic analysis of the overseas kiwi population will be carried out and recommendations regarding best pairings and other parameters will be made. Birds held overseas are beyond the control of the Department of Conservation (DOC). The largest holdings are at San Diego Zoo (8 birds) and Frankfurt Zoo (11 birds).

Data compilation and analysis

Software used:	Package	Version	Author, date
	SPARKS	1.52	ISIS, 26/8/2002
	PM2000	1.175	J.P. Pollak, R.C. Lacy, J.D. Ballou. 2000. Chicago Zoological Society.

Studbook data

Studbook compiled by:	Tracy Johnson
Scope of data:	International
Date first compiled:	1993[4]
Data now current to:	12 March 2003

TABLE A1.1 OVERVIEW OF STUDBOOK DATA (ALL RECORDS INCLUDING OVERSEAS BIRDS).

		NO. OF SPECIMENS (MALE.FEMALE.UNKN SEX)	TOTAL	PERCENTAGE OF TOTAL
Totals	Specimens in studbook	(147.142.96)	385	100%
	Living specimens	(76.53.18)	147	38.2%
Sex	Total females		142	36.9%
	Living females		53	36.1%*
	Total males		147	38.2%
	Living males		76	51.7%*
	Total unknown		96	24.9%
	Living unknown		18	12.2%*
Origins	Captive born	(103.91.96)	290	75.3%
	Wild born	(44.51.0)	95	24.7%
	Unknown origin		0	0%
Rearing	Hand-reared	(21.32.25)	78	20.3%
	Parent-reared	(71.73.24)	168	43.6%
	Rearing unknown	(55.37.47)	139	34.9%
Parentage	Number of founders (both parents 'WILD')	(45.51.0)	96	24.9%
	Living number of founders (both parents 'WILD')	(19.10.0)	29	19.7%*
	Parents known (identified by studbook no. or as 'WILD')		748	97.1%
	Multiple possible parents (listed as 'MULT...')		0	0%
	Parents unknown (listed as 'UNK')		22	2.9%
Birth dates	Known or estimated		302	78.4%
	Unknown		83	21.6%

* Percentage of total living.

[4] Ron Goudswaard at Wellington Zoo initially began compiling a kiwi studbook in 1987.

TABLE A1.2. OVERVIEW OF PROVENANCE (INCLUDING HYBRID) POPULATIONS.

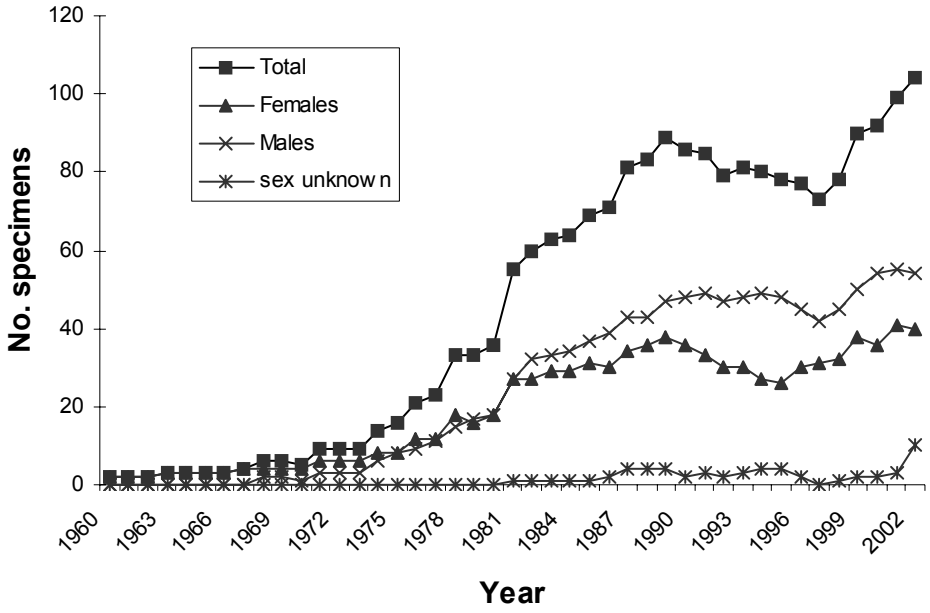
	COMPLETE STUDBOOK	ALIVE AT 12 MARCH 2003 AND IN A NZ CAPTIVE INSTITUTION
Northland		
Female	37	6
Male	55	11
Unknown	27	1
Total	119	18
East Coast/ Bay of Plenty		
Female	30	8
Male	32	14
Unknown	15	2
Total	77	24
Taranaki		
Female	22	5
Male	10	6
Unknown	8	1
Total	40	12
Unknown or hybrid origin		
Female	52	20
Male	50	24
Unknown	47	8
Total	147	52
GRAND TOTAL	385	106

Appendix 2

DEMOGRAPHIC REVIEW OF CAPTIVE NORTH ISLAND BROWN KIWI

Annual census

Data restricted to: Specimens in captivity in New Zealand—all provenances.



Graph 1. Annual census of the New Zealand captive population of North Island brown kiwi. Note: Census figures include changes in numbers resulting from animals being brought from and released to the wild, in addition to births and deaths in captivity.

The studbook indicates that the captive population in New Zealand has been growing over the last 30 years. Some of this growth may not be real; often with studbook data the small numbers in the early years are a reflection not of the populations existing at the time, but of an absence of zoo records for that period. However, the trend over at least the past 10–15 years is likely to reflect reality. Though there are 95 wild captures recorded in the studbook, growth has been mainly due to the 290 captive births.

Recent developments in the captive population

Data restricted to New Zealand captive population of North Island brown kiwi.

TABLE A2.1. DEVELOPMENTS IN THE CAPTIVE POPULATION OF NORTH ISLAND BROWN KIWI, NORTHLAND PROVENANCE (1999–2003).

	1999	2000	2001	2002	2003*	TOTAL
Population size 1 Jan.	21	19	20	20	18	
Acquisitions						
Hatches	1	1	1	2	0	5
Captures from wild	0	0	0	0	0	0
Total acquisitions	1	1	1	2	0	5
Dispositions						
Deaths (total no.)	3	0	1	2	0	6
(Neonatal deaths)†	(0)	(0)	(0)	(1)	(0)	(0)
Exports	0	0	0	0	0	0
Releases	0	0	0	2	0	2
Lost-to-follow-up	0	0	0	0	0	0
Total dispositions	3	0	1	4	0	8
Population size 31 Dec.	19	20	20	18	18*	

* Population size at 12 March 2003. For 2003, the cut-off date is 12 March and not 31 December —this is the last date to which studbook data were current.

† Deaths occurring within 30 days of birth.

TABLE A2.2. DEVELOPMENTS IN THE CAPTIVE POPULATION OF NORTH ISLAND BROWN KIWI, EAST COAST/BAY OF PLENTY PROVENANCE (1999–2003).

	1999	2000	2001	2002	2003*	TOTAL
Population size 1 Jan.	14	15	18	21	23	
Acquisitions						
Births	2	4	3	2	1	12
Captures from wild	0	0	0	0	0	0
Total acquisitions	2	4	3	2	1	12
Dispositions						
Deaths (total no.)	1	0	0	0	0	1
(Neonatal deaths)†	(0)	(0)	(0)	(0)	(0)	(0)
Exports	0	0	0	0	0	0
Releases	0	1	0	0	0	1
Lost-to-follow-up	0	0	0	0	0	0
Total dispositions	1	1	0	0	0	2
Population size 31 Dec.	15	18	21	23	24*	

* Population size at 12 March 2003. For 2003, the cut-off date is 12 March and not 31 December—this is the last date to which studbook data were current.

† Deaths occurring within 30 days of birth.

TABLE A2.3. DEVELOPMENTS IN THE CAPTIVE POPULATION OF NORTH ISLAND BROWN KIWI, TARANAKI PROVENANCE (1999–2003).

	1999	2000	2001	2002	2003*	TOTAL
Population size 1 Jan.	15	15	11	10	12	
Acquisitions						
Births	2	1	2	1	0	6
Captures from wild	0	0	0	2	0	2
Total acquisitions	2	1	2	3	0	8
Dispositions						
Deaths (total no.)	2	5	1	1	0	9
(Neonatal deaths)†	(0)	(0)	(0)	(0)	(0)	(0)
Exports	0	0	0	0	0	0
Releases	0	0	2	0	0	2
Lost-to-follow-up	0	0	0	0	0	0
Total dispositions	2	5	3	1	0	11
Population size 31 Dec.	15	11	10	12	12*	

* Population size at 12 March 2003. For 2003, the cut-off date is 12 March and not 31 December—this is the last date to which studbook data were current.

† Deaths occurring within 30 days of birth.

TABLE A2.4. DEVELOPMENTS IN THE CAPTIVE POPULATION OF NORTH ISLAND BROWN KIWI, UNKNOWN AND HYBRID PROVENANCE (1999–2003).

	1999	2000	2001	2002	2003*	TOTAL
Population size 1 Jan.	29	42	44	49	52	
Acquisitions						
Births	17	8	9	7	2	43
Captures from wild	0	0	0	0	0	0
Total acquisitions	17	8	9	7	2	43
Dispositions						
Deaths (total no.)	4	6	4	4	1	19
(Neonatal deaths)†	(1)	(0)	(0)	(0)	(1)	(2)
Exports	0	0	0	0	0	0
Releases	0	0	0	0	0	0
Lost-to-follow-up	0	0	0	0	0	0
Total dispositions	4	6	4	4	1	19
Population size 31 Dec.	42	44	49	52	53	

* Population size at 12March 2003. For 2003, the cut-off date is 12 March and not 31 December—this is the last date to which studbook data were current.

† Deaths occurring within 30 days of birth.

From the tables above it appears that while the hybrid and East Coast/Bay of Plenty populations have grown significantly over the last four years, the Taranaki and Northland populations have decreased slightly. This may reflect deliberate restraints on breeding, or alternatively a lack of breeding success in those institutions holding Taranaki and Northland stock.

Reproduction

Sample sizes for the different sub-populations are too small to be useful for deriving provenance-specific life-history data. It seems reasonable to assume that general life-history characteristics will not vary between provenances, and so the data has been combined for the purpose of demographic analyses.

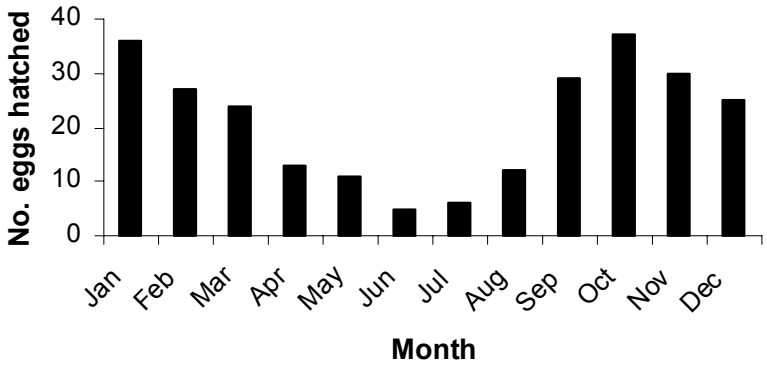
Note: Unfortunately, very few births in the studbook can be attributed to animals of known age (301 births attributed to unknown age parents, 11 births attributed to UNK or MULT parents = 367% of the births attributed to known age parents). With such a small sample size of reproductive data, conclusions about reproductive parameters should be treated with caution.

Seasonality

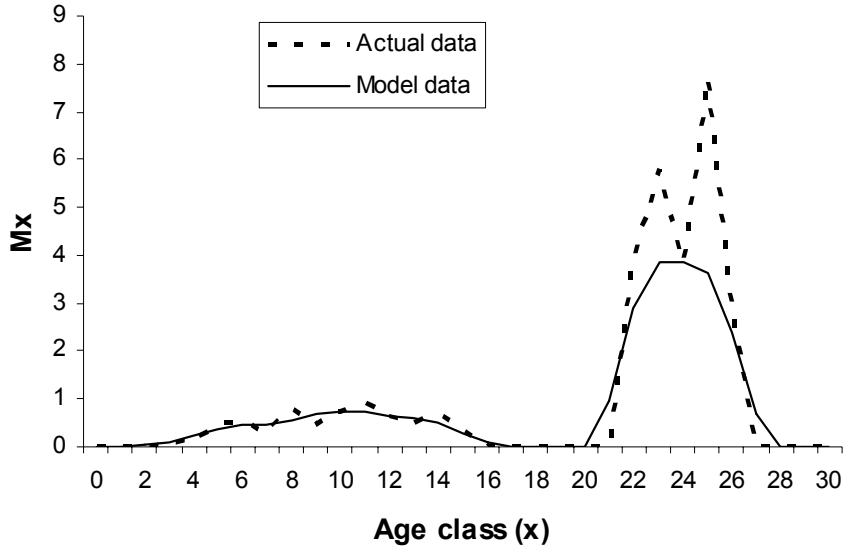
Elsewhere in this report it states that most eggs are laid between June and September. Most captive hatches occur between September and March. Assuming a gestation period of 85 days, this would indicate that in captivity, most eggs are laid June to December.

As already mentioned in Section 1.4, the species is monogamous and pairs persist throughout the year and between years.

Graph 2. Seasonality in New Zealand captive population of North Island brown kiwi.



Graph 3. Age-specific fecundity (Mx) in female North Island brown kiwi: Actual *versus* model data.



Graph 4. Age-specific fecundity (Mx) in male North Island brown kiwi: Actual *versus* model data.

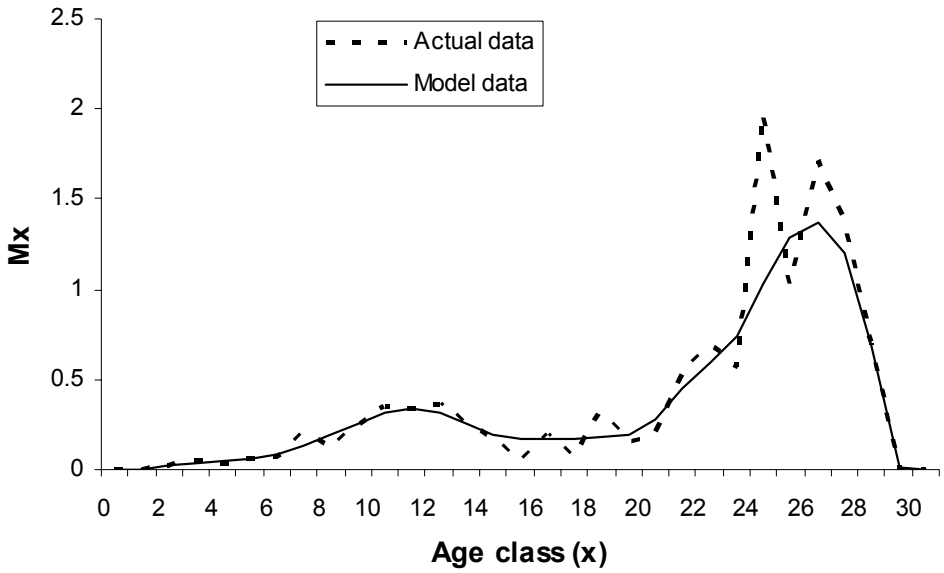
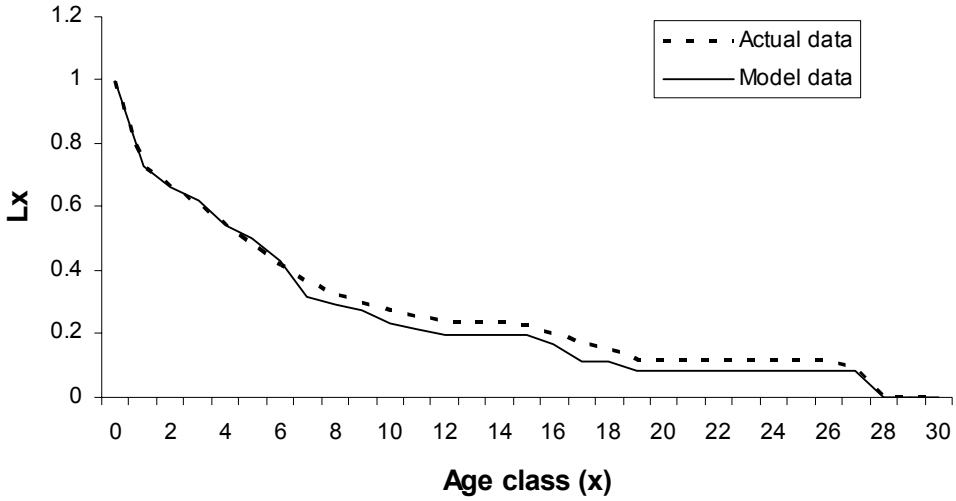


TABLE A2.5. REPRODUCTIVE PARAMETERS FROM STUDBOOK DATA.

FEMALES	
Age range of possible reproduction (age of youngest (with known hatch date) and oldest animals recorded breeding)	3 yr 9 months to 29 yr 10 months
Age range of peak reproduction (age classes for which average (median) Mx value is exceeded)	5 to 15 and 22 to 26 yr
MALES	
Age range of possible reproduction (age of youngest and oldest animals recorded breeding)	2 yr, 3 months to 27 yr, 11 months
Age range of peak reproduction (age classes for which average (median) Mx value is exceeded)	7 to 28 yr (except year 8, 14, 15, 17, 19 and 20)

Mortality

Graph 5. Survivorship (Lx) in female North Island brown kiwi: Actual *versus* model data.



Graph 6. Survivorship (Lx) in male North Island brown kiwi: Actual *versus* model data. Note: Oldest male is 28 years old and still alive (stbk no. 31).

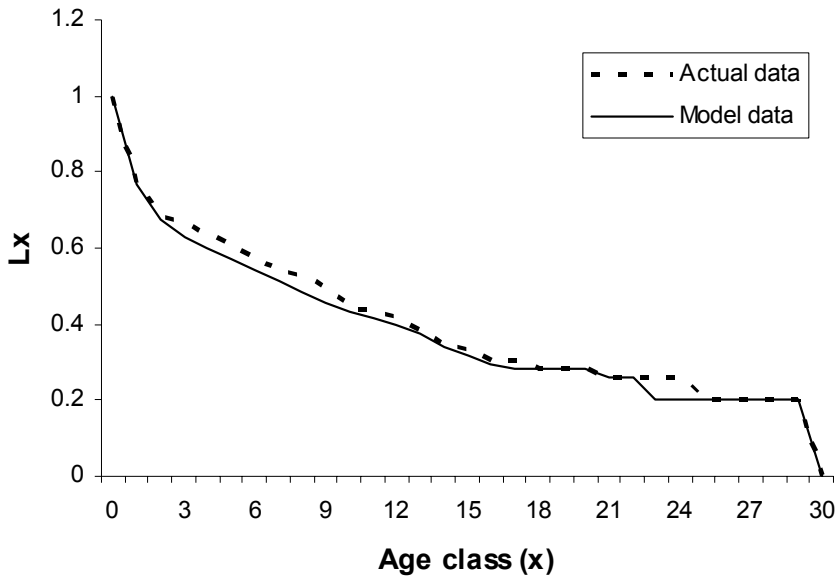


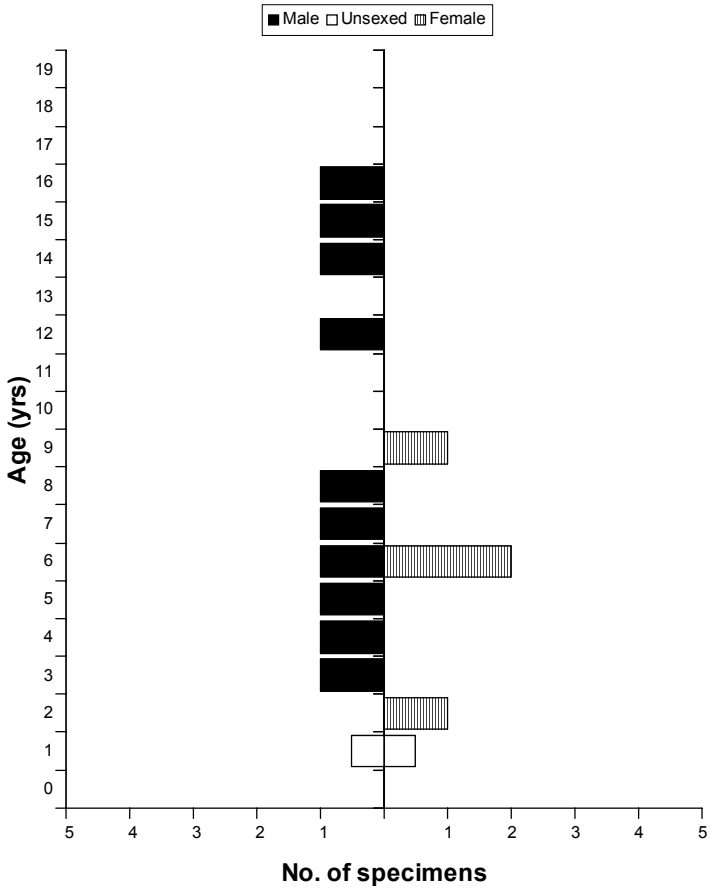
TABLE A2.6. SUMMARY OF MORTALITY DATA FROM STUDBOOK.

FEMALES	
juvenile mortality (% dying in first 2 yr)	26%
Average life expectancy of adults (median age at death of animals surviving juvenile age classes)	12 yr
Maximum longevity (age at death of oldest animal in studbook or current age of oldest living animal if greater)	33 yr*
MALES	
juvenile mortality (% dying in first yr)	23%
Average life expectancy of adults (median age at death of animals surviving juvenile age classes)	18 yr
Maximum longevity (age at death of oldest animal in studbook or current age of oldest living animal if greater)	28 yr

* Female no. 5 (blind female) wild-caught and transferred to Wellington Zoo on 1 January 1960, died at Nga Manu Trust 1 January 1993 aged at least 33 years.

The life histories of male and female birds are similar, with females in general dying earlier than males. Juvenile mortality is about the same in both sexes, with approximately one in four animals dying before adulthood.

Age structure and sex ratio

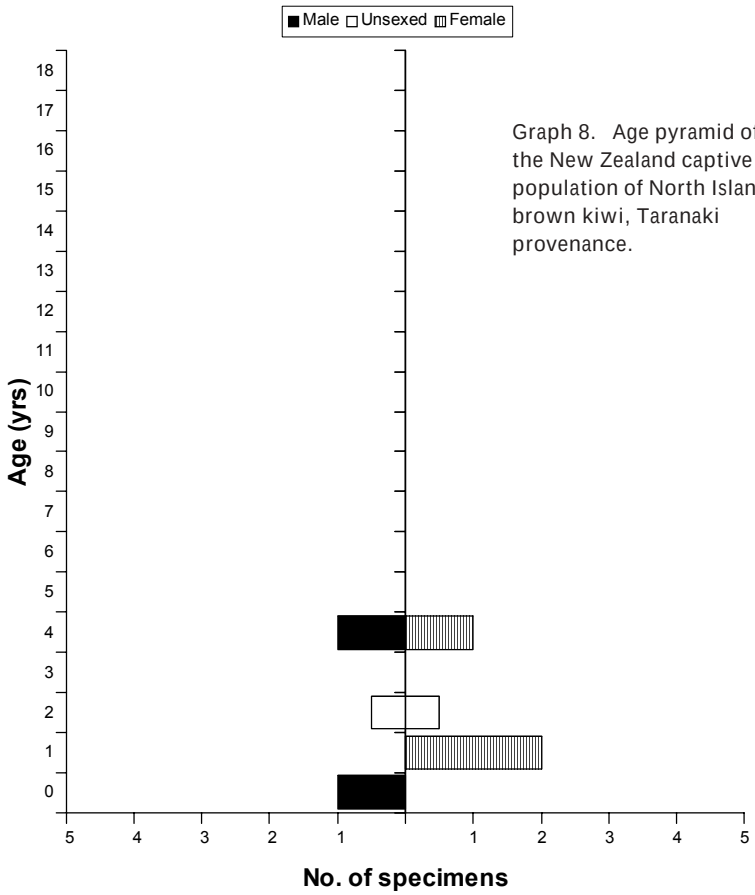


Total living: 11.6.1 (18)

In addition to the specimens represented in Graph 7 are:

- One male specimen of unknown age (minimum 22 years old)
- Two female specimens of unknown age (minimum ages 19 and 22 years old)

Graph 7. Age pyramid of the New Zealand captive population of North Island brown kiwi, Northland provenance.

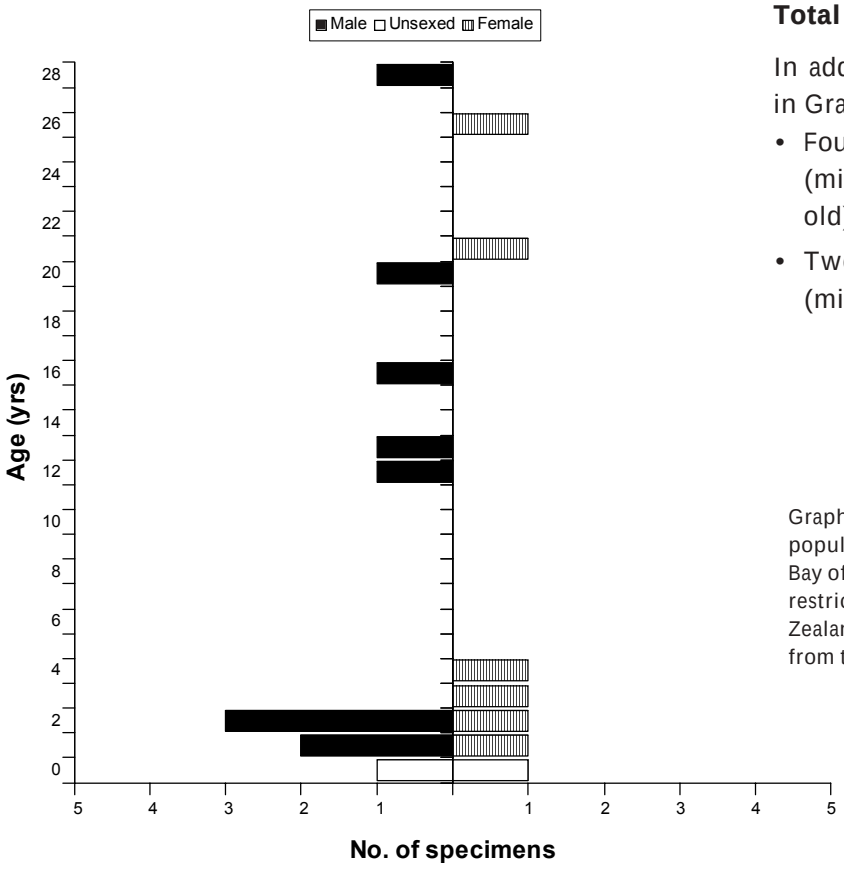


Graph 8. Age pyramid of the New Zealand captive population of North Island brown kiwi, Taranaki provenance.

Total living: 5.5.1 (11)

In addition to the specimens represented in Graph 8 are:

- Three male specimens of unknown age (minimum ages 15, 21 and 22 years old)
- Two female specimens of unknown age (minimum ages 7 and 22 years old)

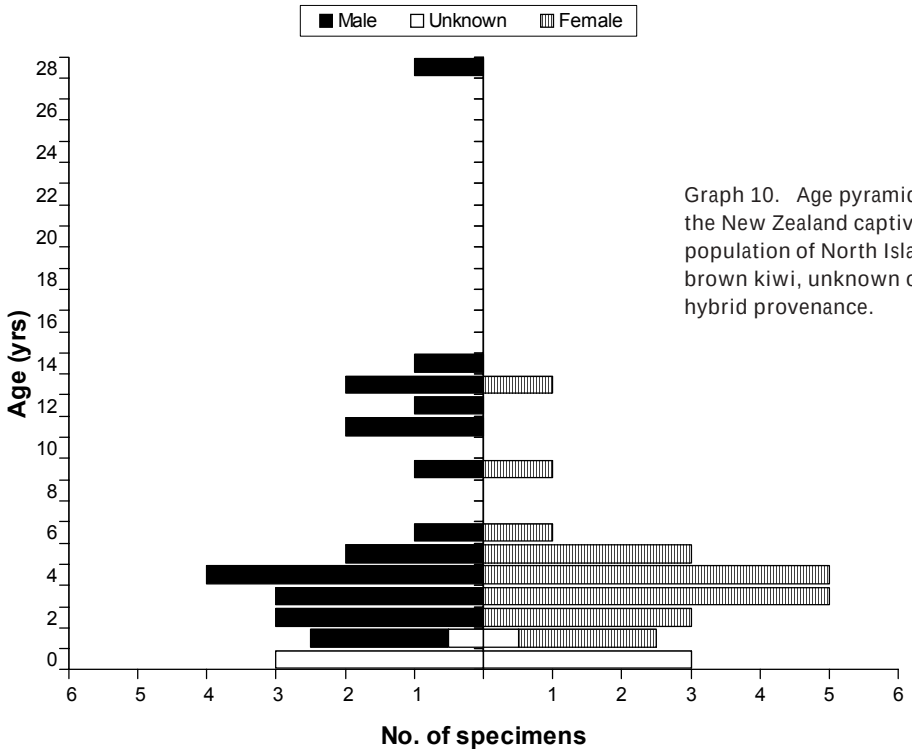


Total living: 14.8.2 (24)

In addition to the specimens represented in Graph 9 are:

- Four male specimens of unknown age (minimum ages 8, 11, 18, and 24 years old)
- Two female specimens of unknown age (minimum ages 10 and 18 years old)

Graph 9. Age pyramid of the New Zealand captive population of North Island brown kiwi, East Coast/ Bay of Plenty (BOP) provenance. Note: Data restricted to Specimens currently living in New Zealand, East Coast provenance. BOP is omitted from this restriction.



Graph 10. Age pyramid of the New Zealand captive population of North Island brown kiwi, unknown or hybrid provenance.

Total living: 24.21.8 (53)

In addition to the specimens represented in Graph 10 are:

- Two male specimens of unknown age (minimum age 25 years old)

TABLE A2.7. CURRENT REGIONAL POPULATION SIZE COMBINED PROVENANCES (INCLUDING HYBRIDS AND UNKNOWNS AS AT 12 MARCH 2003).

ZOO	CURRENT			PLANNED*			TIMELINE
	MALE	FEMALE	UNKN	MALE	FEMALE	UNKN	
Auckland	2	3	0				
Kaitaia Nocturnal Park	2	0	0				
Jacquie Grant's Eco Centre	3	0	3				
Maori Arts and Crafts Institute	4	3	0				
Mount Bruce	0	2	0				
Northern Museum	1	0	0				
Orana Park	4	2	0				
Otorohanga	7	5	1				
Nga Manu Trust	2	0	0				
Isaac's Wildlife Trust	2	1	0				
Queenstown	4	3	0				
Rainbow	3	3	1				
Wellington	3	2	0				
Willowbank	8	12	5				
Westshore	8	5	2				
TOTAL	53	41	12	30*	30*	33*	8 yr (approx.)

* Details of planned kiwi holdings for each institution shall be completed after a survey of holders to be completed before 31 December 2003. Data in this table complete as at 24 June 2003.

Northland provenance

Genetic status

Pedigree assumptions

Birds excluded:
206 (Ipo-R31928—Otorohanga, due to 50% unknown pedigree)
104 (Walk thru female R25635, due to age and previous breeding problems)

Number of specimens requiring assumed sires and/or dams (only include animals impacting on the living population; include all UNKs treated as founders): Nil

Proportion of ancestry traced to founders in studbook: 100%

Summary of results

Number of gene drop iterations: 1000

Data restricted to: Northland provenance, living in New Zealand at 31 March 2002

Founders:

Number of known founders: 8

Number of known potential founders (i.e. known wild-caught animals yet to breed): 0 additional

Living descendants: 12

Current population: 14

Gene diversity:

Fraction of gene diversity retained (GD): 0.8715

Founder Genome Equivalents (FGE): 3.89
Potential fraction of gene diversity retained (if founder skew was adjusted) (potential GD): 0.9118
Potential Founder Genome Equivalents (potential FGE): 5.67

Inbreeding:

Mean inbreeding co-efficient (F): 0.000

Mean kinship:

Descendent population mean kinship (expected mean F of next generation if pairings are random): 0.1285
(Note: usual inbreeding threshold for ASMP programs is 0.125)

Population projections

TABLE A2.8. PLANNED REGIONAL POPULATION SIZE.

ZOO	CURRENT			PLANNED*			TIMELINE
	MALE	FEMALE	UNKN	MALE	FEMALE	UNKN	
Auckland	1	2	0				
Kaitaia Nocturnal Park	1	0	0				
Maori Arts and Crafts Institute	1	1	0				
Orana Park	1	0	0				
Otorohanga	3	1	0				
Isaac's Wildlife Trust	1	1	0				
Rainbow	0	0	1				
Wellington	1	1	0				
Willowbank	1	0	0				
Westshore	1	0	0				
TOTAL	11	6	1	10*	10*	13*	

* Details of planned kiwi holdings for each institution shall be completed after a survey of holders to be completed before 31 December 2003. Data in this table complete as at 24 June 2003.

Implications of planned population size

Population growth:

Estimated time to achieve planned population size through breeding (based on current growth rate (lambda of 1.094) from current population and planned immigration (below): 5 yr

Number of births/hatchlings required per year to attain zero population growth once planned population size is reached: 2.8

Viability:

Expected length of time over which the population will retain 90% of the gene diversity within the (wild) source population without further immigration: 0 yr
Current GD less than 90%

Target population characteristics

Goals for population management: *Rearing 2.8 chicks per annum.*
Retention of 90% gene diversity at end of 50 yr

Population size needed (if assume population growth rate = 1.2, FGE per new founder = 0.6, Ne/N ratio = 0.3): Approx. 33

Available captive space: 33 spaces

Immigration required (imports/collection from wild): Yes. 3 new founders every 5 yr

Taranaki provenance

Genetic status

Pedigree assumptions

Number of specimens requiring assumed sires and/or dams (only include animals impacting on the living population; include all UNKs treated as founders): Nil

Proportion of ancestry traced to founders in studbook: 100%

Summary of results

Number of gene drop iterations: 1000

Data restricted to: Taranaki provenance, living in New Zealand at 31 March 2002, males aged < 28 years, females aged < 25 years

Founders:

Number of known founders: 5

Number of known potential founders (i.e. known wild-caught animals yet to breed): 1 additional

Living descendants: 5

Current population: 10

Gene diversity:

Fraction of gene diversity retained (GD): 0.8300

Founder Genome Equivalents (FGE): 2.54

Potential fraction of gene diversity retained (if founder skew was adjusted) (potential GD): 0.9130

Potential Founder Genome Equivalents (potential FGE): 5.74

Inbreeding:

Mean inbreeding co-efficient (F): 0.000

Mean kinship:

Descendent population mean kinship (expected mean F of next generation if pairings are random): 0.1700

(Note: usual inbreeding threshold for ASMP programs is 0.125)

Population projections

TABLE A2.9. PLANNED REGIONAL POPULATION SIZE.

	CURRENT			PLANNED*			
ZOO	MALE	FEMALE	UNKN	MALE	FEMALE	UNKN	TIMELINE
Maori Arts and Crafts Institute	2	1	0				
Orana Park	0	1	0				
Otorohanga	2	3	1				
Wellington	1	1	0				
TOTAL	5	6	1	10*	10*	33*	

* Details of planned kiwi holdings for each institution shall be completed after a survey of holders to be completed before 31 December 2003. Data in this table complete as at 24 June 2003.

Implications of planned population size

Population growth:

Estimated time to achieve planned population size through breeding (based on current growth rate (lambda of 1.082) from current population and planned immigration (below)	8 yr
Number of births/hatchlings required per year to attain zero population growth once planned population size is reached	2.8

Viability:

Expected length of time over which the population will retain 90% of the gene diversity within the (wild) source population without further immigration	0 yr Current GD less than 90%

Target population characteristics

Goals for population management:	*Rearing 2.8 chicks per annum. Retention of 90% gene diversity at end of 50 yr*
Population size needed (if assume population growth rate=1.2, FGE per new founder =0.6, Ne/N ratio=0.3):	Approx. 20
Available captive space:	33 spaces
Immigration required (imports/collection from wild):	Yes. 1 new founder every year (or 2 founders every 2 years, etc.)

East Coast/Bay of Plenty Provenance

Genetic status

Pedigree assumptions

Birds excluded:

257 (Percy—Jackie Grant's Eco World, amputee)

81 (Te Kaha—Rainbow, long term egg production problems)

Number of specimens requiring assumed sires and/or dams (only include animals impacting on the living population; include all UNKs treated as founders):	Nil
Proportion of ancestry traced to founders in studbook:	100%

Summary of results

Number of gene drop iterations:	1000
Data restricted to:	East Coast / Bay of Plenty provenance, living in New Zealand at 31 March 2002.

Founders:

Number of known founders:	7
Number of known potential founders (i.e. known wild caught animals yet to breed):	1 additional
Living descendants:	17
Current population:	19

Gene diversity:

Fraction of gene diversity retained (GD):	0.8417
Founder Genome Equivalents (FGE):	3.16
Potential fraction of gene diversity retained (if founder skew was adjusted) (potential GD):	0.9229

Potential Founder Genome Equivalents (potential FGE): 6.48

Inbreeding:

Mean inbreeding coefficient (F): 0.000

Mean kinship:

Descendent population mean kinship (expected mean F of next generation if pairings are random): 0.1583
(Note: usual inbreeding threshold for ASMP programs is 0.125)

Population projections

TABLE A2.9. PLANNED REGIONAL POPULATION SIZE.

ZOO	CURRENT			PLANNED*			TIMELINE
	MALE	FEMALE	UNKN	MALE	FEMALE	UNKN	
Jacquie Grant's Eco Centre	1	0	0				
Orana Park	1	0	0				
Queenstown	1	0	0				
Rainbow	2	2	0				
Wellington	1	0	0				
Willowbank	1	2	0				
Westshore	7	4	2				
TOTAL	14	8	2	10*	10*	13*	

* Details of planned kiwi holdings for each institution shall be completed after a survey of holders to be completed before 31 December 2003. Data in this table complete as at 24 June 2003.

Implications of planned population size

Population growth:

Estimated time to achieve planned population size through breeding (based on current growth rate (lambda of 1.09) from current population and planned immigration (below): 5 yr

Number of births/hatchlings required per year to attain zero population growth once planned population size is reached: 2.8

Viability:

Expected length of time over which the population will retain 90% of the gene diversity within the (wild) source population without further immigration: 0 yr
Current GD less than 90%

Target population characteristics

Goals for population management: *Rearing 2.8 chicks per annum. Retention of 90% gene diversity at end of 50 yr*

Population size needed (if assume population growth rate = 1.2, FGE per new founder = 0.6, Ne/N ratio = 0.3): Approx. 30.

Available captive space: 33 spaces

Immigration required (imports/collection from wild): Yes. 1 new founder every 2 yr

Hybrid or unknown provenance

Genetic status

Pedigree assumptions

Number of specimens requiring assumed sires and/or dams (only include animals impacting on the living population; include all UNKs treated as founders):	Nil
Proportion of ancestry traced to founders in studbook:	98%

Summary of results

Number of gene drop iterations:	1000
Data restricted to:	Hybrid or unknown provenance, living in New Zealand at 31 March 2002.

Founders:

Number of known founders:	17
Number of known potential founders (i.e. known wild-caught animals yet to breed):	1 additional
Living descendants:	43
Current population:	57

Gene diversity:

Fraction of gene diversity retained (GD):	0.8861
Founder Genome Equivalents (FGE):	4.39
Potential fraction of gene diversity retained (if founder skew was adjusted) (potential GD):	0.9542
Potential Founder Genome Equivalents (potential FGE):	10.91

Inbreeding:

Mean inbreeding coefficient (F):	0.000

Mean kinship:

Descendent population mean kinship (expected mean F of next generation if pairings are random): (Note: usual inbreeding threshold for ASMP programs is 0.125)	0.1139

Population projections

TABLE A2.10. PLANNED REGIONAL POPULATION SIZE.

ZOO	CURRENT			PLANNED*			TIMELINE
	MALE	FEMALE	UNKN	MALE	FEMALE	UNKN	
Auckland	1	1	0				
Kaitaia Nocturnal Park	1	0	0				
Jacquie Grant's Eco Centre	2	0	3				
Maori Arts and Crafts Institute	1	1	0				
Mount Bruce	0	2	0				
Northern Museum	1	0	0				
Orana Park	2	1	0				
Otorohanga	2	1	0				
Nga Manu Trust	2	0	0				
Isaac's Wildlife Trust	1	0	0				
Queenstown	3	3	0				
Rainbow	1	1	0				
Willowbank	6	10	5				
Westshore	0	1	0				
TOTAL	23	21	8	0*	0*	0*	3 yr (approx.)

* Details of planned kiwi holdings for each institution shall be completed after a survey of holders to be completed before 31 December 2003. Data in this table complete as at 24 June 2003.

Implications of planned population size

Population decline:

Estimated time to achieve planned population size of zero (through release of birds to wild protected sites) once provenance populations are large enough to meet goals — Approx. 3 yr

Target population characteristics

Goals for population management: *Phase out hybrid population*

Population size needed (if assume current reproductive rates): Nil

Recommendations for 2003–04

Information contained in this section will be up-dated annually and presented to holders and the Kiwi Recovery Group as the Annual Report and Recommendations by 1 June each year.

General recommendations

- Gradual replacement of hybrid birds (released) by provenance stock (through increased breeding and introduction of new founders (immigration)).
- Managed breeding to initially produce three balanced populations of provenance birds of approximately 33 birds each with a population structure capable of both satisfying requirements for display birds and providing birds for release (see below).
- Production of juveniles (initially both hybrid and provenance birds but eventually just provenance stock) for release to protected wild sites.

TABLE A2.11. SPECIMEN TRANSFER RECOMMENDATIONS.

NO.	SBK NO.	SEX	PROVEN-ANCE	LOCAL ID	BAND NO.	TRANSFER FROM	TRANSFER TO
1.	371	F	BOP	Bron	R30240	Westshore	Wellington
2.	54	M	BOP	Hoani	R31538	Rainbow	Willowbank
3.	348	F	BOP	Ponga	R30237	Westshore	Orana
4.	326	F	BOP	Silver	R30235	Westshore	Willowbank

TABLE A2.12. BREEDING RECOMMENDATIONS.

NO.	LOCA-TION	PROVEN-ANCE	MALES			FEMALES		
			SBK NO.	LOCAL ID		SBK NO.	LOCAL ID	
1.	NZMACI	NLD	159	Winnie	(R46281)	279	Hinemoa	(R47386)
2.	Auckland Zoo	NLD	141	Kahu	(R28345)	70	Omeka	(R46286)
3.	Peacock Springs	NLD	80		R46290	243		R43368
4.	Westshore	BOP	229	Tarawera		41	Fern	(R30232)
5.	Wellington	BOP	101	Tika	(313)	371	Bron	(R30240)
6.	Rainbow	BOP	129	Tahi	(R31517)	315	Bracken	
7.	Willowbank	BOP	54	Hoani	(R31538)	326	Silver	(R30235)
8.	Orana	BOP	195	Paru	(R28271)	348	Ponga	(R30237)
9.	Otorohanga	TAR	318	Rongo	(R29989)	68	Whitehead's spse	(R34147)
10.	Otorohanga	TAR	67	Whitehead	(R34144)	259		R35039
11.	NZMACI	TAR	136	Aitua	(R34276)	303	Willow	(R19712)
12.	Wellington	TAR	74	Artha	(R18603)	364	Kia Kaha	

Total pairs recommended:

- Northland—3 (at NZMACI, Peacock Springs and Auckland Zoo).
- Taranaki—4 (at NZMACI and Otorohanga (2) and Wellington Zoo).
- East Coast / BOP—5 (at Willowbank, Westshore, Wellington Zoo, Rainbow Springs, and Orana Wildlife Park).
- Hybrid / Unknown—0.
- Total—12 (six new pairs).

TABLE A2.13. SPECIMEN RELEASE RECOMMENDATIONS.

NO.	SBK NO.	PROVEN-ANCE	SEX	LOCAL ID	BAND NO.	CURRENT LOCATION	RELEASE TO
1.	All	HYB/UNK				All	Pukaha/Rimutaka
2.	358	BOP	M	Katote	R30239	Westshore	Waikaremoana
3.	372	BOP	M	Pat	?	Westshore	Waikaremoana
4.	377	BOP	M	Kev	?	Westshore	Waikaremoana
5.	381	BOP	U	Rae	?	Westshore	Waikaremoana
6.	382	BOP	U	Dan	?	Westshore	Waikaremoana

As stated elsewhere in this plan, all hybrid birds should be released over the next few years provided there are sufficient pure provenance birds to meet the objectives of this plan (as stated in Section 2.3). The release of surplus pure provenance birds into approved release sites throughout the country may also be undertaken, provided that the birds intended for release are not required, and are surplus to, any proposed CMP breeding programme. Any intended release programme involving surplus pure provenance kiwi must first be considered and endorsed by the Kiwi Captive Management Advisory Committee.

Management strategies

Demographic management strategy

The number of breeding pairs each year/season will be determined with the aim of achieving the goals outlined elsewhere in this document (e.g. maintaining husbandry skills, producing birds for release to protected wild sites, etc.). The number of breeding pairs recommended each (year/season) will be selected with reference to:

- Available space (if population is not at capacity)
- PM2000 analysis of reproductive rate required to attain DoC targets for numbers of birds required each year for release

Genetic management strategy

Selection of breeding pairs is to be 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):

1. Males aged at least two years, females aged at least three years

2. Low mean kinship values relative to the population average
3. Like mean kinship values between prospective pairs
4. Avoiding inbreeding levels equal to or above 0.125
5. All else being equal, older animals before younger animals
6. Minimising specimen transfers

Programme administration

Management team:	Kiwi Captive Management Advisory Committee
Planned frequency of recommendations:	Annually
Progress reported:	Annually
Program review:	Every 5 yr

Appendix 3

INSTITUTIONS HOLDING KIWI

TABLE A3.1. NEW ZEALAND INSTITUTIONS HOLDING NORTH ISLAND BROWN KIWI (MARCH 2003).

ZOO	CURRENT		
	MALE	FEMALE	UNKN
Auckland	2	3	0
Kaitaia Nocturnal Park	2	0	0
Jacquie Grant's Eco Centre	3	0	3
Maori Arts and Crafts Institute	4	3	0
Mount Bruce	0	2	0
Northern Museum	1	0	0
Orana Park	4	2	0
Otorohanga	7	5	1
Nga Manu Trust	2	0	0
Isaac's Wildlife Trust	2	1	0
Queenstown	4	3	0
Rainbow	3	3	1
Wellington	3	2	0
Willowbank	8	12	5
Westshore	8	5	2
TOTAL	53	41	12

Only two institutions (Otorohanga and Mount Bruce) have held and successfully bred three species of kiwi: *Apteryx mantelli*, *A. haastii*, and *A. owenii*. Orana Park had one *A. australis* from Stewart Island; all other institutions have kept or currently hold *A. mantelli*.

Appendix 4

EGG FERTILITY AND EMBRYO MORTALITY

Data presented here was collected by Bassett & Potter (1998) as part of ongoing research.

	NATURAL INCUBATION		PARTIAL ARTIFICIAL INCUBATION	
Infertile	8	(42.7%)	1	(5.3%)
Early embryonic death	3	(17.6%)	5	(26.3%)
Mid-embryonic death	3	(17.6%)	7	(36.8%)
Late embryonic death	3	(17.6%)	6	(31.6%)
Chick	?		?	
TOTALS	17		19	

Fertility could not be determined in 7 (16%) eggs, because of their advanced state of decomposition.