Kiwi Recovery Plan

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Introduction to the Recovery Plan

1.1 AIMS AND PURPOSE

This recovery plan presents a five-year programme of management and research aimed at a long-term goal of maintaining and, where possible, enhancing the current abundance, distribution and genetic diversity of kiwis. It has been approved for a five-year period from July 1991 and will be due for review at the end of that period, or sooner if new information leads to a proposal for a significant change in direction. It will remain operative until a reviewed plan is in place.

The plan is approved by the Director-General of Conservation as a guide to the Department in its management of kiwis. Its implementation will be overseen by a Kiwi Recovery Group and will be dependent on and vary with the resources and information available at any point. The recommendations contained in this plan do not necessarily represent the views of all those involved in its production, who are acknowledged below.

All kiwi species are included in the one plan because they share many problems and possible solutions. All are considered threatened with extinction unless the causes of declines are addressed. For those in most immediate danger, establishing populations on offshore islands and perhaps captivity may continue to be necessary. But this plan aims to retain kiwis on the mainland, recognising that in the long run the best way of preserving the diversity of New Zealand's fauna and flora is to conserve the species as part of the community they have evolved in.

There is only a small group of individuals with the skills to undertake significant research and management of kiwis, and including all species together allows them to see what needs doing and how they can best fit into the programme. Training further people and involving voluntary groups will be important in implementing this plan.

1.2 ACKNOWLEDGEMENTS

This plan was prepared in consultation with the proposed Kiwi Recovery Group, comprising experts on kiwis together with Protected Species staff from the Department of Conservation's following conservancies: Southland, West Coast, Canterbury, Nelson/Marlborough, Wellington, Wanganui, Bay of Plenty, Hawkes Bay, East Coast, Tongariro/Taupo, Waikato, Auckland and Northland.

The following attended meetings with the authors to formulate plan drafts:

John Cockrem (Massey University), Rogan Colbourne (DOC, Science & Research), Ron Goudswaard (Wellington Zoo), Jim Jolly (private consultant), Murray Potter (Massey University), John Lyall, Raewyn Empson, Wayne Hutchinson, Mike McGlynn, Cam Speedy, Phil Thomson, Shaarina Boyd, Ray Pierce (DOC conservancies).

The plan also benefited from the comments of many individuals both within and outside the Department of Conservation, particularly the New Zealand Conservation Authority and its regional Conservation Boards, and the Royal Forest & Bird Protection Society.

1.3 INTRODUCTION TO THE KIWIS

Kiwis are the smallest members of the ratites, a group of flightless birds which includes the rheas of South America, the cassowaries of Australia and New Guinea, and the ostriches of Africa. They are

endemic to New Zealand and ancient in origin; their ancestor, which may also have spawned the moas, probably arrived in New Zealand some 70 million years ago (Fleming, 1962).

Kiwis are biological oddities, unique in both appearance and behaviour. Many of their features are more typical of mammals than birds, a characteristic which prompted Calder (1978) to describe them as New Zealand's honorary mammals. Kiwis hold a variety of records among birds; their eggs are extremely large and rich in energy, and take an exceedingly long time to hatch. Males are the smaller of the two sexes and perform most of the parental care. This reversal in sex roles is associated with monogamy, a combination which is extremely rare among birds.

The genus *Apteryx* is truly a "one-off design, and it is not surprising, then, that kiwis have become an important part of our culture, an unofficial national emblem proclaiming our uniqueness. They are, without question, among the most distinctive and interesting elements of our fauna.

2.0

Taxonomy

The names used throughout this recovery plan are those listed by Turbott (1990) in the Checklist of the Birds of New Zealand. Three species of kiwi are recognised (the little spotted kiwi, *A. owenii*, the great spotted kiwi, *A. haastii*, and the brown kiwi, *A. australis*) with the last being divided into three sub-species (*mantelli* in the North Island, *australis* in the South Island, and *lawryi* on Stewart Island). The taxonomy of kiwis is currently under review, and some changes to the status of brown kiwi are likely (C. Daugherty pers. comm.). The implications of these changes are considered in later sections.

3.0

Past Distribution and Abundance

3.1 NORTH ISLAND

Sub-fossil bones and archaeological remains show that all three species of kiwi were once more widespread than they are now. Great spotted kiwis seem never to have reached the North Island, despite the land-bridges that existed in the Pleistocene, and Rothschild's (1893) repeated assertions that some of the specimens in his collection were caught there.

Brown kiwis and little spotted kiwis were spread throughout the North Island in the late Holocene (Reid & Williams, 1975; Millener, 1981), but little spotted kiwis were all but extinct there by the time the first Europeans arrived. Two little spotted kiwis

were collected in the North Island in the 1880's, one of which was found in the alpine zone of the Tararua Range (Buller, 1888; Reischeck, 1930).

It is not clear when brown kiwi began to decline in the lower half of the North Island. Their remains have been found in middens at Paremata (just north of Wellington), and their bones are common in caves in the Wairarapa (Millener, 1981). The birds apparently died out in the Tararua Ranges before Europeans arrived. Their retreat northwards seems to be continuing, and only a handful of birds now survive in the northern tip of the Ruahine Range (McLennan, in prep.). There is however an isolated record in the centre of the range (R. Colbourne, pers. comm.).

Anecdotal evidence suggests that kiwis were generally far more numerous in the forests of the North Island than they are now. Buller (1888), for example, reported very high densities of kiwi on Mt Hikurangi, yet the birds are rare there today. Similarly, it is now hard to find a kiwi in the Kaimanawa Ranges, yet Buller (1877) refers to a collection of 300 skins that were taken from there by professional hunters. Kiwi densities which are exceptional by today's standards, such as those in Waipoua in Northland, seem to have been common in the North Island at the turn of the century.

3.2 SOUTH ISLAND

The South Island mainland contained all three kiwi species when European settlers arrived. Little spotted kiwis declined soon afterwards, and are now probably extinct. The last confirmed specimens in the South Island were ones collected near Lake Poteriteri in Fiordland in 1938 and bones from a dead bird from Junction Burn, Fiordland in 1974 (Turbott, 1990). There is a remote possibility the species may still survive in Westland; calls which resemble those of the little spotted kiwi have been heard recently in the Arawhata Valley (J. Jolly, pers. comm.), though a bird caught there in the past making similar calls was a brown kiwi (R. Colbourne, pers. comm.). It was formerly common throughout most of the South Island, and was thought to be still plentiful on the West Coast as recently as 1975 (Reid & Williams, 1975).

The sub-fossil remains of brown and great spotted kiwis are difficult to distinguish, so their former distributions are not well known. (A promising technique for separating the tibia bones of these species is now being developed by T. Worthy, but it is still provisional and has not yet been applied widely). According to Reid and Williams (1975), sub-fossil and midden remains indicate that brown kiwi were formerly widespread in Marlborough and the coastal regions of Kaikoura, Canterbury and northern Otago. Oliver (1955) reported that brown kiwis were seen in the Marlborough Sounds in 1931, and were present in the forests bordering Otago Harbour in 1873. (Roderick (1983) notes that Doubtful Sound was also once known as Otago Harbour and suggests that Oliver's report relates to there). T. Worthy (pers. comm.) has found brown kiwi bones in the Takaka Hills. The northernmost population of brown kiwi in the South Island today is at Okarito on the West Coast.

There is some evidence that great spotted kiwis have contracted in range in recent geological times. A sub-fossil from Pyramid Valley is thought to be of this species, and suggests that the birds were once more widespread east of the Alps than they are now (Reid and Williams, 1975). The present population of great spotted kiwi comprises three more-or-less discrete clumps, which further indicates a recent contraction of range. Oliver (1955) reported that some specimens in the Canterbury museum were collected in Fiordland. These may have been mis-labelled, because there are no other historical records of great spotted kiwi from this area.

3.3 STEWART ISLAND

Nothing is recorded of the origins and historical distribution of kiwis on Stewart Island. Brown kiwis are the only species present there today.

3.4 OFFSHORE ISLANDS

Both little spotted kiwis and brown kiwis were present on at least one offshore island when Europeans first arrived. Little spotted kiwi occur naturally on D'Urville Island, although the birds are all but extinct there today. Their population on Kapiti Island is widely believed to result from an introduction earlier this century (Oliver, 1955) but there are no records of the birds being liberated there (J. Jolly, pers. comm.). The population may be natural, but this obviously requires that some birds survived both the prolonged occupation of the island by Maori, and the more recent attempts to farm it.

The origins of the brown kiwi on Little Barrier Island are now uncertain. Two specimens were collected there in 1862 and 1887, although the natural population was thought to be extinct when other brown kiwi from elsewhere in the North Island were liberated on the island between 1910 and 1940 (Oliver, 1955). This presumed extinction is now suspect, since the birds on the island have their own unique type of lice which are clearly not of mainland origin (Ricardo Palma, in press).

4.0

Present Distribution and Status

The following account is based on *The atlas of bird distribution in New Zealand* (Bull et. al, 1985) and on recent unpublished information held mainly by Rogan Colbourne of DOC, Wellington. A map outlining the range of the different species follows section 4.3.

4.1 LITTLE SPOTTED KIWI

Little spotted kiwis are now probably confined to offshore islands. Their largest remaining population is that on Kapiti, where 500-1500 birds occupy some 1900 ha of mixed forest, scrub and grassland. The D'Urville Island population has failed (probably because of predation by stoats) but two birds from there (a male and a female) were successfully shifted to Long Island in the Marlborough Sounds in the 1980s. One has since paired with a Kapiti bird, which was released on Long island at the same time (Jolly and Colbourne, in press).

Other Kapiti birds were moved to Red Mercury (off the Coromandel coast) in 1983 and to Hen Island (in the Hauraki Gulf) in 1988/89. The population on Red Mercury had increased from 12 to 17 by March 1989. The present size of the Hen Island population is not known, but some of the 30 birds that were originally released there were still present in 1990 (Jolly and Colbourne, in press.).

These new populations have reduced the risk of extinction for this species, but the Kapiti population will remain for some time as the only one of any consequence. The birds were considered by Williams and Given (1981) and Bell (1986) to be `endangered', and that classification is still appropriate today.

4.2 GREAT SPOTTED KIWI

The present distribution of great spotted kiwi is not known in detail. The birds are found only in the South Island, mainly west of the Alps, between Whanganui Inlet (in the north) and the Karangarua River (in the south). Densities are highest (about four pairs per km^2) in the sub-alpine zone of the mountain ranges immediately adjacent to the Tasman Sea (Jolly and Roderick, 1983; McLennan and McCann, unpublished). There are currently three more-or-less discrete populations of great spotted kiwi, of which the largest extends from Northwest Nelson to the southern tip of the Paparoa Ranges. The second population, some 50 km south-east of the Paparoa birds, is intermediate in size and the furthest inland. It is centred on Arthur's Pass and extends eastwards into the headwaters of the Waimakariri and Hurunui Rivers, and northwards to Lake Sumner. The third and most southern population is in Westland, in the foothills of the Alps between the Waitaha and Karangarua Rivers. This sparse and small population might actually extend as far south as the upper reaches of the Haast River, where a few kiwi of uncertain identity are present (J. Jolly, pers. comm.). A few great spotted kiwis might live outside the known limits of these three populations. There are still occasional unconfirmed records from the Howard and Tiraumea Valleys, on the western perimeter of Nelson Lakes National Park. Kiwis were definitely in these valleys at the end of last century, but searches by C.D. Roderick between 1980 and 1983 and by J. Jolly in January 1990 have been unsuccessful. These birds, if confirmed, would extend the known range of the northern population of great spotted kiwis by some 20 km to the east.

There are apparently no populations of great spotted kiwis on offshore islands, though a bird heard and seen on Secretary Island off Fiordland in 1970 may have been this species (M. Foord, pers. comm.). An attempt was made to establish great spotted kiwi on Little Barrier in 1915, but this seems to have failed (Oliver, 1955).

The great spotted kiwi was not considered a threatened species by Bell (1986), but according to the Species Ranking System currently being developed by the Department of Conservation it should now be treated as one and requires work `in the short term'.

4.3 BROWN KIWI

The North Island sub-species of brown kiwi is found only in the upper two-thirds of the North Island r.above about latitude 40°S, but with a northern limit at about a line between Mangonui Harbour and Kaitaia. The birds are widespread in Northland, in a diverse range of vegetation types including exotic forests and rough farmland (Colbourne and Kleinpaste, 1983;). Densities in parts of Waipoua and Tangiteroria forests exceed 20 pairs per square kilometre (R. Pierce, pers. comm., Potter, 1989). Densities in some exotic forests in Northland reach one pair per 5 ha, similar to that in nearby native vegetation (Colboume and Kleinpaste, 1983).

The Northland population extends south to a line running westwards from Mangawhai Heads to the top of the Kaipara Harbour. Repeated attempts in recent years to re-introduce kiwis into the Waitakere Ranges have been unsuccessful (MacMillan, 1990).

Bull et al. (1985) show kiwis as being present in the Hunua Range bordering the Firth of Thames, 15 km south-east of Auckland City, but this single record is probably doubtful. The birds are on the other side of the Firth of Thames, in the forests of the Coromandel Peninsula. This population is sparse but extends southwards along the Kaimai Range (where they may now be extinct) to the Mamaku Plateau.

The brown kiwis in the central regions of the North Island belong to one of two discrete populations, separated from each other by the Waikato Basin and the

Kaingaroa Plateau. The larger of these populations fans out westward from the shores of Lake Taupo to Kawhia Harbour in the north and Wanganui in the south. It includes those birds in the extensive hill country of inland Taranaki and the King Country, and the forests of Egmont National Park. Little is known of kiwi densities throughout this region. A localised and superficial survey at Aotuhia in Taranaki in November 1985 indicated that the scrubland there contained about one pair of kiwis per 15 ha (McLennan, 1985).

The second population in the central North Island lies to the east of Rotorua, and extends from the Raukumara Ranges in the north to the Ruahine Range in the south. The birds are often heard and caught in gin traps in the north-eastern corner of Urewera National Park, and in the foothills along the eastern edge of the Bay of Plenty. Numbers diminish south of Lake Waikaremoana, and finally peter out altogether in southern Hawke's Bay. Average densities in the Kaweka Ranges, near the southern limit of their distribution, are less than one per 100 ha (Speedy, 1985). Few kiwis live in coastal and lowland areas of the east coast, nor in its extensive exotic forests (McLennan, unpublished).

The southern limit of brown kiwis on the eastern side of the North Island is probably the northern tip of the Ruahine Range, where a handful of birds live in catchments draining to both the east and the west (McLennan, unpublished). A few kiwis live slightly further south at Gwavas in southern Hawke's Bay, but these were brought down from Northland in the 1980s.

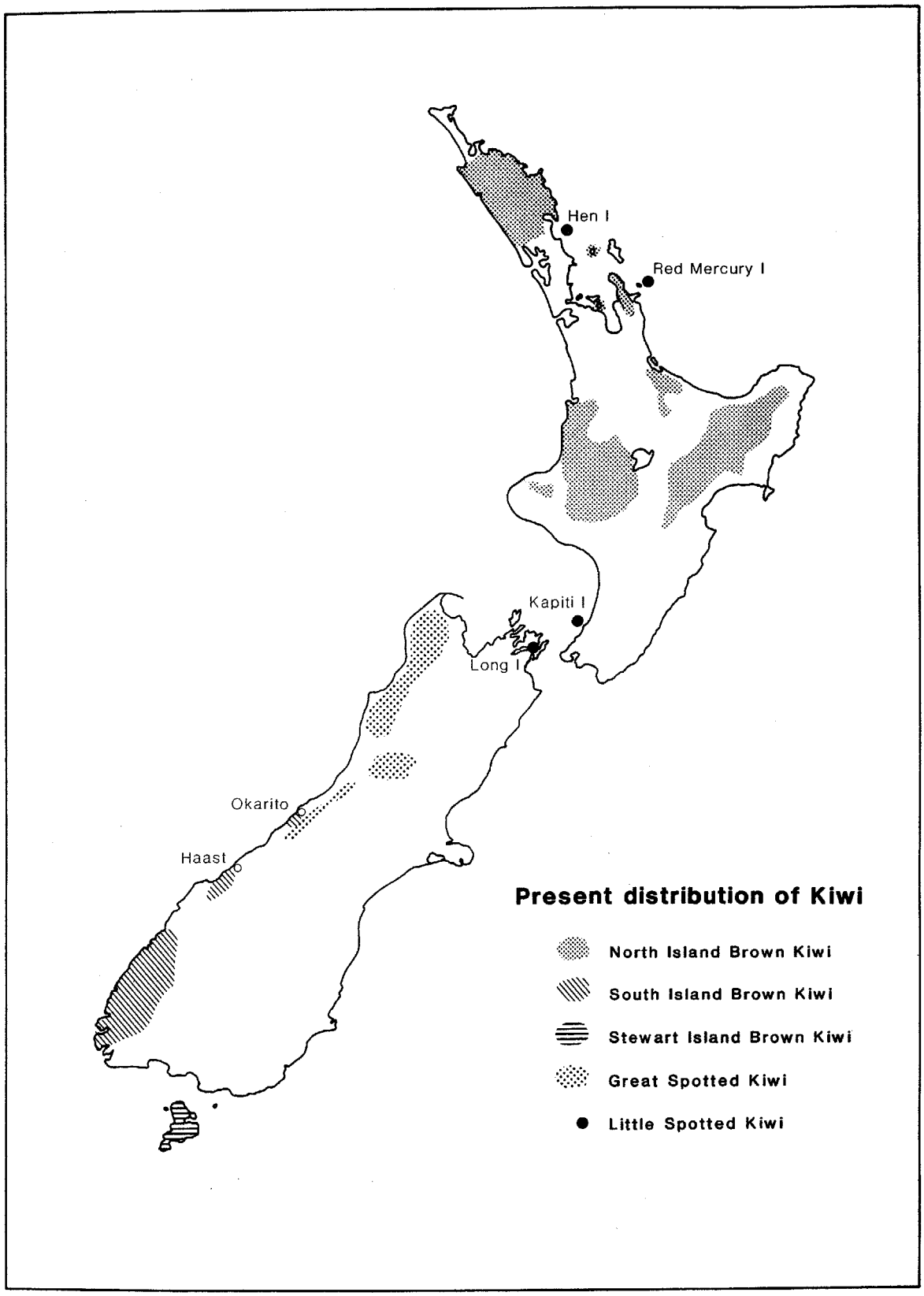
The natural range of North Island brown kiwi has been extended in European times by liberating birds on offshore islands. Small numbers are present on Kawau and Ponui Islands in the Hauraki Gulf, and on Moturoa Island in the Bay of Islands. Brown kiwis from both the North and South Islands were released on Kapiti Island in the early 1900's, but the South Island form (*australis*) seems to be predominate there today (J. Jolly and R. Colboune, pers. comm.). They owe their origins to two birds from Dusky Sound and five from Jacksons Bay. As mentioned above, North Island brown kiwi were released on Little Barrier Island at least twice between 1910 and 1940.

The largest population of brown kiwi in the South Island is in Fiordland, between the Hollyford and Waitutu Rivers (Fig. 1). These birds extend east to the shores of Lakes Manapouri, Monowai, Hauroko and Poteriteri, and the Livingstone Range east of Lake Te Anau. The birds are present in moderate numbers on Resolution Island, where they occurred naturally but were also the subject of liberations by Richard Henry earlier this century. They are also present on Secretary and Parrot Islands. Call counts elsewhere in Fiordland indicate adult densities of 6 to 10 per km^2 (Napper, 1989, quoting R. Colbourne).

Two smaller populations of brown kiwi lie to the north of Fiordland - at Haast, between the Haast and Cascade Rivers, and at Okarito, between the Waiho and Okarito Rivers some 150 km further up the coast. Little is known of the Haast population, except that it is believed to be small (J. Jolly, pers. comm.). The Okarito population is confined to a few thousand hectares and currently estimated at 30-50 birds (Colbourne and Lyall, 1990).

Brown kiwi are spread throughout Stewart Island and two small islets (Ulva and Horomamae) off its eastern coast. Densities of adults around Masons Bay average some 25-30 birds per km^2, but these decline to about 12 per km^2 at Scollays Flat, some 20 km further south (Napper, 1989, quoting R. Colbourne), and even lower in the higher country in the north (e.g. Mt Angelm) (A. Cox, pers. comm.).

Both the North Island and South Island brown kiwis are considered `threatened' by Bell (1986), and this is still the case according to the results of the new Species Ranking System.


Hen I
Red Mercury I
Kapiti I
Long I
Okarito
Haast
Present distribution of Kiwi
North Island Brown Kiwi
South Island Brown Kiwi
Stewart Island Brown Kiwi
Great Spotted Kiwi
Little Spotted Kiwi

Threats to Kiwis and Current Population Trends

5.1 LITTLE SPOTTED KIWI

The factors that caused the extinction of little spotted kiwi on the North Island are unknown. Their demise there largely preceded European settlement. Midden remains show that the birds were hunted by Maori and their dogs, but so too were brown kiwis and they continued to flourish in most areas.

The recent decline of little spotted kiwi to near extinction in the South Island passed almost unnoticed. Stoats possibly caused their demise (Hill and Hill, 1987; Reid, 1978), a view supported by the observation that the birds live today only on islands where these mammals are absent.

The current status of little spotted kiwi on Kapiti Island is not clear, with two independent studies giving contradictory results. Jolly (1985 & 1989) believed that the birds may not be producing enough chicks to replace themselves, because wekas eat most of their eggs. Jolly estimated that the 250-750 breeding pairs of kiwis on the island produce about 40 chicks each year, of which it could be predicted that only 20 survive to maturity. On this basis, each pair would take on average 50 years to replace themselves, and it is highly unlikely that adults live long enough to do this.

R. Colbourne, on the other hand, claims that juveniles make up some 35% of the present population - and are about six times more common than Jolly's figures predict. Colbourne's ratio is based on some 106 kiwis, which were found by his trained dog from 1986 to 1989 inclusive. This information suggests that the population is in good heart, and is probably producing far more chicks each year than the island can support.

Both Jolly and Colbourne do agree that there is a low turnover of adults on Kapiti, that the present population comprises about 250-750 breeding pairs, and that the birds live at high densities (one pair per 1.6 ha, n=12) relative to other species of kiwi on the mainland. Whatever the present trend, the population on Kapiti is unlikely to fail in the next decade, provided other factors remain unchanged.

5.2 NORTH ISLAND BROWN KIWI

The persistence of both brown and great spotted kiwis on the mainland is interesting. Ancient endemics are generally very sensitive to habitat changes and competition, while kiwis in particular seem likely to be extremely vulnerable to mammalian predators. Their resilience must be due in part to both their large size, which exceeds that of the prey commonly eaten by cats and mustelids in New Zealand forests (though a stoat has been observed with a dead kiwi chick, (R. Colbourne, pers. comm.) and to their ability to live in a wide range of habitats.

Brown kiwis have, nevertheless, lost ground since the arrival of humans, and continue to do so in some areas. Land clearance by both Maori and Europeans has eliminated the birds in most coastal and lowland areas of the North Island. The forests that remain in such areas have not provided adequate refuges for the birds because (among other things) they are generally too small to support viable populations (McLennan et. al, 1987). In Hawke's Bay, for example, remnants as large as 500 ha usually lose their kiwis within two decades of becoming isolated (McLennan, in prep.), though whether this applies generally to other areas is not yet known.

The full effects of land clearance have still to be felt in some areas. In both Taranaki and Northland, land clearance has been so recent that many small remnants of vegetation still contain the birds. These kiwis may not be indicators of vigorous and expanding populations, as some optimistically believe. They may instead be the indirect and less obvious casualties of land clearance, trapped in a no-win situation. They and the others like them may gradually disappear and not be replaced. We don't know how many birds in Northland and Taranaki are currently in this predicament, but it could be as many as 20%. Whatever the figure, they will probably decline in these regions over the next two decades, even if nothing else changes.

Of greater immediate concern are the brown kiwi in the large tracts of forest and scrub that remain in the North Island. Little is known of their status, since few of their populations have been surveyed. The little available information suggests that the birds are declining, at least in the southern half of their range.

In Hawke's Bay, for example, two populations (at Haliburtons and Waitere) have declined by about 50% in the last four years (McLennan, unpublished). Anecdotal evidence suggests that declines of similar magnitude are occurring throughout the region, including the extensive forests of Urewera National Park. Their cause(s) have not been identified, but McLennan et al (1987) believe that gin-trapping and cyanide poisoning for possums (which also kills kiwis) and predation by cats on juveniles are the main contributors.

A similar trend may be emerging from the Bay of Plenty, in that kiwis seem to have disappeared from some of the sites where Taylor and Calder (1983) recorded them in 1981 (Miller, unpublished). However further work is needed to confirm this.

The situation in Northland seems to be much better, with the birds apparently flourishing in most areas, though there is evidence of shrinkage northward of the southern limit of the range (R. Pierce, & P. Anderson, pers. comm.). Kiwis have colonised some exotic forests in this region (Reid and Williams, 1975), implying that those in nearby native forests are producing surplus young. Waipoua State Forest on the west coast currently contains 3000 to 5000 kiwis - probably the largest population now extant in the North Island. Some populations in Northland have, however, declined in recent times. In a six week period in late 1987, a feral dog killed about 50% of the 1000 kiwis living in Waitangi State Forest in the Bay of Islands (Taborsky, 1988). The predation was noticed and stopped (by shooting the dog) only because the birds were being studied at the time; clearly on most occasions the birds would not have a willing benefactor on hand to protect them. The losses at Waitangi are not significant in a national context, but they do illustrate both the vulnerability of kiwis to predators and the speed at which seemingly healthy populations can fail. They also serve to warn us that we should not be complacent about the future of brown kiwi in Northland, simply because there happens to be plenty there now. Northland lost c7% of its forest habitat in five years in the late 1970s-early 1980s through government incentives for land clearance, a situation that could re-occur. In addition we should recognise that possums have only recently spread here. They may have a direct impact on kiwis (e.g. burrow competition & egg predation), or an indirect one through increased trapping and poisoning operations to control them. A final cause for some concern is that three of c 15 known birds in part of Waipoua forest were killed on roads over an eight-month period.

5.3 SOUTH ISLAND BROWN KIWI

Unlike their northern counterparts, South Island brown kiwis are not today under immediate threat of land clearance. Most of their populations are on land which is either formally protected, or currently considered too steep for forestry and farming.

The processes that led to the extinction of brown kiwis in the forests of Nelson, Golden Bay and the Marlborough Sounds are not known. It is noteworthy, however, that the birds had largely disappeared before cats and mustelids were introduced, and that little spotted kiwis continued to flourish in the same areas for some decades afterwards. Such events should remind us that processes other than habitat destruction and predation can cause extinction, and that populations on offshore islands are probably not as safe as we imagine them to be.

The population at Okarito was surveyed by the Wildlife Service between June 1979 and 1983 (Roderick, 1983) and again by Colbourne and Lyall (1990) in July 1990 and February 1991. Roderick (1983) defined the boundaries of the population precisely, identifying 20 territories, and estimated its size as being in the "low hundreds." Colbourne and Lyall's survey increased the reported range of the birds, and recorded 18 individuals indicating a total population of only about 30-50. Both surveys indicate that recruitment may not be sufficient to replace lost adults, e.g. Roderick (1983) reported that a banded male who lost his mate in a gin-trap was still unpaired 10 years later; and Colbourne and Lyall found that some of the territories which were occupied in 1979 had become vacant. Colbourne and Lyall (1990) concluded that the Okarito population is declining, and suggested that stoats, dogs, and gin-trapping were the main contributory factors. However further assessment is needed to clarify the comparison between the two surveys.

The presence of brown kiwis near Haast was first documented by the explorer Charles Douglas in the 1870s (Pascoe, 1957). The size, distribution and status of this population is not well known, but it is clearly both small and sparse. Roderick (1983) thought that it might total 100 to 200 birds, but it is not clear how he arrived at this figure.

Charles Douglas wrote that Fiordland brown kiwis are not encountered "til the Hollyford is crossed" and this river still marks the northern limit of the population today. Recent surveys suggest that kiwis have disappeared since the turn of the century from Martins Bay and the Pyke Valley, but the birds are still present in reasonable numbers around Doubtful and Dusky Sounds and the adjoining fiords (R. Colbourne and J. Jolly, pers. comms.). Little is known of their status elsewhere in Fiordland, though they are considered common in the Kepler, Murchison and Stuart Mountains (D. Crouchiey, pers. comm.). They have apparently been rare south of Preservation Net for the last 50 years (J.Jolly, pers. comm.).

5.4 STEWART ISLAND BROWN KIWI

Stewart Islanders often report that kiwis have become more numerous there in the last few decades. A report that the birds were thought to be so rare there at the turn of the century that the Southland Acclimatization Society considered boosting the population with birds from Fiordland (Roderick, 1983) might support such an idea. However other authors do not suggest that the birds were at all rare either late last century or early in this one (Buller (1888), Guthrie-Smith (1914).

Surveys show that the birds are now widespread and abundant on the island, especially round Masons Bay, where densities are similar to those in Northland (Napper, 1989, quoting R. Colbourne). Recent studies show that the birds breed successfully in the presence of cats, and that chick survival is high (R. Colbourne, pers. comm.). The prospects for this population appear favourable for the foreseeable future.

5.5 GREAT SPOTTED KIWI

Great spotted kiwis appear to be maintaining their numbers in alpine and sub-alpine regions of northwest Nelson. In the Saxon area of the Heaphy track, pairs live in exclusive territories, which abut those of their neighbours. The territories extend over

all of the available habitat, apart from a few gaps here and there which are too small to support a pair of kiwis. Few territories are occupied by single males or females; territory owners which lose their partners usually re-mate within 12-36 months, often with another adult that has moved in from elsewhere. The breeding success of the birds at Saxon is low, and juveniles are rare, but the population as a whole seems to be producing more individuals than the habitat can support (McLennan and McCann, unpublished).

Great spotted kiwis in lowland and coastal forests are not faring as well as their counterparts in the mountains. The birds are less numerous in lowland areas, and share their habitat with a number of mammalian predators which are either rare or absent in mountain environments. Lowland birds which are living on the fringes of farmland and settled areas are declining quickly. At Kahurangi Point, for example, 4 of eleven kiwis have been caught at least once in gin-traps, to judge from their mis-shaped and/or missing toes. One of the eleven study birds was killed recently by a pig dog, and another has disappeared. Losses in this locality exceed recruitment, and some parts of the forest are now no longer occupied by kiwis (McLennan and McCann, unpublished).

Little is known of the status of the populations further south, except that the one in the Smythe Range and headwaters of the Wanganui River is both sparse and small (Roderick, 1983; J. Jolly pers. comm.).

6.0

Relevant Aspects of the Ecology of Kiwis

6.1 VULNERABILITY TO PREDATION

Kiwis have evolved with a variety of predators, most recently the mammals introduced by Maori and Europeans. But before these there were large predatory birds, including an eagle *(Harpagornis),* now known only from their sub-fossil remains.

The impact that these predators had on ground-dwelling birds will never be known, but much of the kiwi's behaviour today may be a legacy of their past association with these hunters. All three species are cryptically coloured and hide during daylight, emerging to feed only under the cover of darkness. The Stewart Island brown kiwi, with its occasional bouts of daytime feeding, is the only exception.

Kiwis have also evolved for some 25 million years in the presence of wekas (Fleming, 1962), the only extant natural predator of kiwi eggs and newly-hatched chicks. All species appear to have developed defences against wekas, including such elaborate ploys as placing vegetation over the entrance of their breeding burrows to make them less conspicuous (McLennan 1988, Jolly 1989).

The vulnerability of kiwis to mammalian predators is therefore not because the birds lack anti-predator defences; it is instead because the ones they have are ineffective. They evolved to foil day-active birds which hunted by sight, not nocturnal mammals hunting by sound and scent. Adult brown and great spotted kiwis may be sufficiently

large and aggressive to thwart attacks from rats, cats and probably stoats, the three most abundant predators in New Zealand forests. Their young are, however, vulnerable to these predators, and both young and adults are vulnerable to dogs and pigs. Little spotted kiwis have been the main victim of the new predators; at half the size of the other kiwis, they may be simply too small to defend themselves against stoats and cats.

6.2 HABITAT REQUIREMENTS AND DIET

All kiwis occupied a variety of habitats, spanning a wide range of altitude, temperature, rainfall, terrain, soil and vegetation types (Reid and Williams, 1975).

Brown kiwis reach their highest densities in lowland and coastal indigenous forest, which probably indicates that this is their preferred habitat. Potter (1989) demonstrated experimentally that brown kiwis in Northland prefer regenerating forest to rough farmland, and McLennan et al (1987) found in Hawke's Bay that the birds prefer mature indigenous forest to mature scrubland. However Potter (1990) also showed that birds made considerable use of forest remnants that were separated from major tracts of forest by areas of farmland.

Kiwis colonise exotic pine forests in Northland and Taranaki, generally when the stands reach an age of about 10 years (Colbourne and Kleinpaste, 1983). Despite their structural simplicity and acidic litter, these exotic forests seem to be quite suitable for kiwis, since the birds living within them achieve similar body weights, productivity and densities to those in indigenous forests (M. Taborsky, pers. comm). There are, however, few kiwis in exotic forests in the Bay of Plenty and Hawke's Bay, presumably because few young are being produced nearby to colonise them (McLennan, unpublished).

In contrast to brown kiwis, great spotted kiwis reach their highest densities in wet, mossy, sub-alpine vegetation. Recent studies suggest that a large form of great spotted kiwis inhabits upland areas, and a somewhat smaller form lives in lowland and coastal forests (McLennan and McCann, unpublished). This specialisation implies that a portion of the population is adapted to upland areas, and that the birds there today are not merely a remnant of a once more extensive population.

Great spotted kiwis in Northwest Nelson feed along the fringes of rough farmland, but seldom live in it permanently. They also feed in stunted forest and scrub on sand-dunes, and along the margins of tidal estuaries which abut forest. Great spotted kiwis have not colonised pine forests, although there are some within their present geographical range.

Little is known of the habitat preferences of little spotted kiwi. The birds on Kapiti Island occupy all of the vegetation types there, including flax, mixed scrub, seral and older forest, and rough grassland, though only where the last adjoins forest (R. Colbourne, J. Jolly pers. comms.). Densities may be lower in mixed scrub/grassland areas.

Little spotted kiwis formerly overlapped in distribution with brown kiwis in both the North and South Islands. Richard Henry (quoted by Hill and Hill, 1987) observed in Fiordland that little spotted kiwis generally preferred lighter, drier forest, while brown kiwis preferred moist and shady areas, however the two did move over `the same ground'. Any segregation between the two species is not obvious on Kapiti Island today, the only place where they still live together. The 50 or so brown kiwis on Kapiti do live mainly in moist areas, but they share them with little spotted kiwis (J. Jolly and R. Colbourne, pers. comm.).

Nothing is known of the ecological factors that led to the development of brown and great spotted kiwis as separate species. The ranges of the two species don't overlap today, and may never have. Great spotted kiwis have a shorter, stouter and straighter bill than brown kiwis, but the diets of both

species are similar. Earthworms, cicada nymphs and beetle adults and larvae are their main foods, supplemented by a few seeds and leaves and a wide variety of other invertebrates (Reid, et. al, 1982; Colbourne and Powlesland, 1988; McLennan and McCann, unpublished). Little spotted kiwis also eat a wide range of soil-inhabiting invertebrates (Colbourne, Baird & Jolly, 1990). They may take slightly smaller items and depend less on aquatic insects than do the larger kiwis (Hill and Hill, 1987, quoting Richard Henry).

6.3 SOCIAL BEHAVIOUR AND DISPERSION

In most parts of New Zealand, kiwis are both monogamous and territorial. Pairs generally form long-lasting bonds which persist for several or more years. Territories vary in size from 1.6 ha to 40 ha, depending on species and locality, and are defended by both members of a pair.

Two exceptions to this social system have been noted in Northland. Potter (1989) found at Tangiteroria that pairs occupied home ranges of about 30 ha, which overlapped with those of other birds. A little further north at Waitangi, M. Taborsky (pers. comm.) observed a complex system. Some unpaired males were not territorial and ranged widely, others did hold territories but these overlapped considerably with territories of paired birds. Paired birds' territories hardly overlapped at all with other pairs. The most notable departure from the normal social system is on Stewart Island, where the birds live in groups of varying size and composition (R. Colbourne, pers. comm.). Large groups comprise three to five mature adults, and a similar number of juveniles of various ages. The members of groups appear to be related and co-operate together to brood chicks, defend their territories, and possibly share incubation of eggs.

The social behaviour of kiwis is such that the birds have a large requirement for space, irrespective of whether they are living in pairs or groups. This in turn implies that they need large areas of forest or scrub (in the order of 5 000 - 15 000 ha) to maintain self-supporting populations (McLennan et. al, 1987). Such areas still remain in most districts of the mainland, and they must be preserved in their entirety if kiwis are to have a good chance of surviving indefinitely.

The variety of social behaviour among kiwis also has implications for the techniques used to assess kiwi abundance. The most frequently used technique relies on counts of calls, and assume that these originate from territorial pairs. We now know that this underlying assumption is not always appropriate, and techniques will have to be developed which allow for variations in social behaviour.

6.4 BREEDING BEHAVIOUR AND BREEDING SUCCESS

All three species of kiwi are K-selected, in that adults are long-lived and have low reproductive rates. Average life-spans are probably about 10 years, with some adults achieving an age of 30-35 years. Male kiwis are sexually mature at an age of 18 months; females do not lay until they are 3-5 years old (Reid & Williams, 1975).

All three species have a long breeding season, beginning in June or July and finishing in February or March. This means that kiwis in the mountains of the South Island often lay when the soil is frozen and temperatures at night are well below 0°C.

Egg Production

Brown kiwis in the North Island normally lay two eggs, 20 - 30 days apart, in a short burrow dug into the side of a bank or hill. In Tangiteroria (Northland), kiwis seldom re-lay if their first clutch fails, but instead wait a year before they try again (Potter, 1989). Females in low density populations in Hawke's Bay are more productive. They replace eggs which fail early in the breeding season, and sometimes lay a second clutch after their first one has

successfully hatched (McLennan, 1988). This means that they often lay four or five eggs in as many months, with a combined weight similar to that of their own body.

Little spotted kiwis on Kapiti Island have clutches of one or two eggs, and sometimes lay twice in a breeding season if their first clutch fails (Jolly, 1989). They may also occasionally lay in autumn.

Great spotted kiwis in Northwest Nelson usually lay just one egg a year, irrespective of whether they are in lowland or upland forest (McLennan and McCann, unpublished). Replacement layings are very rare, and seem to be achieved only by females which are exceptionally heavy at the beginning of the breeding season.

The rate of egg production of the birds further south is not known. Nests on Stewart Island usually contain one egg, as did one found at Okarito in July 1990 (R. Colbourne, pers. comm.).

Incubation

Males do all of the incubating in the North Island, but both sexes share the task in the South Island and on Stewart Island (McLennan, 1988; Jolly, 1989; Potter, 1989: McLennan and McCann, 1989; Colbourne, unpublished.). Little spotted kiwis on Kapiti Island also have male-only incubation (Jolly, 1989). Incubation takes 70 to 80 days in all species.

Breeding Success

About 75% of the eggs laid by brown kiwis in the North Island fail to hatch (McLennan, 1988; Potter, 1989). Some are deserted for no apparent reason, some are invaded by microbes, some are chipped or cracked by the incubating male, some are infertile, and a few are eaten by predators, probably possums. About half of the chicks that do hatch die in their first three weeks of life, before they are old enough to leave the nest. Pairs in both Hawke's Bay and Northland fledge 0.3 to 0.5 chicks per year (McLennan, 1988; Potter, 1989). Few chicks probably survive the journey to adulthood, but there is no information on this.

The breeding success of little spotted kiwis on Kapiti Island is extremely low at least in some years and localities. Jolly (1989) measured an average production over five years of 0.08 chicks per pair per year in his two study areas. Wekas ate two-thirds of the kiwi's eggs, and possibly some of their newly-hatched chicks as well.

About 70% of the eggs laid by great spotted kiwis in the Saxon and Kahurangi areas of Northwest Nelson fail during incubation (McLennan and McCann, unpublished). Invasion by microbes seems to be the main cause of egg loss, followed by breakage of the eggs by the incubating adults. A few eggs are lost without trace, possibly to stoats. In the Saxon area, five chicks have probably been produced in 21 pair-years, while at Kahurangi, two chicks have probably been produced in four pair-years. Average production for both populations is therefore about 0.28 chicks per pair per year, a little lower than that of brown kiwis in the North Island.

Summary

In summary, kiwis have a low natural breeding success with many eggs lost in incubation. This is compounded by some additional loss of eggs to introduced predators. However in most populations, pairs appear to be producing sufficient young to replace themselves every two to eight breeding seasons. This implies the failure of some populations on the mainland is caused by poor adult and/or juvenile survival rather than inadequate breeding.

7.0

Ability to Recover

Kiwis in large populations have no known genetic disorders or inherent weaknesses that might prevent them from responding to management. Those in small, isolated populations face, in addition to the usual threats, random processes such as genetic drift and fluctuations in sex ratio which can lead to extinction. These too can be counteracted by appropriate management, although in practice it might not be possible to do this on a large scale.

Kiwis have proved to be robust animals that can be handled and transported with little apparent harm. The North Island brown kiwis breed regularly in captivity and both great and little spotted have done so occasionally.

8.0

Options for Recovery

8.1 OPTION 1: DO NOTHING

All mainland populations of kiwis are either vulnerable or threatened, and therefore require some action, however small. The population of little spotted kiwis on Kapiti requires continuing attention until at least one other viable population has been established elsewhere.

8.2 OPTION 2: MANAGEMENT IN SITU

The preservation of kiwis on the mainland will depend ultimately on our ability to manage them in situ. The prospects for doing this successfully in the immediate future are uncertain: we still don't know enough about the status, distribution, size and genetic make-up of most mainland populations to make informed management decisions. Equally importantly, we do not have a good understanding of the threats to current populations which we need to direct management effectively.

There have been no attempts yet to manage a population in situ to reverse a decline, mainly because few populations have been studied in any detail and the specific causes of attrition are seldom known. In practice, however, it may be difficult to reverse a decline on the mainland, especially if predators are (as suspected) one of the main causes of it. Predator control is currently expensive, time-consuming, of short-term benefit, and applicable only on a small scale. However rapid developments are being made in this area and improved techniques may soon be available.

8.3 OPTION 3: TRANSLOCATIONS

On many occasions in the past 50 years, kiwis have been moved from one part of the country to another, either to remove them from threats (such as land clearance) or to increase their numbers and distribution. Some of these translocations have

succeeded spectacularly, but others have failed dismally, especially those involving movements between mainland areas. There is increasing evidence that transfers are more likely to be successful if `behaviourally related' individuals are used (R. Sadleir, pers. comm.) and lack of recognition of this may have been a factor in some of the failures.

Despite the mixed success, translocation can be an extremely useful management tool, and may have a substantial role to play in the future.

Transfers Between Islands

The option of moving kiwis from one offshore island to another has already been exercised on five separate occasions in the past decade, with the transfer of little spotted kiwis from Kapiti and D'Urville to other offshore islands. There are indications that this has been successful, though some time is needed before the establishment of new self-sustaining populations is confirmed.

Transfers from the Mainland to Offshore Islands

Kiwis have been transferred from the mainland to offshore islands on numerous occasions, following Richard Henry's famous attempts to establish viable populations on Resolution Island at the turn of the century. He was unsuccessful then in the case of the little spotted kiwi, but such transfers have since been crucial to the conservation of this species.

Transfers from the Mainland to the Mainland

There have been a number of transfers of North Island brown kiwis within the North Island to shift birds threatened by land clearance. In general these have been unsuccessful, probably due to the animals being placed in areas where kiwis have disappeared in the past through causes that are still present, or perhaps to them attempting to `home' to their previous areas.

Transfers from Offshore Islands to the Mainland

This option has not yet been exercised, but there are no reasons to think it would not be successful if the threats to the species on the mainland had been addressed.

8.4 OPTION 4: CAPTIVE BREEDING

Captive breeding and rearing can be either a useful aid to the recovery of some populations or the last backstop in a conservation programme. In the North Island brown kiwi, for example, it is technically possible to remove eggs from some populations, hatch them in captivity, raise the chicks to an age where they are no longer vulnerable to predators, then return them to the wild.

Such an option is not yet available for great spotted and little spotted kiwis, nor for South Island brown kiwis. Few representatives of these species and sub-species are held in captivity, mainly because the skills for holding and breeding them have not yet been developed.

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