Some early 1990s studies in kiwi (*Apteryx* spp.) genetics and management

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By Jim N. Jolly and Charles H. Daugherty

Foreword

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Until the late 1970s, the nocturnal habits and isolated habitats of the species of kiwi, New Zealand's iconic national bird, meant that they were among the least well-known New Zealand bird species. North and South Island brown kiwi were thought to be at some risk, from land clearance and forest modification, accidental poisoning and trapping, and possibly predation; great spotted kiwi were not considered threatened; the little spotted kiwi was still thought to be widespread on the west of the South Island. Generally, populations of all three kiwi species were thought to be holding their own where their habitats were intact.

Field surveys and research spurred a new appreciation of the vulnerability of kiwi, and how little was known about them. Little spotted kiwi were found to be all but extinct on the New Zealand mainland; only one substantial population survived, on Kapiti Island. Early molecular genetic work hinted at major inconsistency between the current kiwi taxonomy and the revealed genetic variability in kiwi populations. Chick survival of kiwi on Kapiti Island and in Hawke's Bay was found to be very poor. A 1987 research project on the reproductive biology of brown kiwi in Waitangi forest in Northland found, by chance, that one German shepherd dog (*Canis familiaris*) in the study area had killed approximately 500 kiwi in about six weeks, halving what was earlier a thriving population (Taborsky 1988).

Two breakthroughs in technology were instrumental in developing kiwi knowledge. Radio-transmitters attached to birds made it possible for researchers to track kiwi movement for extended periods, and gain new insights into kiwi ecology, breeding and, significantly, predation. A range of molecular genetic analysis techniques (summarised by Chambers & MacAvoy 1998) for the first time could provide direct evidence of evolutionary history and taxonomic relationships, rather than inference based on morphological features.

The 1991–96 Kiwi Recovery Programme (KRP) was prepared to respond to growing concern for the future of kiwi. Its goal was 'to maintain and, where possible, enhance the current abundance, distribution and genetic diversity of kiwis' (Butler & McLennan 1991). The KRP plan had two strategic aims:

- To identify the distribution, abundance and genetic diversity of kiwi, and their population trends and threats.
- To take action to remove the risk of extinction of endangered taxa, prevent further declines and begin recovery of other kiwi populations.

The plan provided a vehicle to attract greater resources for an intensive programme of kiwi research and management. Research and information gathering were seen as working in tandem with direct conservation management to ensure efforts were focussed on the priority populations.

The information objectives of the plan were (Butler & McLennan 1991):

- To identify the current distribution and abundance of kiwi.
- To identify the genetic variation within kiwi.
- To determine kiwi population trends through monitoring.
- To determine threats to wild populations and to develop management techniques for population maintenance and recovery.

This compilation presents three research papers prepared for the Kiwi Recovery Programme that address particularly the first two of these objectives. These papers present fundamentally new knowledge about kiwi. Although the results of the first paper have featured in the popular media, and in the educative materials of the Kiwi Recovery Programme (including its web site, http://www.kiwirecovery.org.nz), neither that work nor the other two projects have been formally published as scientific papers.[1] The present publication makes these three papers available to a wider audience for the first time. Only limited updating of these reports, which were prepared in 1992–95, has been undertaken.

The results of these papers have been used in the development of the second phase (1996–2006) of the Kiwi Recovery Programme (available from the Department of Conservation).

1. GENETIC VARIATION, SYSTEMATICS AND MANAGEMENT OF KIWI

The first paper, by John Herbert and Charles Daugherty, describes a survey of the genetic variation in all known types of kiwi at a geographically spread range of sites in New Zealand. The results are surprising. A kiwi taxonomy (Turbott 1990) accepting three species (little spotted kiwi, great spotted kiwi, and brown kiwi, the last having three subspecies) and dating back 60 years is erroneous. Genetic data indicate that there are four species of kiwi: little spotted kiwi[2], great spotted kiwi, northern brown kiwi (which includes the Okarito brown kiwi), and tokoeka. Within these basic species units are several highly genetically distinctive populations: Little Barrier Island northern brown kiwi, Okarito northern brown kiwi and Haast tokoeka. Further genetic research is required before a fully revised kiwi taxonomy is available.

Pending further genetic investigations and formal publication of a new taxonomy, Herbert and Daugherty propose informal names for the newly recognised kiwi entities. Name changes apply to brown kiwi only. 'Northern brown kiwi' collectively refers to brown kiwi from the North Island (previously North Island brown kiwi) and from Okarito (previously included in South Island brown kiwi). Other brown kiwi in the South Island and on Stewart Island are referred to by the Maori name tokoeka. Tokoeka at Haast are distinguished from tokoeka in Fiordland and Stewart Island by use of the names Haast tokoeka and

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[1] Baker et al. (1995) report the results of related allozyme and mtDNA analyses of brown kiwi.

[2] Maori names for little spotted kiwi and great spotted kiwi are kiwi pukupuku and roroa, respectively.

southern tokoeka, respectively (see section 3.3.3) These names are used throughout this publication except where historical context or accuracy requires otherwise.

Contemporary and subsequent molecular genetic investigations in a range of other New Zealand species have also revealed a surprising degree of genetic population structuring, and have led to the identification of new species and the resolution of several cryptic species complexes. They have occurred in a wide variety of life-forms: plants (Mitchell et al. 1999), galaxiid fishes (Allibone et al. 1996; Gleeson et al. 1999), *Leiopelma* frogs (Bell et al. 1998), reptiles (Daugherty et al. 1990a, 1990b), marine mammals (Pichler et al. 1998) and birds (Daugherty & Triggs 1991).

These studies suggest not only a new focus for conservation management of kiwi and other newly described or redescribed species in New Zealand. They highlight a new dimension to the target of conservation efforts: the protection of genetic diversity within species. The significance of 'diversity within species' is recognised by its inclusion in the definition of biological diversity in The Convention on Biological Diversity (UNEP 1992).

Protecting diversity within species will challenge existing conservation paradigms and programmes. Protection of one population is unlikely to be sufficient to protect biodiversity; rather, conservation efforts will have to address the protection of the full range of variation within a species. Herbert and Daugherty point to the need for further genetic studies for species of conservation concern, and, in their absence, to the significance of protecting the geographical spread of populations. The 'agony of choice' (Vane-Wright et al. 1991) will become more acute.

2. GENETIC VARIABILITY, DISTRIBUTION AND ABUNDANCE OF GREAT SPOTTED KIWI

The great spotted kiwi was the least known of the three (now four) kiwi species when the first Kiwi Recovery Programme plan was prepared. The distribution, abundance, ecology, behaviour and population dynamics of a bird that was largely confined to high rainfall, densely forested and mainly mountainous areas were difficult objects of study. That dearth of knowledge has been redressed by the second paper, by John McLennan and Tony McCann, on genetic variability, distribution and abundance of great spotted kiwi.

This paper extends earlier work on the ecology of great spotted kiwi in Northwest Nelson (McLennan & McCann 1991). Morphometric data from two study sites, in lowland forest near Kahurangi Point and in upland vegetation in the Saxon River headwaters, had suggested the birds at those sites might belong to distinct lowland and upland forms or races. To test this, and to determine if these differences were more widespread, McLennan and McCann included these and other great spotted kiwi populations in the nationwide blood sampling programme to assess genetic variation in kiwi species (Herbert & Daugherty, this volume). They extended the morphometric sampling to other populations in the known range of great spotted kiwi. To determine the current distribution and abundance of great spotted kiwi, they collated the results of

survey work undertaken for the Kiwi Recovery Programme by staff of Landcare Research and the Department of Conservation, and contributions by people outside these organisations to the Kiwi Call Scheme (administered by the Department of Conservation).

The collation of all information to that time on the genetics, distribution and abundance of great spotted kiwi in this one paper provides a valuable baseline against which future change can be measured. For the first time great spotted kiwi have been recognised as a species at risk, a vulnerable species. The species is not homogenous but has substantial intra-specific genetic variability. Anonymity and isolation do not guarantee that the species, nor its populations, can escape the ravages of introduced predators even in extensive, structurally intact habitats.

3. COMPARISON OF LITTLE SPOTTED KIWI FROM KAPITI AND D'URVILLE ISLANDS

Although other kiwi species were suspected to be at risk when the Kiwi Recovery Programme was initiated, the little spotted kiwi was known to be an endangered species. They were considered to be still widespread in the western mountains of the South Island as recently as 1975 (Reid & Williams 1975), but subsequent detailed checking of records and specimens revealed that they had virtually disappeared from the mainland over the previous 50 years (Jolly 1985). The only two surviving populations were on Kapiti Island (about 1000 birds) and on D'Urville Island (a few birds).

Conservation management of two sole surviving populations of a species requires sound knowledge of relationships between them. Were the D'Urville and Kapiti Island populations distinct reservoirs of genetic diversity, as suggested by physical differences, or were they one genetic unit? If the D'Urville Island birds were genetically distinctive, their parlous state demanded urgent action to promote that precarious gene pool.

Jim Jolly and Charles Daugherty have compiled an authoritative account of the genetic structure, morphometrics and origin of little spotted kiwi on Kapiti and D'Urville islands which provides a sound basis for management of these two populations.

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