Takahe (*Porphyrio hochstetteri*) recovery plan

2007–2012

THREATENED SPECIES RECOVERY PLAN 61

Department of Conservation
Te Papa Atawhai

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Chrissy Wickes, Dave Crouchley and Jane Maxwell

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Foreword

The General Manager—Operations Southern of the Department of Conservation (DOC) formally approved this threatened species recovery plan in June 2008. A review of the plan is due in 2012, or sooner if new information or technology leads to a significant change in management direction. This plan will remain operative until a new plan has been prepared and approved, or will become redundant if recovery is achieved and management effort enters a 'maintenance phase'.

The Takahe Recovery Group prepared this plan in conjunction with people interested in or affected by the plan, or with an expert knowledge of the species. Drafts have been sent to relevant conservancies for comment and to people or organisations with an interest in conservation management of takahe (*Porphyrio hochstetteri*). Changes to the plan were made as a result of that consultation.

The recovery group will review progress in implementation of this plan and will recommend to managers any changes that may be required in management.

The recovery planning process provides opportunities for further consultation between DOC, tangata whenua and others regarding management of this species. Comments and suggestions regarding conservation of takahe are welcome and should be directed to the Takahe Recovery Group via any DOC office or to the Manager, Threatened Species Development Section (Research and Development Group, Department of Conservation, PO Box 10420, The Terrace, Wellington 6143). Those interested in being more involved in management of takahe or in receiving information should also contact the recovery group.

The recovery group consists of people with knowledge of the ecology and management needs of the species. The role of the recovery group is to provide high-quality technical advice that achieves security and recovery of the species.

Threatened species recovery plans are statements of the Department's intentions for the conservation of a particular species of plant or animal, or group of species for a defined period.

Recovery plans:

- Are proactive and operational in nature, focusing on specific key issues, providing direction, and identifying recovery actions for managers and technical workers.
- Set objectives to secure from extinction and recover the species, and outline measurable actions needed to achieve those objectives.
- Are primarily used by DOC staff to guide their annual work programmes; however, they also provide a forum for planned initiatives with tangata whenua, community interest groups, landowners, researchers and members of the public.
- Stimulate the development of best-practice techniques and documents, which can be transferable across similar species recovery programmes.

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A B S T R A C T

The takahe (*Porphyrio hochstetteri*) is an endangered species and classed as Nationally Critical under the New Zealand Threat Classification System. Active management is needed to ensure its long-term survival. This is the third national recovery plan for takahe and replaces the previous (2002–2007) recovery plan. This 5-year plan is a guide for the Department of Conservation and other agencies involved in conserving takahe. Its main objective is a 25% population increase for takahe by 2012. To achieve this, the Takahe Recovery Programme will expand the Fiordland population with liberations of takahe produced on islands or in mainland sanctuaries and at the Burwood Captive Rearing Unit to sites beyond the Murchison Mountains, where the main wild population of takahe currently exists. The programme will maintain the populations on islands or in other sanctuaries at a level of maximum productivity. In the Murchison Mountains, the management focus will be to increase the population to the area's natural carrying capacity. The recovery programme will continue research and monitoring to determine the factors that impact on takahe populations, and will continue to work with Ngai Tahu, other key associates, and the public.

Keywords: *Porphyrio hochstetteri*, takahe, threatened species recovery, predation, competition, habitat quality, island sanctuaries, mainland sanctuaries, captive rearing, Mitre 10 Takahe Rescue, community engagement

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1. Introduction

The takahe or notornis (*Porphyrio hochstetteri* Trewick, 1996; previously known as *Notornis mantelli* Owen, 1848) is a large, flightless, endemic rail, once thought to be extinct, as there had been only four confirmed sightings between 1898 and 1948. However, locations of unconfirmed reports between 1898 and 1948 suggested that takahe survived during this period throughout Fiordland National Park, and in pockets spread along the Southern Alps/Ka Tiritiri o te Moana as far as the northwest of the South Island (Reid 1974). An expedition in 1948, led by Doctor Geoffrey Orbell, located a population in the Murchison Mountains, Fiordland National Park. Surveys subsequently found about 250 birds in the valleys of the Murchison Mountains and neighbouring ranges. Soon after takahe were rediscovered in 1948, the 503-km^2 Takahe Special Area was set aside for their conservation within the Murchison Mountains (Fig. 1).

In the two decades following 1948, a large amount of information on the natural history of takahe was collected, and intensive research commenced in 1972 to determine the species' ecological requirements, breeding biology and population size (e.g. Mills 1975).

By the 1970s, the takahe population in Fiordland had declined dramatically and it appeared that the species was in danger of extinction. The takahe population reached an estimated low of 112 birds in 1981.

The primary cause of takahe decline in Fiordland since 1948 has been habitat deterioration caused by high numbers of introduced red deer (*Cervus elaphus*), which had become established in Fiordland during the 1940s and 1950s. Ground control of deer had started in the Murchison Mountains in 1948; this was extended to intensive helicopter hunting in 1976. Predation by introduced mammalian predators, particularly stoats (*Mustela erminea*), has also contributed to takahe decline.

From 1957 to the 1970s, an attempt was made to establish a captive breeding programme in conjunction with a private bird breeder in what is now the National Wildlife Centre at Pukaha Mount Bruce, Wairarapa (Fig. 2). This was partially successful, and some birds were produced. However, setbacks were encountered due to behavioural and disease problems resulting from the limitations of the facilities. First attempts at captive rearing of wild-laid eggs were also carried out at the Te Anau Wildlife Centre.

By the 1980s, results of earlier research were being used to support the implementation of a wide-ranging management plan for takahe. This included deer and stoat control, the intensive management of the wild takahe population to maximise breeding success, habitat manipulation (territory-based fertiliser trials) to improve habitat quality for the birds, the establishment of a new wild population in Fiordland, and the building of a dedicated captive rearing facility (Burwood Captive Rearing Unit) to provide birds to establish new populations in Fiordland and on browser- and predator-free islands.

The Burwood Captive Rearing Unit was opened near Te Anau, Fiordland, in 1985. This specialist facility was built on a 9.7-ha parcel of land adjacent to the 3104-ha Burwood Bush Scientific Reserve (Fig. 2). (This unit is referred to simply as Burwood in the rest of this plan.) Approximately half of the Burwood

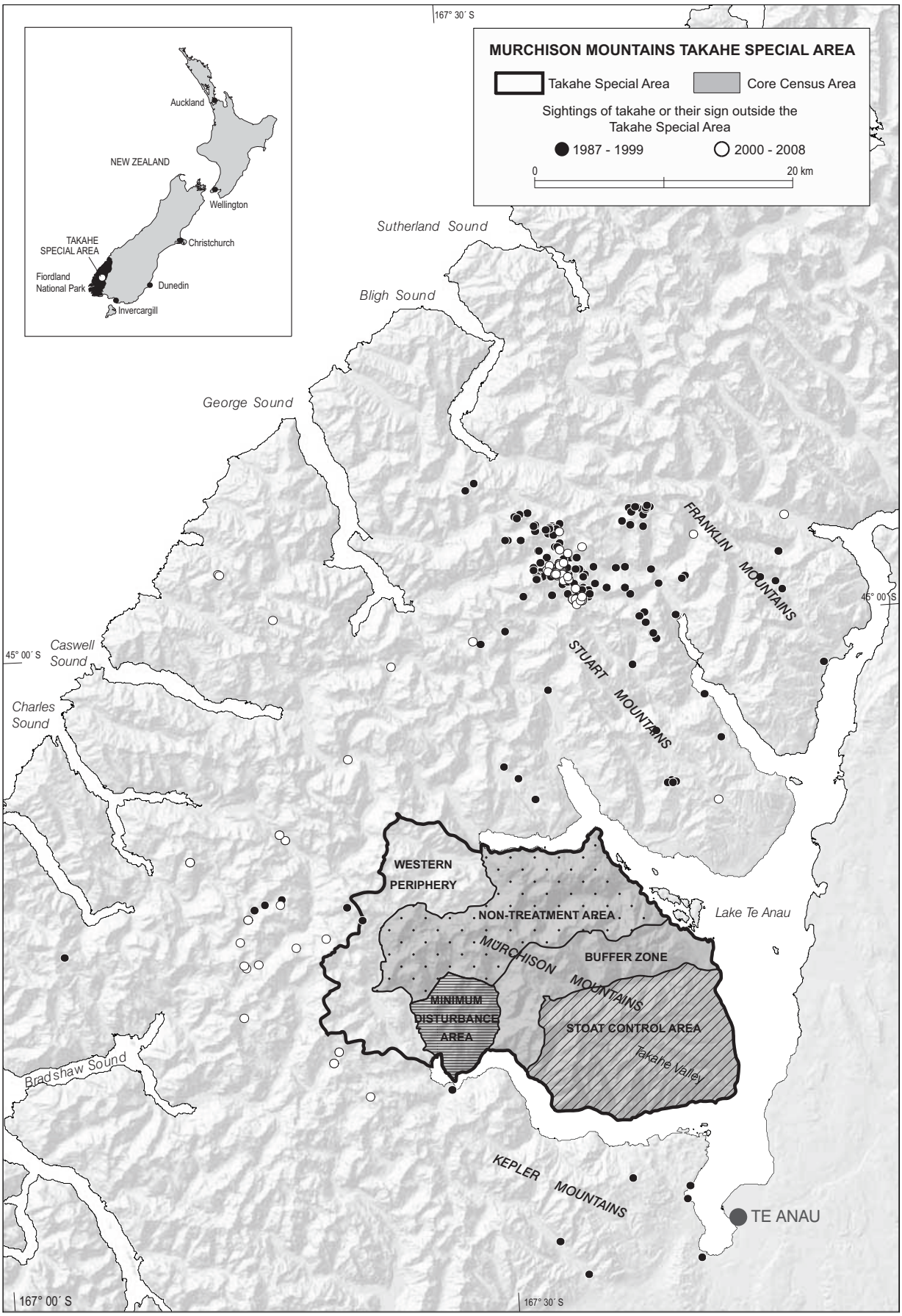

Figure 1. Takahe (*Porphyrio hochstetteri*) distribution in Fiordland, including the Murchison Mountains Takahe Special Area (showing extent of the area under stoat control during stoat trapping trial, c. 15 000 ha) and sightings of takahe outside the Murchison Mountains (between 1987 and 2008).

Figure 2. Map of New Zealand showing the various locations of free-ranging populations of takahe (*Porphyrio hochstetteri*) (Fiordland, four offshore islands and one mainland sanctuary) and captive populations of takahe (Te Anau, Burwood, Pukaha Mount Bruce).

Bush Scientific Reserve is red (*Nothofagus fusca*) and silver (*N. menziesii*) beech forest, with the rest being red tussock grassland and areas of native shrubs. An 80-ha area within the scientific reserve has been fenced to exclude predators and is used to hold takahe. Eggs are collected from nests in the wild and artificially incubated and reared at Burwood, and a small breeding group is also maintained there. Birds from Burwood have been used to establish takahe populations on five offshore islands (Maud, Mana, Kapiti, Tiritiri Matangi and one other[1]) and (latterly) one mainland sanctuary (Maungatautari Ecological Island, near Hamilton) (Fig. 2), and for release back into the wild in Fiordland. Also, in addition to Burwood, a few captive birds are also held at Te Anau Wildlife Centre and at Pukaha Mount Bruce National Wildlife Centre.

Since about 1981, the population of takahe in the Murchison Mountains has fluctuated between 93 and 167 birds. To standardise technique each year, monitoring effort is restricted to the 'Core Census Area' which consists of all

[1] One island is confidential at owners' request.

suitable habitat east of the Esk Burn and Woodrow Burn streams (the remainder of the Takahe Special Area is termed 'the western periphery', where a census is carried out once every 5 years) (Fig. 1).

Weather records have been kept in the Murchison Mountains (Takahe Valley) since 1972. Five of the coldest winters occurred during the mid 1990s, with the winter of 1995 being the coldest since records started. Without the captive-rearing and re-introduction programme and effective deer control over this period, it is likely that the takahe population in the area would have declined to near extinction.

In June 2008, the estimated population of takahe was approximately 93 in the Core Census Area; 91 on islands and at Maungatautari, 36 at Burwood, and 5 display/advocacy birds at Pukaha Mount Bruce National Wildlife Centre and the Te Anau Wildlife Centre. In addition, occasional sightings are made of takahe in Fiordland beyond the Core Census Area. Two such takahe were recorded during the 2007/08 year, bringing the current total population estimate to 227 adult takahe. Birds under 1 year of age are not counted in these totals

With deer now controlled to low numbers in the Murchison Mountains, climatic conditions and predation (especially by stoats) appear to be the key factors limiting recovery of the wild takahe population.

The relative importance of naturally (climate) induced habitat changes versus human-induced changes in the decline of the species prior to European settlement have been debated. Some authors have suggested that the species was more heavily influenced by human hunting than climate-induced reduction of grasslands, and has a wider habitat tolerance than the preference for alpine grasslands exhibited in their remnant natural range; and that management activity thus ought to be spread over a wider selection of habitat types including lowland forest (Jamieson & Ryan 2001). In practice, additional management sites for the birds are limited to those that are predator-free or at least predator-controlled, and the available sites are all lowland. Takahe established on predator-free islands have the choice of lowland forest and grassland habitat types, but have remained predominantly grassland feeders (Dawson 1994; Baber 1996).

2. Plan term and review date

Term of the plan: 5 years, from August 2007 to August 2012

Review date: August 2012

3. Context

3.1 OVERVIEW OF SPECIES

3.1.1 Species ecology and biology

The primary features of takahe ecology which affect their conservation are their specialised feeding habits, some components of their behaviour, and aspects of the environments in which they live. In Fiordland, takahe live in alpine grasslands and feed on tussocks during much of the year. Snow tussocks (*Chionochloa pallens*, *C. flavescens* and *C. crassiuscula*) are their preferred food. In winter, the birds move into forested valleys, where a major food source is the rhizome of the fern *Hypolepis millefollium*. Takahe on islands feed year-round on a mixture of native and introduced grasses. On Kapiti Island, which is mostly covered in forest, areas of grassland and swamps are highly preferred by takahe.

Adult birds live in pairs and maintain large territories, which they defend aggressively against other takahe during the breeding season. This means that, even in very good habitat, population density is low. Takahe are long-lived birds and have a low reproductive rate, with clutches consisting of 1–3 eggs. Usually only one chick is raised per clutch, however, and only a few pairs manage to rear chicks consistently from year to year. While this low reproduction rate is generally sufficient to maintain the population under normal conditions, recovery from catastrophic events is slow.

For a summary of key research into the ecology of the takahe and conservation efforts since 1948, see Lee & Jamieson (2001).

3.1.2 Status and species recovery phases

The takahe is an endangered species classified as 'Nationally Critical' under the New Zealand Threat Classification System (Miskelly et al. 2008).

DOC's Recovery Action Model has four phases (see Appendix 1):

1. Research—identify cause and key agent(s) of decline
2. Security
3. Recovery
4. Maintenance

The recovery programme for takahe has progressed through the first three phases: the agent/s of decline of the takahe have been identified, the species is secure from immediate extinction and recovery is established by having populations at a number of sites. The current recovery programme is focused on managing the agents of decline and is working towards the fourth phase of recovery—maintenance.

Achieving the goals set out in this recovery plan will improve the threat status of takahe from 'Nationally Critical' to 'Nationally Endangered'.

It is not currently feasible to improve the threat status of takahe further (to 'Nationally Vulnerable'). To do this will require a population increase from the current 200+ to 1000–5000 individuals, requiring an area[2] of approximately

[2] Area has been calculated from habitat surveys completed over large areas of Fiordland during the 1980s.

150 000 ha with predators and competitors eradicated or controlled to low levels on an ongoing basis. Such a large area would have to be on the mainland, and have natural boundaries to contain the birds. Takahe will remain under some level of threat and require ongoing management for the foreseeable future.

3.1.3 Past and present distribution

The distribution of subfossil remains indicates that takahe once occurred over a wide area of New Zealand. In prehistoric times, the takahe population appears to have declined from a New Zealand-wide distribution to one centred on Fiordland with scattered pockets of birds elsewhere in the country (Reid 1974) (Fig. 2 shows current distribution). Remains of takahe have been found in middens in the North Island and eastern South Island, showing that at some point Maori encountered takahe in these regions. Printed accounts of Maori legends indicate that by the time of European colonisation in the mid 1800s, takahe were known only in the southern South Island (Williams 1960). Morphometric research has separated the now extinct North Island birds as a separate species from the South Island birds. Birds of the northern species (*P. mantelli*) were taller and less stocky than the southern *P. hochstetteri* (Trewick 1996). Although *P. hochstetteri* now occurs naturally only in alpine grasslands, subfossil remains have been found in a variety of habitats, including areas dominated by forest cover (Atkinson & Millener 1991).

In addition to the wild Fiordland population, work has been carried out since the mid 1980s to establish a second population. To achieve this, takahe have been translocated to five islands (Maud, Mana, Kapiti, Tiritiri Matangi and a further southern island) and (latterly) one mainland sanctuary (Maungatautari) (Fig. 2). The founding birds for this population came from an earlier breeding programme established in Wairarapa during the 1960s and 70s, and the first birds artificially reared at the Te Anau Wildlife Park, before the Burwood Captive Rearing Unit was established nearby. A small number of takahe are also held at Burwood, Te Anau Wildlife Park, and Pukaha Mount Bruce National Wildlife Centre) for captive breeding or display purposes.

3.1.4 Past management and the species response

Past management

Management of takahe has proceeded in some form ever since the birds were rediscovered in 1948. Recovery and maintenance of the remnant wild population within the Murchison Mountains Takahe Special Area in Fiordland National Park (Fig. 1) has been the main priority of takahe research and management since their rediscovery, and research in the early years (1949–60) was directed at gathering basic information about this little known bird (e.g. Falla 1951; Williams & Miers 1958; Williams 1960). Deer control began in 1948 and intensified during the 1960s and 1970s. Early attempts at captive breeding began in 1957, with only sporadic success. An integrated research programme was begun in 1972 (Mills 1990). It covered a wide range of topics including takahe population studies, reproductive biology, feeding and nutrition. An important result of the population studies was the discovery that takahe pairs generally succeed in raising only one chick per year, even though they may hatch up to three. Related work was carried out on stoats, deer and the grassland habitat. Results from the studies emphasised the importance of poor nutrition in chick loss and the detrimental effects of deer on habitat quality.

The most important management technique that resulted from this was the stringent control of deer, involving both ground and helicopter hunting, in the Takahe Special Area. Application of fertiliser to tussock vegetation in takahe territories was tried in an effort to improve habitat quality, but the differences in breeding success between the fertilised and non-fertilised areas were not great enough to justify continuing this trial. No written report was produced for it.

In 1981, a co-ordinated approach to takahe conservation was begun, based on the results from the earlier research (Mills et al. 1982). Nests in the Murchison Mountains have been managed each year to ensure that most pairs incubate fertile eggs, and put their effort into raising single, healthy chicks. A programme was begun to establish another wild population to the north of the Murchison Mountains in the western Stuart Mountains (Fig. 1). The release programme in the Stuart Mountains was stopped in 1993 due to concern over difficulties with monitoring the population and the apparent low number of birds remaining in the release region. At the same time, the Murchison Mountains population was found to be declining, and using captive-reared birds to boost numbers there became the main priority. Artificial rearing involves removing 'extra' eggs (surplus to the one healthy chick per pair regime), artificially incubating and rearing the chicks, and then releasing the young birds (as yearlings) back into the wild. The techniques were developed at the Te Anau Wildlife Park until a new facility was built at Burwood in 1985, where hygiene and behavioural management could be more strictly regulated. Twelve to eighteen Burwood-reared takahe yearlings are now released annually, and at least 38% of breeding pairs in the Murchison Mountains consist of at least one Burwood-raised bird. To date (June 2008), 242 Burwood-reared birds have been released into Fiordland.

Stoat trapping was established in valley floors of five of the six main catchment areas in the Murchison Mountains. It was not set up experimentally or with any associated monitoring to determine its effectiveness at protecting takahe. When resources became limited in the late 1980s, it was discontinued.

Introduction of takahe to relatively secure offshore islands (free of most browsing and predatory mammals) began in the 1980s (see section 3.1.3). This was to ensure that there were self-sustaining 'insurance populations' if the Fiordland population suffered some catastrophic event. The islands where populations have been established so far are Maud, Mana, Kapiti, Tiritiri Matangi and one other southern island (Fig. 2). Birds have been transferred between these islands on a regular basis to assist with building numbers and managing the genetic pool as one larger population. Small numbers of birds continue to be held at Te Anau Wildlife Centre and Pukaha Mount Bruce, mostly for display or advocacy purposes, and birds have also been translocated to a mainland sanctuary at Maungatautari (near Hamilton).

In summary, takahe conservation over the past 25 years has probably prevented the extinction of this species. Long-term research has produced invaluable information for the conservation of the species.

Current management

Current management involves a combination of programmes with the primary aim of increasing the numbers of birds and providing secure habitats:

- Agents of decline are managed within the Murchison Mountains with annual deer control and stoat trapping.
- Murchison Mountain nests are manipulated to ensure maximum productivity. Eggs are incubated and chicks raised at the Burwood Captive Rearing Unit before release.
- Five islands and one mainland sanctuary hold insurance populations and contribute to the breeding population.
- Data is analysed on an ongoing basis to guide management.

3.2 STRATEGIC DIRECTIVES

This recovery plan supports The New Zealand Biodiversity Strategy (DOC & MfE 2000):

Maintain and restore viable populations of all indigenous species and subspecies across their natural range and maintain their genetic diversity.

3.3 CULTURAL IMPORTANCE

Ngai Tahu have a special relationship with a number of endemic and threatened flora and fauna species, including takahe. These species are taonga to Ngai Tahu. This special relationship has been recognised and provided for in sections 287–296 of the Ngai Tahu Claims Settlement Act (1998), which requires DOC to consult with and have particular regard to the views of te Runanga o Ngai Tahu when making decisions regarding the management of any taonga species.

3.4 PUBLIC AWARENESS

There is a high level of public interest in and concern for takahe. Opportunities for people to see wild takahe are limited, but display/advocacy birds are held at Pukaha Mount Bruce National Wildlife Centre and Te Anau Wildlife Centre. Free-ranging takahe may be encountered on islands which allow public access (e.g. Kapiti) and at Maungatautari. There is a commitment to provide up to 4% of the entire takahe population for public display, if suitable birds are available[3] (as of June 2008 this equates to potential maximum of nine birds).

A takahe fact sheet is available from the DOC website (www.doc.govt.nz) and conservation groups are kept informed through occasional updates and contributions to magazines.

A relationship with schools is maintained by supporting the LEARNZ internet- and audio conferencing-based education programme, and annual tours through Burwood for groups from local schools.

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[3] This was agreed at the August 2007 Takahe Recovery Group meeting and recorded in the minutes.

The current sponsorship programme by Mitre 10 also provides opportunities for takahe publicity through promotional events (such as children's art competitions) and publicised activities such as bird translocations involving Mitre 10 staff (see section 3.5).

3.5 PARTNERSHIPS AND KEY ASSOCIATES

Mitre 10 first signed an agreement with DOC to support takahe recovery in 2006. This resulted in DOC receiving $50,000 per annum for a 3-year period, referred to as the 'Mitre 10 Takahe Rescue fund'. The partnership has focused on increasing the capacity of the captive rearing unit at Burwood by investing in infrastructure, facilities and additional staff.

In addition to supporting the captive breeding programme, a number of new initiatives were developed to increase the public's awareness of the partnership between DOC and Mitre 10 and the takahe recovery programme in general. This included setting up annual events such as the Mitre 10 Takahe Rescue National Kids Art Competition (which is promoted through schools), holding short story writing competitions and by encouraging Mitre 10 staff to get involved in promoting takahe in their local stores. The success of these initiatives resulted in Mitre 10 and DOC receiving an award at the 2008 New Zealand Herald Sponsorship awards for the best under $50,000 sponsor/recipient partnership arrangement.

In 2008, a new 3-year agreement was signed and the Mitre 10 takahe Rescue fund was increased to $70,000 dollars per annum.

In addition to Mitre 10, DOC has a number of other partnerships with community groups. In general, the groups support restoration at specific locations rather than focusing specifically on takahe. One exception is the Fiordland Tramping and Outdoor Recreation Club, which provides volunteers to check traps within the Takahe Special Area in the Murchison Mountains.

4. Goals

4.1 LONG-TERM RECOVERY GOALS

Goal 1: Maintain and expand the Fiordland range of the takahe to achieve a population greater than 100 breeding pairs

Goal 2: Maintain the current island and mainland sanctuary populations and expand numbers of island/sanctuary sites to achieve a population of greater than 100 breeding pairs

(*In June 2008, the Murchison Mountains had 21 breeding pairs, and the island and mainland sanctuaries and Burwood had 30 breeding pairs.*)

4.2 RECOVERY PLAN-PERIOD GOALS

4.2.1 Management

There will be a 25% increase in the total number of takahe over the period of the plan from 227 (including 51 breeding pairs) in 2008 to 283 (including 63 breeding pairs) by 2012

4.2.2 Community relations

New Zealanders' awareness and support of takahe and the Takahe Recovery Programme is enhanced

4.2.3 Research and innovation

Investigation of factors likely to limit population recovery will continue. Environmental, breeding and survival records will be analysed to identify key factors affecting population recovery

5. Implementation

This section provides short-term direction for DOC managers and community groups involved in takahe recovery by identifying desired actions for achieving the twelve objectives specified in this plan.

This plan is grouped into three themes which are common to species recovery programmes (management, community relations, and research). Under each theme are topics with background, objectives, issues and actions to resolve the issue(s).

The actions allocated to a particular objective may provide opportunities to work toward the goals of the other themes. Therefore, notes identifying how these actions or areas of work can contribute to the other themes have been included.

The actions have been prioritised as 'essential', 'high', 'medium' or 'low'. A timeline for recovery actions is provided in Appendix 2.

5.1 MANAGEMENT

5.1.1 Topic 1—Murchison Mountains takahe population

The Murchison Mountains (Fig. 1), where the remnant takahe population was rediscovered in 1948, remain the primary mainland site for takahe recovery. They cover a large area (c. 50 000 ha) and have geographical characteristics which facilitate their management as a mainland island[4]. These include natural barriers, with Lake Te Anau to the east, north and south, and the rugged mountains of Fiordland to the west. These barriers also limit the dispersal of takahe outside of the area. This 'containing' of takahe enhances their chance of pairing and therefore breeding. These landscape factors, as well as the limited suite of predators present (i.e. no cats, ferrets or dogs) has enabled the Murchison Mountains to remain a significant stronghold for takahe and a variety of other threatened species including blue duck (whio, *Hymenolaimus malacorhynchos*), kiwi (tokoeka, *Apteryx australis*), yellowhead (mohua, *Mohua ochrocephala*) and rock wren (*Xenicus gilviventrus*).

Studies have shown that competition with red deer (Mills & Mark 1977), extreme environmental conditions (harsh winters in particular; Maxwell 2001), and stoat predation are key agents of takahe population decline in the Murchison Mountains (Hegg 2006).

Red deer in the Murchison Mountains originated from liberations made near Manapouri between 1901 and 1910. They spread via the Kepler Mountains, arriving in some of the western catchments of the Murchison Mountains in the late 1920s. At the time of the rediscovery of the takahe in 1948, deer were at about peak numbers in parts of the northwest Murchison Mountains (Parkes et al. 1978). By the early 1970s, it was apparent that degradation of key takahe food tussocks by heavy deer browse was causing a significant decline in takahe numbers. Deer

[4] Mainland islands are areas of land able to be managed to restore and protect their habitat, particularly through intensive management of pests. They are referred to as mainland 'islands' because they are manageable areas isolated by means of fencing, geographical boundaries or, more commonly, intensive management.

have long been implicated as a major factor in the decline of the takahe. They compete with takahe for the palatable alpine plants (Mills & Mark 1977), and studies have shown that tussocks, especially, take a long period of time to recover their nutritional content after heavy deer browsing (Lee et al. 2000).

Population estimates calculated from harvest data indicate that the deer population in the Murchison Mountains in the early 1960s was approximately 4500 animals (Fraser & Nugent 2003). Intensive ground hunting halved their numbers by 1976, when helicopter hunting was introduced. Helicopter hunting proved highly effective, and resulted in further dramatic reductions in the deer population. Deer numbers in the Murchison Mountains continued to fall until they reached about 300–350 animals in the late 1980s. The commercial value of deer had supported control operations over this period; so, when values dropped at the end of the 1980s, hunting effort also declined significantly. DOC maintained control operations through the 1990s, but the reduced levels of effort resulted in a gradual increase in deer numbers until the population had risen to about 500 animals in 1997. Increased effort and a more systematic and planned approach to hunting operations were implemented following a review of the programme in 1997. This achieved a reduction in the deer population to about 400 animals by 2001 (Fraser & Nugent 2003).

At present, the deer population in the Murchison Mountains is estimated to be approximately 350 animals, and it is thought that controlling the population to this level enables habitat quality suitable for takahe to be maintained in this area. The deer control operation in the Murchison Mountains has supported takahe recovery through improved habitat (Lee et al. 2003).

The main methods of deer control used are helicopter hunting over the summer and autumn, ground hunting during the spring, autumn and early winter, and deer capture pens used occasionally along the eastern lake faces year round. New deer control techniques and efficiencies are being trialled on Resolution and Secretary Islands in south-western Fiordland and any improvements in techniques arising from these trials should be adopted by the Takahe programme.

Monitoring outcomes in terms of vegetation quality is important in assessing the performance of the deer control programme. In 1989, permanent transects and plots were established in *Chionochloa pallens* grassland sites in two representative regions in the Murchison Mountains (Chester Burn and Takahe Valley) and one in the Stuart Mountains (Lee et al. 2003) (see Fig. 1). This monitoring programme targets indicator species in a plant community known to be preferred by both deer and takahe. It is designed to measure vegetation change and use by deer. The plots are measured every 5 years.

Another monitoring programme that targets key takahe winter food plants was established at five forest margin sites in 2002. All sites are known to be used by takahe and deer. Each site has three plots—one fenced to exclude deer, one fenced to exclude deer and takahe, and one unfenced control. These plots are also measured every 5 years.

A new method of monitoring deer browse on selected palatable alpine herbs (based on previous work by Bill Lee) was trialled in four areas in the Murchison Mountains and also in the adjacent Doon region in 2005. This was followed by a baseline survey throughout Fiordland in 2006. The method was designed to provide a quick and relatively inexpensive way of monitoring short-term impacts of deer on alpine environments. Surveys will be repeated every 2 or 3 years in areas where it is suspected that deer numbers are changing.

Stoats arrived in Fiordland during the late 1800s and have had a significant effect on native birds there, with several species becoming locally extinct. Stoats are certain to have been present in the Murchison Mountains for many years prior to the official rediscovery of takahe there in 1948. Anecdotal observations over several decades have confirmed stoats as predators of takahe eggs, chicks and adults. However, there have also been observations of takahe successfully defending themselves from stoat attack. Over the four decades following the rediscovery of takahe, various degrees of stoat control were carried out, but never in a way that their effectiveness could be measured. A 4-year study aimed at determining the effect of stoat predation on eggs and chicks was started in 1998. Some stoat predation was identified, but a precise estimate of the effect of stoats on the takahe population was not able to be obtained (Maxwell & Christie 2005). From 2002, a stoat trapping programme has been run over a 15 000-ha block in the southeastern sector of the Murchison Mountains (Fig. 1). This programme was set up with an experimental design that included a specified comparable non-treatment block within the Murchison Mountains (see section 5.3.1 for more detail, and Fig. 1). Analysis of results from the first 4 years identified a positive benefit to takahe from stoat trapping (Hegg 2007). Records of takahe deaths over recent years suggest that the takahe population in the Murchison Mountains is most vulnerable to stoat predation in winters when stoat numbers are high. Stoat numbers periodically increase when heavy beech mast[5] raises the density of their key prey species (especially mice).

Radio transmitters and colour leg bands attached to individual birds have been valuable tools in the monitoring of takahe. They have enabled basic biological data to be gathered and the results of management actions to be monitored.

During the period of this plan (2007–2012), the focus of radio-tracking of takahe will shift from monitoring Burwood-raised takahe released in the Murchison Mountains (providing data for evaluating the experimental stoat control programme until the 2008/09 season), to monitoring island-raised takahe released in the Murchison Mountains and takahe released at new sites in Fiordland.

Within the Murchison Mountains, the 8000-ha Waterfall Creek block (including the Lake Eyles catchment; Fig. 1) has recently been set aside as a minimum disturbance area where no takahe are captured or eggs handled . This area acts as a non-treatment area to help in evaluating the long-term impacts of the handling of birds and eggs and the disturbance this causes to nesting behaviour.

Issues

Issue 1.1: Deer at high numbers have a negative impact on the vegetation, which causes a decline in takahe numbers

Issue 1.2: Stoats prey upon takahe

Issue 1.3: There are some risks and costs to the birds that are fitted with bands and radio tracked using telemetry (Godfrey & Bryant 2003)

Issue 1.4: Wild Takahe lay 2–3 eggs but generally can only raise one chick. This is a loss to potential productivity

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[5] Every few years, beech (*Nothofagus* spp.) trees have a particularly heavy seed crop. This is known as a beech mast.

Objectives and actions

Objective 1.1: Takahe numbers are maintained in the Murchison Mountains

Takahe numbers within the Murchison Mountains Takahe Special Area are increased to 170 birds, including 60 pairs
(Numbers to be refined after further analysis of population modelling; see section 5.3—Research).

	ACTION	ACCOUNTABILITY	PRIORITY
1.1	Control deer. Complete annual helicopter and ground hunting operations, plus operation of deer capture pens, to achieve a harvest of deer to control the Murchison Mountains population to a level of less than 350 deer (currently, approx. 120 deer are killed annually).	Deer Control Ranger, Te Anau Area (Southland Conservancy)	Essential
1.2	Monitor deer control. Maintain complete records of hunting operations and deer removed to monitor performance and changes in the deer population, and provide harvest targets for the following season to achieve Action 3.1.	Deer Control Ranger, Te Anau Area (Southland Conservancy)	Essential
1.3	Monitor vegetation:	Monitoring team (Southland Conservancy)	
	1. Remeasure vegetation monitoring established in *Chionochloa pallens* alpine tussock grasslands (once during the life of this plan).		Essential
	2. Remeasure the forest margin takahe winter habitat plots. Record results and report 5-yearly.		Essential
	3. Remeasure the alpine herb baseline survey plots if and when required. Record results and report.		High
1.4	Control stoats (see Objective 8.1).	Takahe Programme Manager and Takahe Programme staff	Essential
1.5	Release the appropriate number of takahe into the Murchison Mountains annually, in order to increase the population to the natural recruitment and carrying capacity for the Murchison Mountains (see Action 5.8).	Takahe Programme Manager and Takahe Programme staff	Essential
1.6	Monitor takahe population in the core census area (Fig. 1) of the Murchison Mountains:	Takahe Programme Manager and Takahe Programme staff	
	1. Survey in March to determine breeding pairs and nesting outcomes.		Essential
	2. Band chicks over 8 weeks old and monitor their survival.		Essential
	3. Carry out November egg survey.		Essentail
	4. Complete chick censuses in Feb/March annually in the Waterfall Creek block.		Essential
	5. Record reliable reports of takahe or sign of takahe outside the Murchison Mountains Takahe Special Area.		Medium
	6. Undertake takahe census within known territories in the western periphery of the Takahe Special Area (once during the life of this plan).		Medium

5.1.2 Topic 2—Island and mainland sanctuary populations

Adult takahe survivorship on the islands (Maud, Mana, Kapiti, Tiritiri Matangi, plus one other un-named island[6]) and, latterly, Maungatautari Ecological Island (near Hamilton) is high, but there are problems with egg fertility/embryo death and young chick survival (Bunin et al. 1997; Jamieson & Ryan 1999; Boerman & Suselbeek 2007). Current (June 2008) island populations are as follows: Maud—12, including 4 breeding pairs; Mana—35, including 8 breeding pairs; Kapiti—15, including 4 breeding pairs; Tiritiri Matangi—10, including 4 breeding pairs; one un-named island—17, including 3 breeding pairs; Maungatautari—2, 1 breeding pair.

A number of research projects have been carried out over the years to try to determine the cause of the egg fertility/embryo death problems (Jamieson & Easton 2002; Jamieson 2003; Jamieson & Wilson 2003a, b). To date, however, no specific factor has been identified as the cause of infertility and low chick survival.

The takahe population is known to have gone through a severe bottleneck and has very low genetic variation (Lettink et al. 2003; Grueber 2005). It has been suggested that the entire population is inbred, but inbreeding depression (e.g. egg infertility, poor hatching/fledging success) is only being expressed when Fiordland-adapted takahe are transferred to new environments on offshore islands (Jamieson & Ryan 2000). Another explanation is that deleterious alleles may have become fixed in the island populations through genetic drift (Jamieson et al. 2003). Support for both these explanations comes from extensive island pedigree analyses, which indicate that both related and unrelated breeding pairs have similar but very low (relative to Fiordland takahe) reproductive success (Jamieson et al. 2003). The only inbreeding depression detected within the pedigree was inbred females having significantly lower breeding success than non-inbred females (Jamieson et al. 2003; Grueber 2005).

To allow new genetic stock to recruit more easily and to increase takahe numbers in the wild, some birds from the island populations will be removed from the islands. After going through a quarantine period and winter training/hardening at Burwood, these birds will be translocated to expand the wild takahe population in Fiordland (see Objective 7.1 for more details). The recruitment required to maintain productive breeding pairs on islands will be arranged by supplying birds of appropriate genetic background from Burwood or other island populations.

Some of the non-breeding 'surplus' island birds, especially those that are highly inbred, have a poor history of breeding, or have made an exceptionally large contribution to the gene pool, could be made available for advocacy (see Objective 7.1 for more details).

A commitment at conservancy level needs to be made to resource takahe work on islands. This is particularly important for the period of this plan when translocations of island birds are significant to the recovery goals.

Issues

Issue 2.1: Currently, the majority of the islands with takahe populations appear to be near carrying capacity for takahe (Grueber & Jamieson 2006)

Issue 2.2: Egg fertility and chick survival on islands is poor

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[6] Owners have requested confidentiality.

Issue 2.3: Island takahe have lost 7.5% of their genetic diversity relative to the original founding population from Fiordland, and are predicted to lose 76% in the next 100 years if left unmanaged

Issue 2.4: Islands have 'surplus' non-breeding birds that are taking up valuable breeding territories

Issue 2.5: Island takahe are losing habitat to regenerating woodlands

Issue 2.6: Water supplies and supplementary food on islands, especially in drought years, are insufficient

Issue 2.7: Hours and funds budgeted within DOC for takahe work on islands are often inadequate

Issue 2.8: Training and support for island staff is inadequate

Issue 2.9: Information and monitoring is not standardised between islands

Issue 2.10: There are no guidelines for when staff should intervene with sick or injured birds

Objectives and actions

Objective 2.1: Island and mainland sanctuary takahe populations are maintained

Existing takahe populations on Maud Island, Mana Island, Kapiti Island, Tiritiri Matangi Island, one other un-named island and Maungatautari Ecological Island (near Hamilton) are managed to achieve the maximum number of productive breeding pairs at each site, while also maintaining at least 90% of their current genetic diversity.

	ACTION	ACCOUNTABILITY	PRIORITY
2.1	Minimise inbreeding by managing island/ sanctuary pairs. Transfer birds between existing islands, Burwood or new islands or mainland sanctuaries as required.	Island Coordinator	Essential
2.2	Translocate adult birds surplus to the breeding pool on islands or in mainland sanctuaries to increase the Murchison Mountain population and/or seed new Fiordland sites.	Island Coordinator	Essential
2.3	Crop young produced on islands when 5–6 months old for release into the Murchison Mountains and/or to new sites (see Objectives 1.1 and 5.1).	Island Coordinator	Essential
2.4	Establish adequate funds and staff hours (through annual business planning) for takahe programmes for each island or mainland sanctuary.	Programme Manager —Biodiversity, Warkworth Area (Auckland Conservancy); Kapiti Area (Wellington Hawkes Bay Conservancy); Sounds Area (Nelson/ Marlborough Conservancy); Maungatautari (Trust staff)	Essential

Continued on next page

ACTION		ACCOUNTABILITY	PRIORITY
2.5	Establish a dedicated Island Coordinator position, based at Burwood or Te Anau. The Island Coordinator will visit each island or mainland sanctuary, coordinate information sharing and provide mentoring for island/sanctuary staff.	Island Coordinator, Takahe Programme Manager	Essential
2.6	Train island and mainland sanctuary staff to carry out takahe work, and follow best practice.	Island Coordinator	Essential
2.7	Carry out habitat planning and management annually to maintain suitable areas of takahe habitat.	Island Coordinator	Essential
2.8	Provide adequate water and food sources for takahe. At least one water supply per territory.	Island Coordinator	Essential
2.9	Establish takahe management guidelines by 2008 for island and sanctuary staff involved in takahe management. Guidelines will include monitoring breeding success, establishing cause of mortality, colour banding all chicks by 6 months of age, and for estimating percentage weight loss to allow decisions to be made about intervention.	Island Coordinator	High
2.10	Update pedigrees of island and mainland sanctuary birds annually and use these to direct decisions about transferring birds between islands and to new sites (to avoid close inbreeding and to increase under-represented lineages). Annual translocations are planned by the Takahe Recovery Group so that provision can be made for them in business planning.	Takahe Recovery Group and Takahe Programme Manager	Essential
2.11	Update survival, breeding and banding records annually and forward them to the Island Coordinator.	Island Coordinator, Takahe Programme Manager and respective island takahe staff	High
2.12	Establish guidelines for when to intervene when takahe are sick or injured. Takahe are to be critically assessed before treatment is started, and treatment is only to be inititated if there is a high probability that the bird will recover and be able to continue to contribute to the breeding population. If a full recovery is not likely or the bird may become disabled in some way, then euthanasia is recommended. (Decisions are to be made by island staff, but consultation with the Island Coordinator is recommended.) (See Action 4.9.)	Island Coordinator, Takahe Programme Manager and respective Island/mainland sanctuary takahe staff	High
2.13	Manipulate nests each season to maximise productivity (at the discretion of island or sanctuary staff, depending on experience, skills available and opportunities).	Island Coordinator, Takahe Programme Manager and respective Island/mainland sanctuary takahe staff	High

5.1.3 Topic 3—New sanctuaries

The existing island populations are showing a loss of genetic diversity, partly as a consequence of the relatively small effective population size that the islands carry, but also because of unequal founder representation in the descendent population; for example, 52% of the current island takahe can trace their lineage back to one breeding pair. Modelling work has indicated that 90% genetic diversity could be maintained in the island population if a new island or mainland sanctuary population is founded (to expand the population) and if two new Fiordland birds are transferred to islands every 4–5 years (Grueber & Jamieson 2008).

At the time of writing, high adult survival in the island populations means that the majority of the islands are close to or at their carrying capacity for takahe. Further islands or mainland sanctuary sites should be selected if they can offer good breeding habitat so offspring can be cropped for expanding the Fiordland population. These new sites are increasingly likely to be mainland sanctuaries in private ownership or run by community restoration trusts.

An evaluation of potential island locations for takahe was carried out in 2001, with 164 New Zealand islands assessed according to particular criteria (Ussher 2001).

Issues

Issue 3.1: Several institutions have expressed interest in holding takahe for breeding

Issue 3.2: The majority of the existing islands with breeding populations have reached their carrying capacity for takahe

Issue 3.3: Genetic diversity in the current island populations is low, but can be improved with the establishment of a further island or mainland sanctuary breeding site

Issue 3.4: The takahe is an icon of Fiordland and any new populations on islands or in mainland sanctuaries must be established in the expectation that they will be used to enhance the Fiordland population through annual translocations (see Objective 5.1)

Objectives and actions

Objective 3.1: New island and mainland sanctuaries are identified and takahe populations established

Further suitable islands and mainland sanctuaries are established to support takahe populations of at least five breeding pairs. Management of new populations and existing populations will be integrated to preserve genetic diversity.

	ACTION	ACCOUNTABILITY	PRIORITY
3.1	Assess potential island or mainland sanctuaries for new takahe populations through the criteria stipulated in the guidelines for establishment of new sites for takahe (see Appendix 3). These criteria ensure that proposed sanctuaries will assist takahe recovery.	Takahe Recovery Group and Takahe Programme Manager	Essential
3.2	Select at least one suitable new island or mainland sanctuary within the life of this plan.	Takahe Recovery Group and Takahe Programme Manager	Essential
3.3	Those responsible for managing any new site must sign a Memorandum of Understanding about future use and location of takahe bred at the site.	Takahe Programme Manager and Takahe site managers	Essential
3.4	Transfer an appropriate number of founder birds from other existing takahe populations to the selected island or mainland sanctuary. New introductions should attempt to maximise genetic variation amongst founding birds.	Island Coordinator and Takahe Programme Manager	Essential
3.5	Monitor takahe transferred to the new site regularly to determine breeding success/bird survival. Determine the need for any further transfers and for any other ongoing management requirements.	Island Coordinator and Takahe Programme Manager	Essential

5.1.4 Topic 4—Burwood Captive Rearing Unit

The captive breeding programme for takahe has been an essential management tool for the recovery of the species. Captive-reared birds have been used to establish island populations and boost the remnant wild population in Fiordland.

Eggs and chicks are collected annually from the wild population in the Murchison Mountains and artificially incubated and then captive-reared at Burwood. This maximises the productivity of wild nests that contain two viable eggs, as it is uncommon for adults to successfully raise two chicks in the wild. Productivity of unmanaged nests in the Murchison Mountains is 0.43 chicks per breeding pair. With manipulation of eggs in nests[7] and the use of Burwood, this increases to 0.66 chicks per breeding pair, a 55% increase to the reproductive output. In comparison, island productivity is currently 0.49 chicks per breeding pair (D. Hegg, pers. comm.).

[7] Some surplus eggs are sent to Burwood; some are used to replace infertile eggs in other nests.

The Burwood Captive Rearing Unit started captive rearing of takahe in 1985. Since that time, there has been continued improvement in incubation and rearing techniques (Eason 1992; Eason & Willans 2001). Now, most of the yearlings that are released into the Murchison Mountains have had some time outside in an enclosed 80-ha outdoor area with foster parents rather than being totally puppet-reared in the brooder environment. This parent-rearing gives the chicks an advantage in that they learn essential life and feeding skills from the adults, which increases their chances of survival in the wild. Each juvenile also spends its first winter with a group of juveniles and an adult pair in an enclosed outdoor area at Burwood. The adults teach the juveniles how to grub for *Hypolepis* fern. This is a critical skill to learn, since this fern is what the birds live on over the winter months in the Murchison Mountains.

Initial comparisons of productivity for wild-wild pairs, wild-captive pairs, and captive-captive pairs indicate that productivity is slightly better for wild-wild pairs (Maxwell & Christie 2005; Crouchley et al. 2006). However, the quality of birds being released from Burwood has been improving as techniques have been developed (i.e. using the resident pairs at Burwood as foster and teacher birds), and it is likely that the difference in productivity between wild-reared and captive-reared birds will decline.

Further improvements in the genetic management of the Fiordland population could be gained by maintaining pedigrees for the Burwood breeding pairs, and regular replacement of older pairs that have been particularly productive.

Further development of the Burwood Bush Scientific Reserve by extending the predator fencing would be beneficial to takahe recovery. The Burwood Bush Reserve is considered to be suitable, relatively unmodified habitat within the takahe's natural range. Its large area (3600 ha) means that if the whole reserve was enclosed by predator-proof fencing, it would provide habitat for a significant breeding population (approximately 25 breeding pairs). Fencing this reserve has been considered as a long-term goal for increasing the mainland population. Construction and testing of a suitable fence is being tackled, but some practical problems with fence design and the cost of the currently preferred design preclude fencing the whole reserve at present.

Issues

Issue 4.1: Captive rearing increases risk of disease and infections and the transfer of disease to the wild population if inadequately managed.

Issue 4.2: Wild takahe have an average clutch size of two eggs but can generally raise only one chick. This is a loss to potential productivity.

Issue 4.3: Captive-reared chicks require training by Fiordland adults to increase their chance of survival when translocated back to Fiordland.

Issue 4.4: Takahe on islands have low genetic variation.

Issue 4.5: There are no guidelines for when to intervene with a sick or injured bird.

Objectives and actions

Objective 4.1: Juveniles are reared annually at Burwood Captive Rearing Unit for release back into the wild

At least 18 takahe juveniles are produced annually at the Burwood Captive Rearing Unit for the enhancement of existing and/or establishment of new takahe populations

ACTION		ACCOUNTABILITY	PRIORITY
4.1	Maintain hygiene standards and facilities at Burwood Takahe Rearing Unit to the standard clarified in the Burwood Standard Operating Procedures (see Appendix 3).	Takahe Programme Manager and Burwood Programme staff	Essential
4.2	Establish recovery pens for sick and/or injured takahe at Burwood with appropriate quarantine and hygiene standards.	Takahe Programme Manager and Burwood Programme staff	Essential
4.3	Transfer a maximum of 14 developing eggs or takahe chicks from the Murchison Mountains to Burwood to captive-raise to 1 year old.	Takahe Programme Manager and Burwood Programme staff	Essential
4.4	Ensure 50% of any group of juveniles being transferred from Burwood are health-screened 1 month prior to transfer.	Takahe Programme Manager and Burwood Programme staff	Essential
4.5	Ensure there are a maximum of six pairs of adult takahe resident at Burwood to provide further eggs and chicks.	Takahe Programme Manager and Burwood Programme staff	Essential
4.6	Use resident pairs at Burwood as teacher birds. Have groups of juveniles live with the adult birds over their first winter, so the adults can show the juveniles how to grub for *Hypolepis* fern rhizomes.	Takahe Programme Manager and Burwood Programme staff	Essential
4.7	Retire resident pairs at Burwood when they are 7 years old and transfer them back to the wild. Replace with genetically suitable juveniles from islands, mainland sanctuaries or the Murchison Mountains. To ensure their survival, island/mainland sanctuary birds will need to be paired with a Burwood bird for *Hypolepis* training.	Takahe Programme Manager and Burwood Programme staff	High
4.8	Release Burwood juveniles back into the Murchison Mountains in mid October, except in years when they may be required for transfer to islands or mainland sanctuaries to establish another takahe population and/or increase genetic variation in existing populations.	Takahe Programme Manager and Burwood Programme staff	Essential
4.9	Establish guidelines for setting percentage weight loss to indicate when intervention is necessary. Treatment of a sick or injured takahe is to be critically assessed before being started and is only to be initiated if there is a high probability of recovery, and it is likely the bird will continue to contribute to the breeding population. If a full recovery is not likely or the bird may become disabled in some way, then euthanasia is recommended (see Action 2.12).	Takahe Programme Manager and Burwood Programme staff	High

5.1.5 Topic 5—Expanding the Fiordland population

Increasing the range of wild takahe in Fiordland is a significant step in the recovery of the species. The success of recent large-scale stoat and deer control programmes in Fiordland (Secretary Island, Resolution Island, Murchison Mountains) has increased confidence that a second takahe population can be established in a suitable Fiordland site with on-going predator and competitor management (K. Edge & C. Wickes, unpubl. data.). This expectation is consistent with the pest control plan being developed for the Fiordland area, which aims to extend stoat and deer control through large areas of land east of Lake Te Anau to the Main Divide. These would adjoin those of the current Operation Ark programmes in the Eglinton, Clinton and Arthur catchments to the north (see www.doc.govt.nz/conservation/land-and-freshwater/land/operation-ark/ for more information about Operation Ark).

The islands where takahe have already been established have reached their carrying capacity for takahe and the populations are showing signs of inbreeding. It is therefore important to pursue strategies that will expand the range of takahe in Fiordland and provide a new location for island progeny to be moved to. A new release site needs to be selected. This will require habitat suitable for takahe, a commitment to the ongoing management of their agents of decline, and need to be of a size large enough to allow a significant number of breeding pairs to establish. It is preferable that the takahe population established at this new site will be able to mix with the Murchison Mountain population as it expands.

The islands and mainland sanctuaries will become 'incubation' facilities for restocking Fiordland, similar to the function of Burwood. Juveniles will be cropped annually from island and mainland sanctuary stock and translocated to Fiordland. Young (5–6-months-old) birds will be removed from the islands and mainland sanctuaries and over-wintered at Burwood to allow them to be trained to feed on *Hypolepis* and become accustomed to the colder temperatures. Adult birds to be translocated from the islands will all have to be moved about the same time of year so they are also able to have a full winter at Burwood (for training as described for juveniles) before release into the wild.

Lessons have been learnt from the Stuart Mountains reintroduction programme (1987–1991), where 58 yearlings were released in small groups of 2–8 birds. Radio transmitters were used to monitor 24% of the birds released, and annual surveys of catchments close to the release area were conducted up to 1993. Combined results showed at least 13 (22%) of the 58 birds released survived their first year, and two breeding pairs had formed. At least two yearlings were produced by these pairs. Only four (7%) of the released birds were confirmed dead, but the majority (72%) were unaccounted for. A wider survey of the Stuart and Franklin Mountains in 1994 accounted for only eight birds (14%), including one unbanded bird (probable offspring of released birds). Since then, further occasional sightings of birds and sign have been found over a wide (c. 35 000 ha) area, and up to 27 km from release sites (Maxwell 2001). One bird from an early release was recorded near its release site 16 years after its release (unpubl. data, Te Anau Area Office, DOC). These results indicate that the area offers habitat suitable for takahe maintenance and some breeding. Failure to establish a breeding population may be due to a combination of factors, including:

- The number of birds released was small
- Dispersal—takahe tend to disperse widely
- The lack of an *in situ* wild population to teach released birds survival skills in the mountain habitat and to encourage them to settle locally
- Inadequate pre-release foraging training, particularly winter foraging, of the earliest released birds
- Deficiencies in the mode of release
- Poorer-quality habitat in the release area than in the Murchison Mountains
- Some unusually harsh winters (see Maxwell 2001)
- The sample size of transmittered birds being too small to give robust data

Until recently, takahe raised outside Fiordland have not been considered for translocation to Fiordland because of the risk of transferring disease to the Fiordland population. The translocation option can now be considered because of an improved understanding of the disease risk status of the various takahe populations, and plans to establish quarantine facilities and protocols specifically designed to facilitate translocation. The quarantine standard for takahe will be similar to or higher than those presently applied to other species translocations to Fiordland sites.

Issues

Issue 5.1: The risk of disease associated with moving birds from islands and mainland sanctuaries to Fiordland must be addressed

Issue 5.2: Takahe require translocation sites with specific habitat features and ongoing management of agents of decline

Issue 5.3: The change of habitat for island- and mainland sanctuary-bred birds is a potential problem that will need to be closely managed

Issue 5.4: Island and mainland sanctuary birds will not be acclimatised to Fiordland winter conditions and will not know how to feed in winter

Issue 5.5: Holding facilities at Burwood will need to be expanded, to allow for island birds to be appropriately quarantined, to acclimatise and learn essential foraging skills

Issue 5.6: Currently, there are 'surplus' adult birds on islands taking up precious breeding territories on islands

Issue 5.7: Translocated birds require close monitoring to allow the success or failure of the translocation and the productivity of the released birds to be assessed

Objectives and actions

Objective 5.1: Available island/mainland sanctuary and Burwood birds are translocated to Fiordland

Available island/sanctuary and Burwood birds are to be translocated to expand the Fiordland range of takahe beyond the Murchison Mountains

It is recognised that this is a long-term objective and that the priority is to first increase the Murchison Mountain population to its carrying capacity. All actions from this objective may not be achieved in the life of this plan. Achieving this objective is dependent on the rate of increase of takahe in the Murchison Mountains (see Topic 8).

ACTION		ACCOUNTABILITY	PRIORITY
5.1	Select suitable translocation site or sites which satisfy habitat requirements and where ongoing habitat management is both appropriate and feasible. Site/s selected by Takahe Recovery Group in consultation with Ngai Tahu and recreational and conservation interest groups, as appropriate.	Takahe Recovery Group	Essential
5.2	Produce a monitoring plan for the new Fiordland population (Takahe Recovery Group). This needs to have guidelines to enable success or failure of establishment of takahe at release sites to be measured. Guidelines must be completed before translocations start.	Takahe Recovery Group	Essential
5.3	Prepare a translocation plan to enable birds and sites to be selected in ways that ensure takahe genetic diversity is enhanced.	Takahe Programme Manager	Essential
5.4	Prepare a quarantine procedure for birds moving from the islands and mainland sanctuaries to Burwood and from Burwood to the new Fiordland site/s.	Takahe Programme Manager	Essential
5.5	Construct quarantine pens at the island and mainland sanctuaries and Burwood.	Takahe Programme Manager	Essential
5.6	Establish winter holding pens that include vegetation containing *Hypolepis millefolium* at Burwood for birds translocated from the islands and other mainland sanctuaries. Burwood birds will be selected to train the island birds.	Takahe Programme Manager	Essential
5.7	Establish plans to manage agents of decline at new Fiordland translocation site/s before any takahe are translocated.	Takahe Programme Manager	Essential
5.8	Translocate current 'surplus' birds from islands and mainland sanctuaries to the second Fiordland site.	Island Coordinator	Essential
5.9	Crop young produced on islands/mainland sanctuaries annually at 5–6 months of age. These juveniles must spend one winter at Burwood before being translocated to the second Fiordland site.	Island Coordinator	Essential

5.2 COMMUNITY RELATIONS

5.2.1 Topic 6—Tangata whenua

Ngai Tahu have a special association with takahe, and takahe are included in Schedule 97 Taonga Species of the Ngai Tahu Claims Settlement Act 1998. Through the Act, the Crown formally acknowledges the cultural, spiritual, historic and traditional association of Ngai Tahu with the taonga species, which include takahe.

Issues

Issue 6.1: The requirements of the Act, in particular sections 293 and 294, are pertinent to this plan

Issue 6.2: DOC needs to work with and involve Te Runanga o Ngai Tahu and the relevant Papatipu Runanga in giving effect to this plan, and the requirements of the Ngai Tahu Claims Settlement Act 1998.

Objectives and actions

Objective 6.1: Ngai Tahu are involved in takahe research and management

Ngai Tahu are involved at all levels of takahe research and management in an interactive way, as specified in the requirements of the Ngai Tahu Claims Settlement Act 1998

	ACTION	ACCOUNTABILITY	PRIORITY
6.1	Inform Te Runanga o Ngai Tahu and the Papatipu Runanga of progress within the recovery programme through annual reports on breeding success, pest control and other major issues. These will be provided within 2 weeks of their completion.	Takahe Programme Manager with Community Relations staff, Te Anau Area Office (Southland Conservancy)	Essential
6.2	Takahe Recovery Programme staff to continue to work closely with Te Runanga o Ngai Tahu's nominated representative on the recovery group.	Takahe Programme Manager with Community Relations staff, Te Anau Area Office (Southland Conservancy)	Essential
6.3	Ensure Te Runanga o Ngai Tahu (through Toitu Te Whenua and Papatipu Runanaga) is consulted in accordance with the Ngai Tahu Claims Settlement Act 1998 (this includes all bird transfer proposals).	Takahe Programme Manager with Community Relations staff, Te Anau Area Office (Southland Conservancy)	Essential
6.4	Where appropriate, invite representatives from Ngai Tahu to participate in the recovery programme in the field (at least once per year).	Takahe Programme Manager with Community Relations staff, Te Anau Area Office (Southland Conservancy)	High

5.2.2 Topic 7—Public awareness

Historically, there have been two places where the public can readily see takahe: Pukaha Mount Bruce National Wildlife Centre and the Te Anau Wildlife Centre. There is a commitment to maintain these advocacy or display sites with non-breeding pairs. Currently, two takahe are on display at Pukaha Mount Bruce and three at Te Anau Wildlife Centre.

There is a commitment to provide up to 4% of the total takahe population for advocacy or display purposes (equating to nine birds in 2008).

Issues

Issue 7.1: DOC needs to inform and involve the public in order to maintain their understanding and support for the Takahe Recovery Programme

Issue 7.2: Several institutions have expressed interest in holding takahe for display

Issue 7.3: There are currently no guidelines providing criteria specific for takahe display sites

Objectives and actions

Objective 7.1: Increase public awareness of takahe and the Takahe Recovery Programme

ACTION		ACCOUNTABILITY	PRIORITY
7.1	Implement annually the Te Anau takahe community relations actions, from the Te Anau Community Relations Action Plan.	Community Relations staff, Te Anau Area Office	Essential
7.2	Complete, annually, a public awareness programme in Te Anau promoting takahe.	Community Relations staff, Te Anau Area Office	Essential
7.3	Maintain non-breeding, advocacy (display) takahe at existing display sites (Pukaha Mount Bruce National Wildlife Centre and Te Anau Wildlife Centre).	Takahe Programme Manager and staff at takahe advocacy/ display sites	Essential
7.4	Complete the guidelines for establishing display sites for takahe (draft 2007).	Takahe Programme Manager, Takahe Recovery Group	Essential
7.5	Establish further appropriate advocacy/ display sites using 'surplus' (not required for breeding) birds from island populations. Provide up to 4% of the total takahe population for public display.	Community Relations staff, Te Anau Area Office	High
7.6	Update annually the education pack on takahe, the Takahe Recovery Programme for school students and the DOC takahe fact sheet. Support the LEARNZ education programme.	Community Relations staff, Te Anau Area Office	High
7.7	Promote and facilitate one major media event per year.	Community Relations staff, Te Anau Area Office	High
7.8	Keep conservation groups informed with annual updates (Forest & Bird, OSNZ and regional conservation groups).	Community Relations staff, Te Anau Area Office	High

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ACTION		ACCOUNTABILITY	PRIORITY
7.9	Submit or facilitate one takahe article in a suitable magazine per year.	Community Relations staff, Te Anau Area Office	Medium
7.10	Update annually DOC and NZ Ecological Society websites.	Community Relations staff, Te Anau Area Office	High
7.11	Provide one public open day at Burwood per year.	Community Relations staff, Te Anau Area Office	High
7.12	Actively support sponsorship. Recognise sponsors through media and events.	Community Relations staff, Te Anau Area Office	High

5.3 RESEARCH

5.3.1 Topic 8—Stoat control

Despite a lack of conclusive historical evidence, stoat predation has long been considered to have some impact on takahe survivorship (e.g. Williams 1952). Stoat signs (remains of egg, dead chick, stoat droppings) were observed in 1949, soon after takahe were rediscovered in 1948 (Lee & Jamieson 2001: 29).

Various stoat trapping programmes have been carried out in the Murchison Mountains since 1949. Unfortunately, none of these were carried out in a way that made it possible to measure any positive effect, or otherwise, on the takahe population. Thus, it has not been possible to accurately determine the impact of stoats on takahe.

In an effort to determine the true impact of stoats on the Murchison Mountain takahe population, and whether management via landscape-scale trapping could significantly reduce the effect of predation, a balanced trial was initiated in 2002. In 2001, the Core Census Area of the Murchison Mountains was divided into three areas: a 15 000-ha trapped (treatment) area (also called the stoat control area), a 13 000-ha untrapped (control) area (also called the non-treatment area), and a 8000-ha buffer zone between the two areas (see Fig. 1). Hegg (2006) has estimated that, for the years 2001–06, takahe mortality in the trapped area was 30% lower than in the un-trapped area. As this period did not include a stoat plague year[8], it gives a good indication of the benefit of trapping in inter-plague years. A moderate beech and tussock mast occurred in the 2005/06 summer. This resulted in a stoat plague in 2006/07. Over the winter of 2007, the Murchison Mountains takahe population sustained an estimated 35%–40% loss, a decline unprecedented since monitoring began in the 1950s. However, the takahe population in the trapped area recorded a decrease of 8%, while there was an estimated decrease of 55%–60% in the un-trapped area. During this year, 525 stoats were caught in the trapped area, three times the average for the preceding three years.

Although the trapping trial was initially intended to run for 10 years, including two stoat plague years, the results of modelling carried out by D. Hegg using the 2001–06 inter-plague years data, and the overwhelming disparity in survivorship between the treatment and non-treatment areas following the 2006/07 plague year, have prompted an emergency response. The trial has clearly shown the threats to takahe posed by stoat predation and the benefits of stoat trapping.

[8] A stoat plague is a period of increased numbers of stoats following heavy (mast) fruiting of trees such as beech (*Nothofagus* spp.) and tussock (*Chionochloa* spp.) grasses.

Therefore, the objectives of the trapping trial are deemed to have been fulfilled and the primary objectives met. It is considered that the benefits gained by continuing the trial through to its original finish date are far outweighed by the risks associated with leaving a large portion of the Murchison Mountains takahe population unprotected through another stoat plague year.

The trapping network will be extended to cover the full 40 000 ha of the Core Census Area and reach into part of the 10 000-ha western periphery (Fig. 1). Although the extended trapping will not be as intensive as that in the treatment area, the whole western periphery area is likely to gain some benefit from it. It is intended that extending the trapping network will be completed by June 2009. The general design and frequency of trap checking will be the same as that applied in the trapped area during the trial (quarterly), as this regime was found to be effective.

The priority for the life of this plan will be to restore the takahe population within the Murchison Mountains to the carrying capacity of the area. The stoat trapping required to achieve this is likely also to benefit other threatened species in the area; e.g. kiwi, mohua, blue duck and rock wren.

Tracking tunnels were set up early in 2005 in the trapped and untrapped trial areas in an attempt to gain information on relative stoat tracking rates as a further indication of stoat densities in these areas. Very low tracking rates were recorded and it was determined that the tunnels as set up were not sensitive enough to track stoats at low densities. The tunnels were run in the 2006/07 summer. Results showed that the tracking rate in the untrapped area was approximately double the rate in the trapped area. The rate in the non-trapped area was considerably higher than previously recorded. Although it might be possible to increase the sensitivity of the tracking tunnel method, it is probable that it would require a large effort in low stoat-density years (Hegg 2006). Therefore, it seems more appropriate not to run the tracking tunnels in such years. The effectiveness of stoat trapping for the takahe programme has been determined by comparing overall takahe survival and breeding success in the trapped and untrapped trial areas and also (with the assistance of radio tagging) by comparing causes of deaths. As stoats will be trapped in the whole of the core census area of the Murchison Mountains from 2009, treatment v. non-treatment data will no longer be available for comparisons. If the tracking tunnels were continued, they would only indicate seasonal fluctuations of small mammals within the trapped area. Monitoring of mohua, kiwi and blue duck numbers is carried out within the Murchison Mountains.

Issues

Issue 8.1: Stoats are a predator of takahe

Issue 8.2: During a stoat plague year (2007/08 census), the non-trapping area in the Core Census Area showed a 55%–60% decline in takahe compared with a decline of 8% in the trapped area

Issue 8.3: Results from tracking tunnels using the current methodology are not sensitive enough to track stoats in areas of low stoat densities

Objectives and actions

Objective 8.1: Large-scale stoat control is implemented in the Murchison Mountains

The stoat trapping programme is extended to cover the whole Core Census Area and into the western periphery in the Murchison Mountains

	ACTION	ACCOUNTABILITY	PRIORITY
8.1	Maintain stoat traplines (check traps four times per year) over the southeast sector of the Murchison Mountains as set out in the project plan (see project plan—Murchison Mountains stoat control in Appendix 3 for details).	Trapping project manager and Takahe Programme Manager	Essential
8.2	Replace currently-used fenn traps with DOC 150 traps. Complete by the end of this plan.	Trapping project manager and Takahe Programme Manager	High
8.3	Increase stoat trapping to cover the entire 40 000-ha Core Census Area, and extend into the 10 000-ha western periphery. Apply the same checking regime as in Action 8.1.	Trapping project manager and Takahe Programme Manager	Essential
8.4	Collect trap data and input results after every check, as set out in the project plan.	Trapping project manager and Takahe Programme Manager	Essential
8.5	Integrate improvements (new traps, baits etc.) as appropriate, to increase efficiency of stoat control.	Trapping project manager and Takahe Programme Manager	High
8.6	Confirm the effectiveness of the trapping programme for takahe recovery from data analysis following completion of 2007/08 takahe breeding season.[a]	Takahe Programme Manager, Science Advisory members of Takahe Recovery Group and Takahe Ecologist (Te Anau Area Office)	Essential
8.7	Consider best method of running tracking tunnels as a measure of the effect of trapping on stoat densities.	Takahe Programme Manager, Science Advisory members of Takahe Recovery Group and Takahe Ecologist (Te Anau Area Office)	High
8.8	Continue monitoring stoat and rat numbers with the annual mohua, kiwi and blue duck monitoring results.	Research team (Southland Conservancy)	High

[a] Specifically: summarise information on predation of all radio-tagged birds, treating the trial as a BACI design (Before-After, Control-Impact) comparing breeding and non-breeding adults and captive-reared with wild-reared birds and what stoat management area they were found within—trapped, un-trapped or buffer and whether they died during the period of the stoat control. Also, from standard population census and breeding monitoring data, compare adult survivorship and breeding success (mean clutch size, egg fertility, fertile eggs hatched per pair, survival of hatched chicks to 30 days) between trapped and un-trapped areas.

5.3.2 Topic 9—Research, monitoring and data analysis

For management decisions to be sound, they need to be based on an accurate understanding of the relevant issues; otherwise, recovery actions may not achieve the desired benefits. Any gaps in knowledge about takahe must be identified and the research to address them prioritised and then promoted. DOC cannot expect to carry out all of the research required for takahe recovery. It is therefore important to work with external research experts to ensure that the research required is achieved.

Since takahe were rediscovered in 1948, a variety of management approaches have been applied to their recovery. The effects of these different approaches and techniques on the takahe population are currently being analysed. This analysis will ensure that takahe recovery actions are based on informed management decisions. Similarly, recovery actions need to be monitored to assess the extent to which they achieve their desired outcomes. Ongoing monitoring and analysis associated with all identified agents of decline is important.

Issues

Issue 9.1: Research beneficial to takahe recovery needs to be prioritised

Issue 9.2: The takahe carrying capacity in the Murchison Mountains is not known and needs to be determined

Issue 9.3: Data on wild- v. captive-reared chick survival and their eventual breeding productivity requires ongoing analysis

Issue 9.4: The relationship between environmental effects and takahe productivity and survival requires ongoing analysis

Issue 9.5: What causes infertility and high chick mortality in island takahe populations is not known and needs to be investigated

Issue 9.6: Ongoing analysis of data is needed to guide future management of takahe

Objectives and actions

Objective 9.1: Research, experimental management and monitoring

Research, experimental management and monitoring to determine the factors that impact on takahe populations must be advanced, and reports written to provide management advice

	ACTION	ACCOUNTABILITY	PRIORITY
9.1	Peer-review the Takahe Research Strategy once within the life of this plan.	Science Advisory members of Takahe Recovery Group	High
9.2	Annually update and follow the Takahe Research Strategy (see Appendix 3). This details priority research questions and timeframes relevant to the Takahe Recovery Programme.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	High
9.3	Use the most up-to-date data available to analyse the efficacy of current nest management regime for population enhancement and report to management with appropriate advice.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	Essential

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ACTION		ACCOUNTABILITY	PRIORITY
9.4	Compare survival and lifetime productivity of captive-reared and wild-reared individuals, by reviewing population parameter information within the takahe database.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	Essential
9.5	Using results from actions 9.3 and 9.4 above, produce a population model that recommends the level of annual harvest of eggs and/or chicks from the Murchison Mountains population (and how it might vary, depending on circumstances) to supplement the Murchison Mountains and other populations.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	High
9.6	Carry out modelling to refine the estimate of the takahe carrying capacity of the Murchison Mountains, and recommend a suitable population size goal for management.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	Essential
9.7	Analyse currently-available data to investigate the effects of various environmental variables on aspects of takahe breeding in the wild; in particular, climate, beech seed-fall, tussock flowering and habitat improvement.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy).	High
9.8	Calculate annual survival rates of takahe from chick to yearling age and adult annual survival rates and compare with environmental variables analysed in environment/breeding work detailed in Action 9.7.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	High
9.9	Continue ongoing monitoring of weather in Takahe Valley and record results in Takahe Valley Weather Database.	Research team (Southland Conservancy)	Essential
9.10	Continue ongoing monitoring of beech seedfall.	Research team (Southland Conservancy)	High
9.11	Continue annual measurement of tussock flowering in Takahe Valley (set up and measured by Dr W.G. (Bill) Lee, Landcare Research).	Research team (Southland Conservancy)	High
9.12	Continue pedigree data analyses and investigation of inbreeding effects on population productivity (established by Dr Ian Jamieson and students, University of Otago).	Otago University researchers	Essential
9.13	Continue programme of research into the causes of infertility, embryo death and low chick survival in island takahe populations (established by Dr Ian Jamieson and students, University of Otago).	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	Essential

5.3.3 Topic 10—Viability of *Chionochloa conspicua* re-establishment

Chionochloa conspicua (bush snow-grass) is a known winter food of takahe in the Murchison Mountains, although it is currently rather uncommon. Compared with rhizomes of the fern *Hypolepis millefolium* that takahe eat in larger amounts in the winter, *C. conspicua* has higher levels of P, K and lipids (Mills et al. 1980). Research has shown that grasses of this type and sedges were once more common in the forest understorey in the Takahe Special Area than they are now. The arrival of deer brought a sharp decline in their density (Wilmshurst 2003). Heavy deer browse of preferred species, especially in the times of peak deer numbers, appears to have all but removed *C. conspicua* from the Murchison Mountains. Even though deer are now controlled to low densities, this grass is still uncommon. The lack of a significant seed source may be preventing the species from re-establishing or, even if sufficient seed was available, this tussock may be so highly preferred by the few remaining deer that small seedlings may not be able to grow through to adulthood. Perhaps, if there was more of this grass available, it would form a larger proportion of the takahe winter diet, and contribute to an improvement in takahe body condition and, ultimately, survival and breeding productivity. It could be a worthwhile management action to re-establish the species throughout the Murchison Mountains as part of habitat restoration; however, we first need to test whether planting out seedlings or scattering seed would be viable methods of establishing the plant with deer at current densities.

A re-establishment trial will be carried out, aiming to obtain information on whether the tussock can establish and grow with current deer and takahe densities, what level of browse is likely at current deer and takahe densities and, perhaps, to provide some indication of site preferences and make recommendations for relevant management actions (see Appendix 3 for more information on this trial).

Issues

Issue 10.1: *Chionochloa conspicua* is currently uncommon, and this may be contributing to a reduction in takahe productivity

Issue 10.2: There is a lack of seed source of *C. conspicua* in the Murchison Mountains

Issue 10.3: It is unknown whether *C. conspicua* can re-establish at current takahe and deer densities

Objectives and actions

Objective 10.1: Determine the viability of re-establishing *Chionochloa conspicua* in the Murchison Mountains

ACTION		ACCOUNTABILITY	PRIORITY
10.1	Plant out tussock seedlings in five sites in the Snag Burn Valley, Murchison Mountains, in late summer 2007. At each of these five sites, there will be three treatment plots: Plot 1—fenced, excluding access by both takahe and deer Plot 2—fenced, excluding access by deer but allowing access by takahe Plot 3—unfenced 'control' allowing access by both takahe and deer In each plot, 63 *C. conspicua* tussock seedlings will be planted out.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	High
10.2	Monitor the above plots—each plant will be checked for survival, deer browse and stature in spring 2007, autumn 2008, spring 2008, spring 2009 and then annually until plants reach adult stature.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	High
10.3	Scatter tussock seed (matching weighed amounts) at selected permanently marked non-fenced sites in the Snag Burn.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	High
10.4	Monitor non-fenced sites to determine success of germination and seedling establishment. Timing same as for seedling plot checks (see Action 10.2 above).	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	High

5.3.4 Topic 11—Fiordland data

For more than 30 years, detailed data has been collected on the population and productivity of takahe in the Murchison Mountains. Several different systems have been used to record the data, which has made it impossible to analyse all the historical data together. There was a need to set up a database to integrate all the past historical information so that information such as adult mortality rates, egg fertility and chick survival can be compared over the years. A database has now been set up that has integrated the last 25–35 years of takahe data so it can now be used to provide answers to some management issues (see Objective 9.1).

A simple data entry system has also been set up so that the records from all fieldwork can be entered onto the database soon after the fieldwork is completed. It is important that the database is as up-to-date as possible.

Analysis of the current data is necessary to enable detailed reporting and evaluation of progress that will then guide management decisions. The results of database analysis could also identify some important areas of research that are required.

Issues

Issue 11.1: Data require ongoing updating

Issue 11.2: Prompt detailed reporting from current data analysis is essential to guide management

Objectives and actions

Objective 11.1: Maintain Fiordland takahe data

All Te Anau takahe programme fieldwork data are entered into the appropriate database

ACTION		ACCOUNTABILITY	PRIORITY
11.1	Continue auditing and correcting data from database as required.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	High
11.2	Update (annually) all Fiordland takahe records on database.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	Essential
11.3	Update (annually) banding records for all takahe on database and forward copy of annual update to the National Banding Office in the prescribed format.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	Essential
11.4	Update (annually) deer control database, weather database and beech seed fall and tussock flowering records.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	Essential
11.5	Using takahe and environmental databases, make annual summaries of population size and breeding to provide detailed reports and evaluation of progress for Takahe Programme annual reports.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	Essential

5.3.5 Topic 12—Island, mainland sanctuaries and captive takahe data

Takahe managers on islands, at mainland sanctuaries, Burwood and the takahe display sites have kept takahe records independently on locally-held spreadsheets. Information on survival, breeding and banding of takahe in the island populations has been forwarded annually to the person carrying out the Islands Coordinator role for the recovery group, for inclusion in the takahe programme annual reports. These records need to be collected and combined into one master database holding information on all birds at the island, mainland sanctuary, display, and Burwood sites. Some progress has been made towards this, with island managers being provided with spreadsheets for recording information on takahe breeding success and population size. Information on eggs, chicks and adults, banding and bird names, condition (e.g. health and weights at times of capture and handling) similar to that held in the Te Anau (Fiordland) Takahe Database still needs to be organised. Pedigree status information also needs to be recorded (a separate pedigree database may need to be created with a suitable programme to manage this type of information). This will make it far easier to keep track of individual birds, especially those which are moved from site to site as part of population management. This data will become more and more helpful as the takahe population grows. To simplify annual data entry, all sites will need to record data in a standard format.

Issues

Issue 12.1: Data recorded on different summary sheets/databases makes transfer and analysis of data difficult

Issue 12.2: Inappropriate naming and doubling-up of names for takahe has occurred

Objectives and actions

Objective 12.1: Establish and maintain a database for island, mainland sanctuary and captive takahe

An 'islands, mainland sanctuaries, Burwood Takahe Rearing Unit and takahe display sites' database will be established and maintained annually

ACTION		ACCOUNTABILITY	PRIORITY
12.1	Design the new database structure to hold all required information for islands, mainland sanctuaries, Burwood Takahe Rearing Unit and takahe display sites takahe populations.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	High
12.2	Enter historical data into the new database by 2010.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	High
12.3	Provide a standardised summary sheet to island/ mainland sanctuary/display site staff. Data are entered onto this as part of their annual report.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	Medium
12.4	Te Anau takahe staff annually transfer the summary sheet information to the master takahe database, collate information into the takahe programme annual report and update and forward banding records to the national banding office.	Takahe Ecologist, Te Anau Area Office (Southland Conservancy)	Medium
12.5	Proposed new takahe names are sent by local managers to the takahe naming coordinator, who checks the master naming list from the various databases before confirming the name's suitability to the local manager and entering the new name into the master list.	Takahe naming coordinator, Te Anau Area Office (Southland Conservancy) and takahe island staff	Medium

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Appendix 1

PRINCIPLES OF SPECIES RECOVERY: FOUR PHASES OF RECOVERY ACTION MODEL

Research—identify cause and key agent(s) of decline

Where status, distribution, threats, and the means to recover the species are not well understood and where research to identify the cause and key agent(s) of decline is the main focus of the plan.

Identifying cause and key agent(s) of decline is a fundamental step in recovery of threatened species and, as such, must be adequately addressed in the recovery plan.

Security

Where urgent management effort is required to secure the species from extinction.

Security from extinction in the wild is achieved when:

- There is a viable population
- Key agent(s) of decline have been identified and removed or mitigated
- The population can recover given additional resources

A population is defined as being viable when it is predicted to have a 95% probability of survival where:

- There is an intrinsic ability to increase given additional management because the population is large or because recruitment = mortality; and
- There is resilience against low and moderate level stochastic events over a 50-year time frame

Management action may be undertaken with a knowledge of (and targeted at) the cause and key agent(s) of decline or undertaken in the absence of this knowledge and on the best advice on interim management from recovery experts. A 'salvage' operation maybe required in the latter situation (e.g. transfer the species to a suitable safe site). The prescription for managing the causal agents of decline is likely to follow an adaptive management approach in this phase. It may be appropriate to undertake the research and security phases at the same time.

Recovery

Where enough information exists on the status and distribution of a species, and the causal agent(s) of decline, to enable priority recovery sites to be selected.

Management effort is instigated at these sites to achieve recovery of the species.

This broader recovery phase involves establishing/enhancing multiple populations within their historic range, or at suitable sites and, where practical, maintaining genetic diversity.

Maintenance

Where the recovery plan goals have been achieved and the threat classification of the species has sufficiently improved, through implementation of recovery plan actions, management intervention can be reduced.

The final, but ongoing, maintenance phase will involve sustaining gains made through all phases of recovery management by applying ongoing and appropriate monitoring and management at appropriate intervals and at key sites.

These phases of recovery were developed from the model described by Jansen (2001) and from the 'Species Recovery Optimisation' project work.

Appendix 2

TIMELINE FOR RECOVERY ACTIONS FOR TAKAHE

Actions have been abridged to include key points; see section 5 for full details. Shaded areas are years when actions should be implemented or completed.

Where two objectives share the same action, the action is described only once in the chart.

Priorities (national)

E—Essential: Needs to be carried out within the timeframe and/or at the frequency specified to achieve the goals for takahe recovery over the term of this plan. Highest risk for takahe recovery if not carried out within the timeframe and/or at the frequency specified.

H—High: Necessary to achieve long-term goals. To be progressed and ideally completed within the term of the plan, with moderate risk if not carried out within the timeframe and/or at the frequency specified.

M—Medium: Necessary to achieve long-term goals. To be progressed within the term of the plan, but least risk if not completed within the term of the plan or within the timeframe and/or at the frequency specified.

ACTION NUMBER	ACTIONS	PRIORITY	2007	2008	2009	2010	2011
Topic 1—Murchison Mountains takahe population							
1.1	Control deer	**E**	■	■	■	■	■
1.2	Monitor deer control	**E**			■		
1.3	1. Monitor vegetation—alpine tussock grasslands	**E**			■		
	2. Monitor vegetation—forest margin winter habitat	**E**				■	
	3. Monitor vegetation—alpine herbs as appropriate	**H**		■			
1.4	*See Actions 8.1 to 8.8*						
1.5	*See Action 4.8*						
1.6	1. Survey Core Census Area for breeding pairs and nesting outcome	**E**	■	■	■	■	■
	2. Band chicks over 8 weeks old	**E**	■	■	■	■	■
	3. Carry out November egg survey	**E**	■	■	■	■	■
	4. Complete chick censuses in the Waterfall Creek Block	**E**	■	■	■	■	■
	5. Record reports of takahe or takahe sign	**M**	■	■	■	■	■
	6. Undertake takahe census in western periphery of Takahe Special Area	**M**			■		
Topic 2—Island and mainland sanctuary populations							
2.1	Transfer birds to minimise inbreeding	**E**	■	■	■	■	■
2.2	Translocate surplus birds to Murchison Mtns and/or new Fiordland sites	**E**	■	■	■	■	■
2.3	Crop young birds for Murchison Mtns and/or new Fiordland sites	**E**	■	■	■	■	■
2.4	Allocate adequate funds and staff hours in business planning	**E**	■	■	■	■	■
2.5	Establish and operate Island Coordinator role	**E**	■	■	■	■	■
2.6	Train staff to carry out takahe work	**E**	■	■	■	■	■
2.7	Carry out habitat planning and management	**E**	■	■	■	■	■
2.8	Provide adequate water and food sources	**E**	■	■	■	■	■

Continued on next page

ACTION NUMBER	ACTIONS	PRIORITY	2007	2008	2009	2010	2011
2.9	Establish takahe monitoring guidelines	**H**					
2.10	Update pedigrees and use to inform translocation planning	**E**					
2.11	Update survival, breeding and banding records	**H**					
2.12	Establish intervention guidelines	**H**					
2.13	Manipulate nests each season to maximise productivity	**H**					
Topic 3—New sanctuaries							
3.1	Assess potential new site/s	**E**					
3.2	Select at least one suitable new site	**E**					
3.3	Sign MOU about future use of new site	**E**					
3.4	Translocate founder birds to new site	**E**					
3.5	Monitor translocated birds	**E**					
Topic 4—Burwood Captive Rearing Unit							
4.1	Maintain hygiene standards and facilities to SOP standard	**E**					
4.2	Establish recovery pens for sick/injured takahe	**E**					
4.3	Raise ≥ 14 Murchison Mountains eggs or chicks to 1 year old	**E**					
4.4	Health-screen juveniles transferred from Burwood	**E**					
4.5	Retain up to six adult pairs at Burwood for further eggs and chicks	**E**					
4.6	Use adult pairs to teach juveniles to grub for *Hypolepis* fern rhizomes	**E**					
4.7	Retire and replace Burwood pairs at 7 years	**H**					
4.8	Release Burwood juveniles into the Murchison Mountains	**E**					
4.9	*See Action 2.12*	**H**					
Topic 5—Expanding the Fiordland population							
5.1	Select suitable site or sites	**E**					
5.2	Produce monitoring plan	**E**					
5.3	Write translocation plan	**E**					
5.4	Write quarantine procedure plan	**E**					
5.5	Construct quarantine pens on islands and at Burwood	**E**					
5.6	Establish winter holding pens at Burwood	**E**					
5.7	Establish plan to manage agents of decline at translocation site/s	**E**					
5.8	Translocate 'surplus' island birds to new Fiordland site as appropriate	**E**					
5.9	Crop young island birds annually for new Fiordland site as appropriate	**E**					
Topic 6—Tangata whenua							
6.1	Provide annual reports on breeding success, pest control etc.	**E**					
6.2	Work closely with representative of Te Runanga o Ngai Tahu	**E**					
6.3	Ensure Te Runanga o Ngai Tahu is consulted	**E**					
6.4	Invite Ngai Tahu representatives to participate in field work	**H**					
Topic 7—Public awareness							
7.1	Implement Te Anau takahe community relations actions	**E**					
7.2	Complete Te Anau takahe public awareness programme	**E**					
7.3	Maintain advocacy takahe at existing display/advocacy sites	**E**					
7.4	Complete guidelines for establishing takahe display/advocacy sites	**E**					
7.5	Establish further advocacy/display site/s	**H**					
7.6	Update and support educational material and activities	**H**					
7.7	Promote and facilitate one major media event	**H**					

Continued on next page

ACTION NUMBER	ACTIONS	PRIORITY	2007	2008	2009	2010	2011
7.9	Submit or facilitate one takahe article in a suitable magazine	**M**					
7.10	Update DOC and NZ Ecological Society websites	**H**					
7.11	Provide one public open day at Burwood	**H**					
7.12	Actively support sponsorship	**H**					
Topic 8—Stoat control							
8.1	Maintain stoat traplines	**E**					
8.2	Replace Fenn traps with DOC 150 traps	**H**					
8.3	Extend stoat trapping to entire Core Census Area + western periphery	**E**					
8.4	Collect trap data and input results	**H**					
8.5	Integrate improvements to increase efficiency of stoat control	**H**					
8.6	Analyse the effectiveness of the trapping programme for takahe recovery	**E**					
8.7	Review tracking tunnel methods and use, as appropriate	**H**					
8.8	Annually monitor stoat, rat, mohua, kiwi and blue duck numbers	**H**					
Topic 9—Research, monitoring and data analysis							
9.1	Peer-review the Takahe Research Strategy	**H**					
9.2	Update and apply the Takahe Research Strategy	**H**					
9.3	Analyse efficacy of current nest management regime	**E**					
9.4	Compare survival and productivity of captive- and wild-reared takahe	**E**					
9.5	Produce model for annual harvest of Murchison Mtns eggs and chicks	**E**					
9.6	Refine Murchison Mountains takahe carrying capacity estimate	**E**					
9.7	Analyse effects of environment on breeding in wild takahe	**H**					
9.8	Calculate annual survival rates and compare with environmental variables	**H**					
9.9	Monitor and record weather in Takahe Valley	**E**					
9.10	Monitor beech seedfall in Takahe Valley and Princhester Creek	**H**					
9.11	Monitor tussock flowering in Takahe Valley	**H**					
9.12	Analyse pedigree data and investigate inbreeding effects	**E**					
9.13	Continue study of the causes of low survival of eggs/chicks on islands	**E**					
Topic 10—Viability of *Chionochloa conspicua* re-establishment							
10.1	Plant tussock seedlings in five sites	**H**					
10.2	Monitor tussock seedlings sites	**H**					
10.3	Scatter tussock seed at non-fenced sites	**H**					
10.4	Monitor non-fenced sites where seed scattered	**H**					
Topic 11—Data on Fiordland takahe are maintained							
11.1	Audit and correct data from database, as required	**H**					
11.2	Update Fiordland takahe data on database annually	**E**					
11.3	Update takahe banding records	**E**					
11.4	Update deer, weather, beech seed fall and tussock flowering records	**E**					
11.5	Use databases to evaluate progress for annual reports	**E**					
Topic 12—Island, mainland sanctuaries and captive takahe data							
12.1	Design new database	**H**					
12.2	Enter historical data into database	**H**					
12.3	Provide staff with standardised summary sheet for data	**M**					
12.4	Transfer summary sheet information to database	**M**					
12.5	Manage new takahe naming	**M**					

Appendix 3

DOCUMENTS RELEVANT TO TAKAHE RECOVERY

Bullet points summarise the key points/contents of each document.

Where the document has a reference to a DOC intranet (DOCDM) file, this has been included. Note that these are only accessible by DOC staff.

Takahe Rearing Unit, Burwood Bush Reserve, Standard Operating Procedure 2007–2012

Ross Curtis, April 2007 (unpublished).
DOCDM-167537 Revised Burwood SOP (incomplete)

Are the island populations of takahe showing signs of reaching carrying capacity?

Catherine Grueber and Ian Jamieson, Department of Zoology, University of Otago, May 2006 (unpublished).

- Report to the Takahe Recovery Group
- Sets out information on number of birds on islands since establishment
- Sets out trends in recruitment to breeding population
- Suggests islands are at or close to carrying capacity for numbers of breeding pairs
- Argues that removal of surplus birds for release elsewhere will not compromise productivity of island populations

Chionochloa conspicua re-establishment trial, Murchison Mountains Special Takahe Area, Fiordland National Park, New Zealand—project proposal

Glen Greaves and Jane Maxwell 2007 (unpublished).

DOCDM-85289

- Background to interest in restoring *C. conspicua* tussock in the Takahe Special Area as an aid to improving the winter diet of takahe
- Evidence of greater density of this tussock in the area before invasion of browsing red deer
- Outlines seedling planting trial and seed scattering trial
- Proposes methods for field work and analysis

Translocation proposal template instructions

DOCDM 79713: Takahe egg translocation guidelines—2002 (unpublished).

- A summary of the SOP for a translocation of takahe eggs from the Murchison Mountains
- Justification, ecological impacts, outcomes and targets
- Population effects of removal
- Release location and transfer methods

- Disease management
- Monitoring and post-release management
- Consultation
- Budget for translocation

Establishing long-term changes in takahe winter feeding grounds in Fiordland using pollen analysis

Janet M. Wilmshurst 2003. *Science for Conservation 228*. Department of Conservation, Wellington. 25 p.

- Takahe rediscovered in Murchison mountains at the same time as introduced deer were reaching peak numbers.
- Little is known about takahe diet in the forests.
- Little is known about what the forest understorey was like before deer.
- Both takahe and deer use the forest during winter.
- Study involved pollen analysis of short peaty cores from under the beech forest in Chester Burn.
- Results show forest change over past 50 years since deer invasion: sedges, grasses and *Celmisia* are less common now than 50 years ago and some ferns are now more abundant.
- Present takahe diet in the Murchison Mountains may not be typical of past diet. The depleted understorey may be limiting takahe winter diet and affecting their condition and, ultimately, survival/reproductive capability.

Evaluating the effectiveness of the Murchison Mountains stoat trapping programme: a preliminary assessment, 2002–2005

Danilo Hegg 2006 (unpublished).

- Trap capture data shows a decrease in stoats caught and an increase in rat captures
- Stoat captures decreased 63% in central sector but constant on edges
- Strong relationship between stoat and rat numbers caught on same line and same tunnel
- Tracking tunnels not sensitive enough to give meaningful data when mustelids are at low densities
- No positive effect of stoat trapping on takahe breeding success was detected, though there was a positive effect on takahe adult survival
- Mohua decreased 28% in treatment area and 85% in control area
- Kiwi sample too small to show the effects of trapping programme

Guidelines for establishing display sites for takahe (draft)

C. Wickes 2007 (unpublished).

DOCDM 157791: Guidelines for takahe display sites

- Management objectives
- History of display sites
- Description and role of display sites and physical criteria
- Maintenance and community relationship requirements
- Assessment process

Guidelines for the establishment of new sites for takahe within lowland habitats

April 2004 (unpublished).

OLDDM 425662: Takahe sites criteria

- Ngai Tahu support proposal
- Habitat supports 5 breeding pairs
- Commitment to ongoing management of site and predator control, including a 10-year management plan
- Instructions and report to Takahe Recovery Group
- Adequate water essential

Instructions for fitting harnesses to takahe

June 2007 (unpublished).

DOCDM 164687: Takahe transmitter SOP

- Only trained staff should do this (training involves demonstration then supervised fitting of 5 harnesses)
- Check condition of bird and old harness
- Details provided of 'Wedge testing' method
- Record all information
- Hygiene—sterilisation of all equipment, including clothing, is important

Long-term effects of defoliation: incomplete recovery of a New Zealand alpine grass, *Chionochloa pallens*, after 20 years

W.G. Lee; M. Fenner; A. Loughnan; K.M Lloyd 2000. *Journal of Applied Ecology 37*: 348–355.

- *Chionochloa pallens* is an important food plant for takahe
- Experiment measured the long-term rate of recovery of the grass after simulated severe deer grazing
- After two decades, recovery was incomplete
- Other slower-growing species of *Chionochloa* would likely take even longer to recover after deer grazing

Objectives for takahe programme to reduce the effects of inbreeding in the takahe population outside of Fiordland

Jane Maxwell, May 2005 (unpublished).

OLDDM 428773: Takahe inbreeding management objectives

- Recent research by Catherine Grueber has highlighted the level of inbreeding occurring in island takahe populations. This is starting to have an effect on breeding efficiencies.
- Inbreeding coefficient greater than 0.125 is undesirable and should be avoided.
- Need to manage pairings to prevent certain lineages becoming over represented.
- Objective should be good quality productivity rather than high productivity.
- Techniques: break up pairs, create desirable pairings, transfer birds not required for breeding to display sites, introduce new birds.

- Burwood breeding pairs creating an unnatural selection in the Murchison Mountains population. Increase the rate of changing Burwood breeding pairs to prevent over-representation of the genetics of particular pairs.

Project plan—Murchison Mountain stoat control

Dave Crouchley 2001 (unpublished).

OLDDM-422643 Stoat programme

- Documents examples of stoat predation recorded in the Murchison Mountains
- Identifies that previous stoat control operations unable to measure their impact
- Provides trapping programme design: treatment and non-treatment areas, low-intensity landscape trapping over 15 000 ha, 120 km of trapline, 720 double Mark 4 Fenn trap boxes, rebaiting of trap boxes four times a year
- Monitoring: climate, beech and tussock seedfall, small mammal indexing, records of trap catch, takahe predation and breeding results to be considered when results assessed
- Map of takahe distribution
- Affects of trapping assessed after 3 years

Standard format for Species Recovery Plan

OLDDM 756838: New recovery plan template instructions

- Contains the standard format for Recovery Plans
- Instructions and examples of what is required and definitions of terms
- Gantt chart
- Phases of Recovery Action Model
- Species Recovery Model

Species Administration Management System

DOCDM 151172: Species administration management system

A DOC document that provides links to other documents relevant to the following subjects:

- Recovery Groups
- NZ threat classification
- Wildlife health
- Captive management
- Island eradication network
- Island biosecurity network

Takahe (*Porphyrio hochstetteri*) Captive Management Plan 2004–2009

Andrew Smart
OLDDM 770198

- Description of takahe taxonomy and captive management history
- Origin of birds held in captivity as of October 2003
- Captive management policies: producing stock for re-introduction , providing

insurance population, salvaging last survivors, providing individuals for research to enhance conservation of threatened species

- Goals and objectives: increase public awareness, maximise Burwood yearlings suitable for release, minimise risk of disease, minimise risk of predation of captive stock, provide representative of birds for research, improve survival of released birds
- Breeding success and status of released birds
- Performance measures

Takahe information sheet: July 2004

DOCDM 79728: Takahe information sheet

- Current status, history and description of takahe
- Habitat—Fiordland and on islands
- Feeding and breeding behaviour
- Conservation management and graph updates of population trends
- Future prospects and further references

Takahe (*Porphyrio hochstetteri*) health investigation project

Karrie Rose DVM, DVSc, Taronga Park Zoo, Sydney, NSW, Australia. October 2000 (unpublished).

OLDDM 423080: Takahe health reconnaissance project report

- Contract report presented to Takahe Recovery Group, Department of Conservation, Te Anau
- Reconnaissance of health status of takahe nationally, comparing subpopulations
- Reports physical exam results, haematological data, pathogens and parasites found
- Recommendations for movement of birds between sites
- Quarantine procedures
- Necropsy protocol

Takahe Recovery Plan 2002–2007

Dave Crouchley

OLDDM 424282: Standard format Takahe Recovery Plan

- Background on takahe and past conservation management
- Long-term goal: two viable populations of at least 100 pairs each. One maintained within its present and former range in Fiordland National Park, and the second comprising takahe on groups of islands and other mainland sites.
- 12 Objectives relating to community relations, management and research needs.
- Actions required to reach the 12 objectives.

Takahe Research Strategy

- Updated annually
- Lists and prioritises all research pertaining to takahe nationally
- Indicates status of projects; planned, ongoing, in progress, recently completed

Wellington Conservancy Takahe Management Manual

Jason Christensen; Lynn Adams

OLDDM 696446 takahe husbandry manual draft

- Standardising management in Conservancy sites: Mana, Kapiti, Pukaha Mount Bruce Wildlife Centre
- Calendar of events
- Nesting and chick monitoring best practice
- Disease and hygiene management
- Transporting birds
- Public awareness
- Database annually updated
- Relevant forms and contacts

New Zealand Government