

Whio/blue duck (*Hymenolaimus malacorhynchos*) recovery plan

2009-2019

Andrew Glaser, Paul van Klink, Graeme Elliott and Kerri-Anne Edge

THREATENED SPECIES RECOVERY PLAN 62

Published by
Publishing Team
Department of Conservation
PO Box 10420, The Terrace
Wellington 6143, New Zealand

Cover: A brood of just-hatched ducklings on the Te Waiiti Stream, Te Urewera National Park.
Photo: Brenda R. Baillie.

Limited copies of *Threatened Species Recovery Plans* are printed. Electronic copies are available from the departmental website in pdf form. Titles are listed in our catalogue on the website, refer www.doc.govt.nz under *Publications*, then *Science & technical*.

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ISSN 1170-3806 (hardcopy)

ISSN 1170-3806 (web)

ISBN 978-0-478-14840-4 (hardcopy)

ISBN 978- 0-478-14841-1 (web PDF)

This report was prepared for publication by the Publishing Team; editing and layout by Amanda Todd. Publication was approved by the General Manager, Research and Development Group, Department of Conservation, Wellington, New Zealand.

In the interest of forest conservation, we support paperless electronic publishing. When printing, recycled paper is used wherever possible.

Foreword

The General Manager Operations (Northern) of the Department of Conservation (DOC) formally approved this threatened species recovery plan in June 2010. A review of the plan is due in 2017, 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 Whio Recovery Group prepared this plan in conjunction with people interested in or affected by this 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 whio. 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 whio are welcome and should be directed to the Whio 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 whio 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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Whio/blue duck (*Hymenolaimus malacorbynchos*) recovery plan

2009–2019

Andrew Glaser¹, Paul van Klink², Graeme Elliott³ and Kerri-Anne Edge⁴

¹ Whakatane Office, Te Urewera Area Office, Department of Conservation,
1-100 Valley Road, Whakatane 3120, New Zealand
Email: aglaser@doc.govt.nz

² Hokitika Area Office, Department of Conservation, Private Bag 701,
Hokitika 7842, New Zealand

³ Nelson/Marlborough Conservancy, Department of Conservation, Private Bag 5,
Nelson 7042, New Zealand

⁴ Te Anau Area Office, Department of Conservation, PO Box 29, Te Anau 9640,
New Zealand

ABSTRACT

The whio/blue duck (*Hymenolaimus malacorbynchos*) is an endangered species that is listed as Nationally Vulnerable under the New Zealand Threat Classification System (2008) due to a significant decline in abundance and distribution. Active management is needed to ensure the species' long-term survival, as whio are dependent on *in situ* management in suitable large-scale river systems, and require protection from the key threat of stoat (*Mustela erminea*) predation. This is the second national recovery plan for whio and follows on from the previous (1997–2007) recovery plan. This 10-year plan is a guide for the Department of Conservation (DOC) and interest groups involved in conserving whio. Its first priority is to secure populations to a minimum of 400 pairs at eight 'Security Sites' throughout New Zealand by 2014. To achieve this, the whio recovery programme will control introduced predators, and target research towards gaining a further understanding of whio biology, threats and management requirements. The second priority is to recover or re-establish populations throughout their former range ('Recovery Sites'). The recovery programme will continue to investigate translocation/re-establishment techniques and improved predator control management. Public awareness, education and community involvement are important tools that will be used to assist the recovery of whio.

Keywords: *Hymenolaimus malacorbynchos*, blue duck, whio, WHIONE, threatened species recovery, predation, river, captive breeding, habitat quality, water flow

© Copyright December 2010, Department of Conservation. This paper may be cited as:
Glaser, A.; van Klink, P.; Elliott, G.; Edge, K-A. 2010: Whio/blue duck (*Hymenolaimus malacorbynchos*) recovery plan: 2009–2019. *Threatened Species Recovery Plan 62*. Department of Conservation, Wellington. 39 p.

1. Introduction

The whio/blue duck (*Hymenolaimus malacorhynchos*) is endemic to New Zealand and is one of only four of the world's 165 waterfowl species that live permanently in rivers (Kear 2005). Whio inhabit one of New Zealand's harshest environments and have evolved to endure these conditions. They are an icon of back-country waterways of New Zealand, and have cultural, spiritual, historic and traditional significance for Māori (Young 2006).

Whio are in the upper trophic level in New Zealand riverine ecosystems, so their presence serves as an indicator of riverine ecosystem health and the completeness of ecological relationships within that ecosystem. Their presence can also be used to measure the success of restoration and protection programmes in these riverine ecosystems (Adams et al. 1997).

Whio have vanished from many areas where they were once common, and it is widely accepted that they have declined in number and distribution (Mills & Williams 1979). This decline is the result of modification of waterways, loss of riparian (stream-side) vegetation, and the introduction of mammalian predators (Adams et al. 1997). Today, whio are classified as 'Nationally Vulnerable' under the New Zealand Threat Classification System (NZTCS) (Miskelly et al. 2008). The IUCN red list ranks whio as endangered and population trend decreasing (BirdLife International 2008).

Stoats (*Mustela erminea*) have been identified as the main agent of decline for whio at some sites, and are also one of the most manageable threats (Whitehead et al. 2007; Glaser & Allerby 2010). Consequently, stoat control is the main focus of management activities in this plan.

Although many New Zealand endangered species are protected on predator-free offshore islands, there are no offshore islands with sufficient large rivers and streams to support a viable population of whio (Shaw 2002a). Whio survival is thus dependent upon *in situ* management of key threats in back-country rivers and streams on the mainland.

The goal of this recovery plan is to ensure the retention of viable wild whio populations throughout their natural range, by protecting whio at eight first-priority 'Security Sites' as well as at a number of second-priority 'Recovery Sites'. These sites are distributed equally between the North and South Islands in recognition of the apparent genetic distinctiveness of North and South Island whio (Robertson et al. 2007).

2. Plan term and review date

Term of the plan: 10 years, from September 2009 to September 2019.

Review date: September 2017.

3. Context

3.1 OVERVIEW OF SPECIES

3.1.1 Taxonomy

The blue duck or whio (*Hymenolaimus malacorhynchos*) is one of New Zealand's ancient endemic waterfowl species and is the only member of its genus (Kear 2005). It was first described in 1789 by Gmelin. Its taxonomic relationships with other waterfowl species are uncertain; DNA analysis has placed it as a sister to the South American dabbling ducks (Anatini), but with no close relative (Kear 2005). Although the North Island and South Island whio are genetically distinct, they are not described as sub-species; they are, however, treated as separate management units (Robertson et al. 2002).

3.1.2 Species ecology and biology

Whio live year-round on rivers—a mode of life shared with only four of the world's other 165 waterfowl species (Kear 2005). They are widely distributed throughout New Zealand, but are largely confined to forested headwater catchments. Their present-day distribution is centred on the rivers of the central plateau and ranges of the North Island, and the western ranges of the South Island. Whio occupy stream and river systems with high water quality, stable stream banks, low transport of fine or suspended sediments, standing native riparian scrub or forest, and a wide diversity and abundance of aquatic invertebrates (Collier et al. 1993).

Whio appear to be river specialists, though fossil evidence shows that they once foraged well away from flowing water (Worthy & Holdaway 2002). They are well camouflaged, with their slate-blue plumage allowing them to blend into their rocky surrounds. Whio are mostly crepuscular (active in twilight) feeders, though they are known to feed for short periods during the night (Douglas & Pickard 1992). Most feeding occurs by dabbling or up-ending in riffles (Veltman & Williams 1990) and occasionally by diving. Their most distinctive feature is a fleshy membrane on their upper bill that enables them to feed amongst rocks without causing wear to the bill (Kear & Burton 1971).

The male makes a distinctive high-pitched 'whio' whistle, which contrasts with the guttural call of the female. Males are larger than females, with males weighing 950–1300 g and females 750–1100 g (Whio Recovery Group, pers. obs.). Nesting occurs between August and January, with each clutch containing 3–9 eggs. The female incubates the eggs for 35 days (Williams 1985), and ducklings fledge between 70 and 80 days of age. Adult birds moult for 2 weeks between December and May, during which time they are flightless (Williams 1985).

Whio pairs are strongly territorial (average territory is about 1.5 km of river), resulting in their populations occurring at low densities throughout linear river habitats. Their average lifespan is 7–8 years, though some will live longer than 10 years (Adams et al. 1997). Juvenile whio dispersal appears to be related to population density, with increasing numbers of young birds dispersing from their

source population as who density increases (Whitehead et al. 2007). Juvenile birds have been known to disperse as far as 40 km from their natal territory, including into different catchments.

3.1.3 Status and species recovery phases

Who were assigned a threat status category of ‘Nationally Endangered’ in the 2005 listing of the NZTCS (Hitchmough et al. 2007). The criterion for this ranking was a trend decline of 60% or more in the total population in the last 100 years. In 2008, a revision of NZTCS occurred (Townsend et al. 2008), and a review of the threat status for who improved the ranking to ‘Nationally Vulnerable’ (Miskelly et al. 2008). This means that the population is estimated at between 1000 and 5000 individuals, with a trend decline of 10–50%.

In recovery planning for threatened species, the Department of Conservation’s (DOC’s) Recovery Action Model (DOC 2008) has four phases of action:

- Research to identify cause and key agents of decline
- Security from extinction
- Recovery
- Maintenance

The different managed populations of who currently fall into one of the first three phases. All who management effort over the next 10 years is focused on progressing these populations through the phases. Who will remain under some level of threat and require ongoing management for the foreseeable future.

3.1.4 Past and present distribution

Archaeological and historical evidence shows that who were once far more widespread than they are today (Worthy & Holdaway 2002). In early European times, who were prevalent throughout both the North and South Islands of New Zealand, with the exception of Northland, and possibly coastal parts of Canterbury and Otago. There are no fossil records from the Chatham Islands, Stewart Island/Rakiura, Great Barrier Island (Aotea Island), or other smaller outlying islands (Worthy & Holdaway 2002).

The most recent estimate of total population size is 2500–3000 individuals, with 1200 pairs at most (Who Recovery Group, pers. comm.). The population is declining, particularly in the South Island. The largest numbers today are found in rivers or streams in the catchments of the Bay of Plenty, central North Island, Northwest Nelson, West Coast and Fiordland (Who Recovery Group, pers. comm.). Current estimates of the number of pairs receiving some form of protection as of June 2007 are given in sections 5.1.1 (Table 2—Security Sites) and 5.1.2 (Table 3—Recovery Sites).

3.1.5 Agent(s) of decline and threats

Whio have undoubtedly declined as a result of human-induced environmental changes. The clearance of forest for pastoral farming and exotic forestry have rendered many waterways unsuitable for whio, through loss of riparian vegetation and reduced catchment stability and water quality. Water diversions and dams for electricity generation have also impacted on whio and their habitat (Buller 1888; Williams 1964; Innes et al. 2009). Although these changes have had a large impact on whio in the past, rates of forest clearance and river diversion are now relatively low.

Naturally occurring floods also affect whio by washing out nests, fragmenting broods and temporarily reducing invertebrate abundance in rivers. However, these are totally unmanageable.

Since large-scale native forest clearance has been curtailed in the last 20 years, the most important agent of decline for whio has been predation by mammals introduced to New Zealand during the 19th and 20th centuries. While there is some evidence that cats (*Felis catus*), dogs (*Canis familiaris*), possums (*Trichosurus vulpecula*), and ferrets (*Mustela furo*) prey upon whio and affect some whio populations, there is compelling evidence that stoats are the most important agent of decline for both the North and South Island whio populations (Whitehead et al. 2007; Glaser & Allerby 2010).

Nesting females, eggs, young broods and juvenile whio are particularly vulnerable to predation by stoats (Whitehead et al. 2007; Glaser & Allerby 2010). Low productivity and a male-biased sex ratio have also been observed throughout their range, which are most likely attributable to predation, mainly by stoats. Video monitoring of nests initiated in 1999 found that stoats were the major predator of whio in Fiordland; and where effective stoat control has been undertaken, the whio population has recovered strongly (Whitehead et al. 2007).

A suite of native predators also prey upon whio. However, this predation is a natural process and some of the predators are themselves endangered, so we do not propose to manage native predators.

Didymo (*Didymosphenia geminata*) may also pose some threat to whio. Didymo is a freshwater alga that has recently arrived in New Zealand and is currently confined to parts of the South Island. Thick growths of didymo form large mats on the bottom of streams and rivers, which can adversely affect freshwater fish, plants and aquatic invertebrates. The effect of didymo on whio is unknown, but it likely results in reduced food supply and, in turn, reduced productivity. As a result, whio may be forced into sub-optimal habitats where they are more vulnerable to predation.

The range of threats to whio are shown in Table 1.

TABLE 1. THREATS TO WHIO.

This table has been derived from the cumulative knowledge of the Whio Recovery Group and the reporting of whio deaths into a national database (Riddler 2009), and close-order monitoring results from Fiordland (Whitehead et al. 2007) and Te Urewera (Glaser & Allerby 2010). The various threats or agents of impacts are categorised into introduced pests, natural and human induced. The first five rows of the table indicate which stages of the whio life-cycle (whio adult – subadult) are affected by each of the threats or agents of decline using a score of 1 (has an impact) or 0 (limited or no effect). ‘Threat abundance’ indicates the current relative abundance of predators or relative likelihood of other threats on a 1–3 scale, 3 being the highest abundance and 1 the lowest. ‘Current risk’ identifies the risk of these impacts to whio populations in today’s environment. ‘Manageable’ indicates whether these threats can be mitigated by conservation management using a score of 1 (manageable) or 0 (unmanageable). The total can be used to assess the priority of each agent of decline for conservation management, where the highest score represents the greatest threat ranking. Overall, unmanageable agents of decline and those of low abundance or likelihood are ranked low, whereas manageable agents of decline that are abundant and affect many life-cycle stages are ranked high.

	INTRODUCED PEST						NATURAL				HUMAN INDUCED				
	STOAT	FERRET	DOG	CAT	POSSUM	RAT	FALCON	HARRIER	WEKA	EEL	FLOOD	HYDRO	LAND CLEARING	DIDYMO	DISEASE
Adult male	1	1					1	1				1	1	1	1
Adult female	1	1	1	1			1	1				1	1	1	1
Nest	1	1	1	1	1	1			1	1	1	1			
Duckling	1	1	1	1		1			1	1	1	1	1	1	1
Subadult	1	1					1	1			1	1	1	1	1
Threat abundance	3	2	1	1	3	3	1	3	1	3	2	1	1	1	1
Current risk	1	1	1	1	1	1	1	1	1	1	1			1	
Manageable	1	1	1	1	1	1						1	1	1	
Total	10	9	6	6	6	7	5	8	3	6	6	7	7	7	5

3.1.6 Past management and the species’ response

DOC published the Conservation Strategy for Blue Duck in 1988 (Williams 1988), which covered the period 1988–1992, and the Whio Recovery Plan 1997–2007 in 2007 (Adams et al. 1997). These documents and subsequent actions have resulted in significant progress in whio conservation. The following is a summary of key achievements over this period:

- The development of a national database of whio sightings on the Department of Conservation’s Bioweb database (previously the National Distribution Scheme Database).
- A significant amount of research on the biology of whio, which has provided an increased understanding of the ecology and demography of the species.
- Nationwide surveys to determine the distribution and abundance of whio.
- Regional monitoring of representative populations to assess population trends. This work has identified population declines, agents of decline and a strong gender bias towards adult males.
- Population re-establishment through translocation of captive-reared young and Whio Operation Nest Egg (WHIONE), which have increased understanding of the techniques needed for whio re-establishment and management (Caskey & Peet 2005).
- Completion of the blue duck captive review (Bell 1999).

- Identification of the key agents of who decline in Fiordland through video monitoring work.
- Research-by-management controlling stoats at key sites to determine the benefits for who, which has led to increases in pair densities and productivity.
- An increase in the profile of who, which has helped projects to get established and secured finances through community contributions, a bequest and mitigation revenue, all of which have been vital to project successes.
- Establishment of the extent of genetic variation between North Island and South Island populations, resulting in these populations being treated as separate management units (Robertson et. al. 2007).

The long-standing who population monitoring programmes within Te Urewera Mainland Island, Manganuioteao and Clinton/Arthur have demonstrated a positive response to stoat control. In the case of Te Urewera Mainland Island, the who population increased 2.8 fold over 4 years, producing three fledged juveniles per pair and 94% survival of young in favourable years (Glaser 2007). In non-treated environments, nesting success was recorded at 91% failure rate and stoats have been identified as the main cause of nest failure. An average of 0.64 juvenile fledglings per pair was measured over an 8-year period in a non-treated environment (Glaser & Allerby 2010).

In 2003, DOC initiated the Operation Ark Programme, which aimed to protect a suite of endangered animals in South Island beech (*Notbofagus* spp.) forests. Who are one of the focal species of Operation Ark and three South Island who sites are now managed using Operation Ark funding. Operation Ark management has improved the security of who at these sites and has minimised their decline; however, the methodologies have not yet been fully tested over time. Pair densities have increased 2.3 fold in Clinton and Arthur, and productivity has increased from 0% survival to as much as 90% survival of young, and from an average of 0.07 juveniles per pair to 1.6 juveniles per pair. Other Operation Ark sites are still at the building stage, with population densities increasing either through WHIONE or *in situ* management, so the true benefits cannot yet be measured (Gummner 2010).

The Who Recovery Group also prepared a self-review in 2003, which was followed by a more comprehensive technical review undertaken by DOC's Biodiversity Recovery Unit in 2004. The technical review team devised a set of goals and objectives for who recovery, which are adopted in this plan.

3.1.7 Options for recovery and preferred option

It is unclear whether stoats are the main cause of decline of who at every site. However, we are at a turning point in the history of conservation management of who, as the species' conservation status is now so precarious that the focus of conservation management must shift from determining the relative importance of the agents of decline to securing who from extinction by active management of the key manageable threats. Reducing the density of stoats is the only conservation action we can currently take that is likely to lead to a significant improvement in who population performance, even at sites where other factors may be more important.

The preferred option for recovery of whio is to manage whio at selected sites within their natural range by controlling introduced predators, particularly stoats, and by supplementing population growth by releasing captive-reared and/or captive-bred whio.

This recovery plan begins with a 5-year security phase (2009–2014), during which time representative whio populations will be secured. The security phase concentrates on eight first-priority Security Sites. Each site must be capable of protecting 50 whio pairs on sequential territories on a river, or multiple neighbouring rivers, connected by juvenile dispersal. Although the goal of 50 pairs may not be achieved by 2014, sites should be fully operational by this point in time.

The four North Island and four South Island Security Sites identified in this plan will provide security for a minimum of 400 whio pairs using predator-control techniques tailored to fit the landscapes and histories of each site. Captive-raised birds could also be introduced if there was a requirement for this technique. The success or failure of the predator-control techniques will be assessed by using standard best-practice repeat ‘walk-through’ surveys at key times or, in some cases, more intensive population monitoring at research sites. Where necessary, management will be modified to improve the rate of whio recovery. Five of the eight Security Sites are already receiving intensive management: Te Urewera Mainland Island, Tongariro Forest Kiwi Sanctuary, Oparara/Ugly Operation Ark, Wangapeka Fyfe Operation Ark and the Clinton/Arthur/Cleddau Operation Ark. These sites already have mandates to conduct close-order monitoring as part of their outcome monitoring and are, therefore, the preferred sites to conduct further research.

The second stage of the plan is a 5-year recovery phase (2014–2019), during which the management techniques developed and refined during the security phase will be applied at a wider range of second-priority Recovery Sites (Fig. 1).

Recovery Sites fall into three categories: existing community initiatives, existing ecosystem restoration projects, and new sites chosen to ensure that whio populations persist throughout their natural range. Some work is already being undertaken at Recovery Sites, including predator trapping, and whio and predator monitoring.

The security and recovery phases will overlap due to the current management requirements of each of the existing managed sites. However, the priority for resources should focus on ensuring that Security Sites (in the first 5 years of this plan) are fully operational before initiating new Recovery Sites. Opportunities may arise where sponsors want to contribute to the whio recovery programme; where possible, they should be guided to helping to secure whio at Security Sites, but the sponsor’s initiative should be supported where possible.

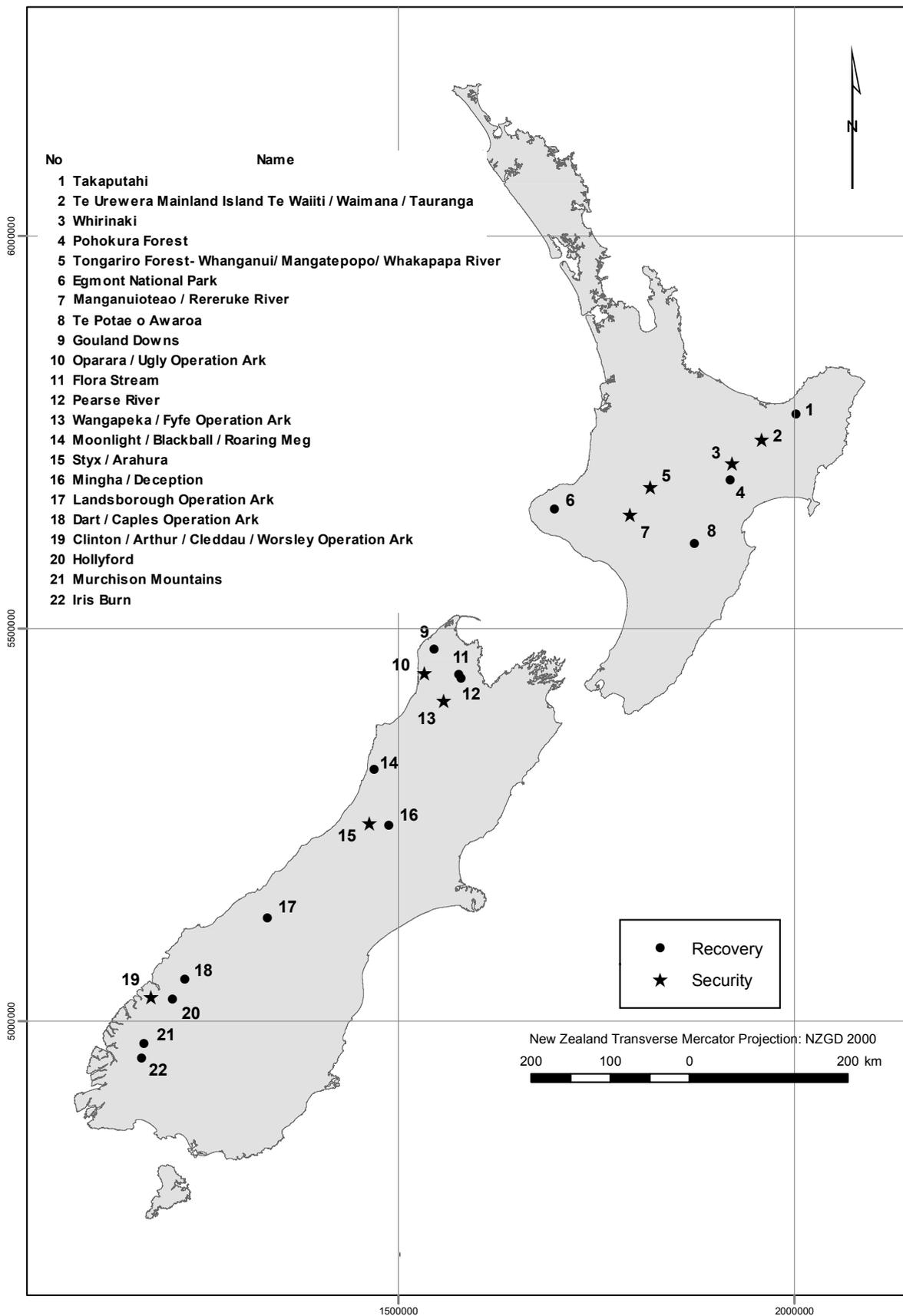


Figure 1. Security and Recovery Sites where whio protection is currently occurring.

3.2 STRATEGIC DIRECTIVES

3.2.1 New Zealand Biodiversity Strategy

This plan supports three of the four goals of the New Zealand Biodiversity Strategy (DOC & MfE 2000), as well as key associated principles, actions and strategic priorities:

Goal 1: Community and individual action, responsibility and benefits

Enhance community and individual understanding about biodiversity, and inform, motivate and support widespread and coordinated community action to conserve and sustainably use biodiversity; and

Enable communities and individuals to equitably share responsibility for, and benefits from, conserving and sustainably using New Zealand's biodiversity, including the benefits from the use of indigenous genetic resources

Goal 2: Treaty of Waitangi

Actively protect iwi and hapu interests in indigenous biodiversity, and build and strengthen partnerships between government agencies and iwi and hapu in conserving and sustainably using indigenous biodiversity

Goal 3: Halt the decline in New Zealand's indigenous biodiversity

Maintain and restore a full range of remaining natural habitats and ecosystems to a healthy functioning state, enhance critically scarce habitats, and sustain the more modified ecosystems in production and urban environments; and do what else is necessary to

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

3.2.2 Department of Conservation Statement of Intent

This recovery plan is in line with DOC's Statement of Intent 2010–2013 (SOI; DOC 2010). It aligns with the expectation of DOC's outcome statement: 'New Zealanders gain environmental, social and economic benefits from healthy functioning ecosystems, from recreational opportunities, and from living our history'.

DOC works towards the outcome statement through six intermediate outcomes that express the impacts DOC seeks to make through its interventions. These are:

1. The diversity of our natural heritage is maintained and restored.
2. Our history is protected and brought to life.
3. More people participate in recreation.
4. More people engage with conservation and value its benefits.
5. More business opportunities delivering increased economic prosperity and conservation gain.
6. Statutory obligations and other government functions are met.

Specific reference to the strategic focus of this recovery plan and species management is referred to within Intermediate Outcome 1 Natural Heritage and has links with 3 Recreation, 4 Engagement and 5 Business Opportunities.

Under Intermediate Outcome 1, we are seeking to achieve the following:

- Conserving a full range of New Zealand's ecosystems to a healthy functioning state.
- Conserving nationally threatened species to ensure their persistence.
- Improving nationally iconic natural features.
- Improving populations of nationally iconic species.
- Improving locally treasured natural heritage
- Holding public conservation lands, waters and species for the benefits they deliver now and for the future.

Through the implementation of the whio recovery plan and the collaborative efforts of DOC, iwi, communities, groups, recreational users and organisations, whio populations can be secured and restored, thereby improving the functioning of these ecosystems. More people will be engaged in conservation through their active involvement, increasing the value of New Zealand's natural heritage. Opportunities can be fostered with tangata whenua, communities, groups, organisations, recreational users and businesses through the management of whio, increasing economic prosperity and delivering greater conservation gains and thereby connection to our natural heritage.

Through this process, we can aspire to DOC's vision: 'New Zealand is the greatest living space on Earth'.

3.3 CULTURAL IMPORTANCE

Māori throughout New Zealand have a spiritual connection not only to awa (the river), but also to the wildlife that inhabits it. The whio has always been taonga (treasure) to tangata whenua (iwi or hapū that have customary authority in a place), who have a strong cultural, spiritual and historic association with the bird.

The special traditional relationship between tangata whenua and species has been recognised through the Section 4 requirements of the Conservation Act 1987 (to give effect to the Principles of the Treaty of Waitangi), and through Treaty Settlements legislation and Protocols set up under the legislation, which require DOC to give consideration to places and species of significance to tangata whenua.

The bird was also admired by early settlers and explorers. The sight and sound of whio and the image of New Zealand's back-country waterways have been synonymous for a long time, and today the whio is acknowledged by New Zealand's back-country users as an icon of the waterways (Young 2006).

3.4 PUBLIC AWARENESS

Communities, businesses and conservation groups have demonstrated their commitment to whio conservation through active participation in and the provision of financial assistance to whio management. Whio conservation has also benefited from mitigation revenue, whereby agencies or persons responsible for certain commercial activities that cause an adverse effect to whio or their habitat are required to pay compensation to offset any impact. Mitigation has provided an important source of funding for many projects.

Although whio recovery does not have a national sponsor, the regional and local contributions from communities, businesses and groups are fundamental to the success of the whio recovery programme. A full list of the groups and organisations contributing is provided in Appendix 1.

Back-country users have been invaluable in providing whio sighting records for the Bioweb database, which are used to indicate changes in whio abundance and distribution. A milestone for whio advocacy was the 2006 publication of a book specifically based on whio conservation by David Young: 'Whio: saving New Zealand's blue duck' (Young 2006).

4. Goals

4.1 LONG-TERM RECOVERY GOAL

The long-term goal for whio recovery is to ensure the retention of viable wild whio populations throughout their natural range.

Whio will ultimately be maintained in their existing range and reintroduced to a series of strategically chosen Security and Recovery Sites located in their former range, which are close enough together to be linked by migration.

An important milestone will be reached when the IUCN threat status (endangered and population decreasing) has improved by at least one category and the New Zealand Threat Classification System (NZTCS) (Townsend et al. 2008) ranking has improved from 'Nationally Endangered' to a lower category of threat, i.e. 'Nationally Vulnerable' (or better). The NZTCS ranking for all New Zealand bird species was reviewed in 2008 (during the writing of this plan), as a result of which whio have now been reassigned as 'Nationally Vulnerable' (Miskelly et al. 2008). This is largely due to the protection in place at Security Sites, although this success still needs to be demonstrated for key populations over a longer timeframe.

4.2 RECOVERY PLAN-PERIOD GOALS

To secure whio in New Zealand such that there is a minimum of 400 pairs at eight Security Sites.

Within the 10-year period of this plan, the whio meta-population will comprise a minimum of 400 pairs distributed between eight sites (i.e. a minimum of 50 pairs at each site). Sites will be managed such that whio populations are stable or increasing.

To have at least 100 whio pairs distributed between priority Recovery Sites that are strategically located.

An additional 100 whio pairs will also be protected at Recovery Sites that are being managed specifically for whio, or as part of other predator control or ecosystem restoration programmes. Once whio security has been achieved and the targets met at the Security Sites, additional strategically located Recovery Sites will be identified for management to increase the number of populations that are protected to restore their natural range.

5. Implementation

This section provides short-term advice for DOC managers, iwi, groups, businesses and organisations involved in whio recovery, by identifying desired actions for achieving the 18 objectives specified in this plan.

The plan is grouped into three themes that are common to species recovery programmes: management, community relations and research. Several topics are listed under each of these themes, for each of which background information, issues, objectives and actions to resolve the issues are presented.

It is implicit throughout the implementation section that Area Managers at each location will endeavour to meet these objectives. However, it is also recognised that they will have to weigh up competing priorities according to DOC's annual business planning process.

It must be noted that the recommended objectives and actions in this plan are subject to normal business planning processes for resource allocation within DOC. In some cases, external funding will be sought where departmental resources are insufficient.

All actions in this plan have been placed in one of three priority classes: 'essential', 'high' or 'medium'. These indicate the relative importance of each action in terms of its contribution towards achieving the recovery objectives and goal. This classification is based on the following recommendations made during the development of this plan:

E—Essential: Recommended as essential for the recovery of whio. These actions should be carried out in the first 5 years of this plan, subject to resources being available and existing decision-making processes.

H—High: Recommended as necessary for achieving the long-term goal for whio recovery. These actions should be carried out during the 10-year term of this plan, subject to resources being available and existing decision-making processes.

M—Medium: Recommended to support the recovery of whio. Some progress should be made towards these actions during the 10-year term of this plan, subject to resources being available and existing decision-making processes.

A timeline for recovery actions is provided in Appendix 2.

5.1 MANAGEMENT

5.1.1 Topic 1—Security Sites

Eight Security Sites will be established for who conservation, to secure key populations from extinction (Fig. 1 & Table 2).

Stoat control is the main management activity required at all sites, using DOC best practice and the layouts outlined in Table 2. In addition, captive-reared (WHIONE) and captive-bred birds (see Topics 4 and 5) will be released at some or all of the sites to increase the rate of who recovery, particularly in the early stages.

The control techniques that are being implemented at each of the Security Sites have not yet been fully tested. Security Sites will have varying combinations of topography, habitat and predator guilds, so that techniques that have proven successful at one site may not be effective at all sites, e.g. stoat trapping that is effective in the steep, incised and mountainous ranges of beech forest of Fiordland may not work in the gentler rolling terrain of mixed podocarp and beech at Whirinaki. Outcome monitoring over time will determine the trend and effectiveness.

TABLE 2. PAIR PROTECTION AT SECURITY SITES AS OF JUNE 2007.

SITE NAME	PAIRS IN 2007	TARGET PAIRS	STOAT TRAPPING	POISON	WHIO MONITORING	STOAT MONITORING	CAPTIVE RELEASE
North Island							
Te Urewera Mainland Island	25	50	Grid using topographic features— catchment based. Single sets at 100-m spacings.		Walk-through and close order monitoring		
Whirinaki Forest	4	50	Grid using topographic features— catchment based. Tram lines of single sets at 100-m spacings.	Aerial 1080 (in parts)	Walk-through		
Tongariro Forest	30	50	Grid using topographic features— catchment based. Tramlines of single and double sets at 100-m spacings.	Aerial 1080	Walk-through	✓	✓
Manganuioteao/ Retaruke	30	50	Grid using topographic features— catchment based. Tram lines of single sets at 100-m spacings.		Walk-through	✓	
South Island							
Oparara/Ugly	14	50	Grid using topographic features in the Oparara catchment, double lines in the Ugly valley. Single set traps at 200-m spacings.	Aerial 1080	Walk-through	✓	✓
Wangapeka/Fyfe	17	50	Single and double lines of single traps at 100-m spacings in valley floors.	Aerial 1080	Walk-through and close order monitoring	✓	✓
Styx/Arahura	16	50	Double lines of single traps at 100-m spacings in valley floors.	Aerial 1080	Walk-through (Styx only)		✓
Clinton/Arthur/ Cleddau and Worsley	28	50	Single lines of double-set traps at 200-m spacings in valley floors.	Aerial 1080 (Worsley excluded)	Walk-through	✓	✓

The Recovery Group recommends that conservancies develop strategic plans to guide and direct who recovery work in each conservancy. The strategic plans will provide direction on how each conservancy will implement the actions of this recovery plan and provide strategic direction for operational planning within Areas.

An operational plan for each of the eight Security Sites should be produced by conservancy and area office staff, with input from interested groups and individuals. These plans will describe the operational component of how the 50-pair goal is to be achieved and maintained, and will include a budget. Current Operation Ark site plans are sufficient to meet this need, provided they cover the goals and objectives of this recovery plan.

Strategic plans should have a term consistent with the Who Recovery Plan (to 2019), whereas operational plans should be reviewed annually to consider the programme's progress towards meeting its goals.

Issues

Issue 1.1: There is no single management prescription that can be effectively applied at all eight Security Sites. It is essential for who recovery that nationally consistent and locally relevant management prescriptions be developed.

Issue 1.2: Resources allocated to who recovery are not currently focused on securing who from extinction at the eight Security Sites.

Issue 1.3: Populations of who are in decline because of introduced predators.

Issue 1.4: The predator control regimes at the Security Sites have not been fully tested.

Objectives and actions

Objective 1.1: To prepare operational plans for each Security Site and strategic plans for Security and Recovery Sites in each conservancy, which are nationally consistent and locally relevant.

Objective 1.2: To cost management requirements at Security Sites and seek resources, as part of DOC business planning and stakeholder partnerships, to meet the needs at each site by June 2011.

Objective 1.3: To secure representative populations of who through effective predator control.

Objective 1.4: To monitor who and predator abundances to determine whether the predator-control regime at each site is effective.

ACTION	ACCOUNTABILITY	PRIORITY
1.1 Prepare an operational and strategic plan template by January 2010.	Recovery Group	Essential
1.2 Prepare an operational plan for each Security Site as per DOC best practice by June 2011. Implement these plans as soon as they have been prepared, and update plans annually.	Area Managers/ Site Managers	Essential
1.3 Prepare a strategic plan for each conservancy that includes Security and Recovery Sites by June 2012. Implement these plans as soon as they have been prepared, and review and monitor their implementation annually.	Conservators	Essential
1.4 Write operational reports to quantify progress towards targets by 30 June each year.	Area Managers	Essential
1.5 Prioritise area office resources (where available) as part of business planning, to meet the resource requirements for each Security Site.	Area Managers	Essential
1.6 Implement effective predator control at Security Sites as per best practice and the recommendations of this recovery plan by 30 June 2012.	Area Managers	Essential
1.7 Continually develop and refine pest-control methods annually to reduce costs and increase effectiveness of predator management.	Area Managers	Essential
1.8 Provide feedback on improvements to predator control best practice to the Whio Recovery Group prior to each Recovery Group meeting.	Area Managers	Essential
1.9 Monitor whio abundance at all Security Sites annually using the walk-through survey method as a minimum.	Area Managers	Essential
1.10 Monitor stoat abundance annually at selected Security Sites, using best practice.	Area Managers	Essential
1.11 Analyse the results, review the predator management regime and present these findings to the Whio recovery Group prior to each Recovery Group meeting.	Area Managers/ Recovery Group	Essential

5.1.2 Topic 2—Recovery Sites

Recovery Sites include existing second-priority managed sites (refer Table 3) and new sites where predator management is being undertaken or will be undertaken, and where opportunities exist to reintroduce whio to currently unrepresented parts of their natural range. Recovery Sites fall into three categories:

1. Community initiative sites, where whio management is community-led and funded but receives technical support and advice from DOC.
2. Existing sites that are ecosystem-restoration focused and take advantage of management that is already in place. Some of these sites may not currently contain whio.
3. New sites chosen to ensure that whio populations persist throughout their natural former range.

Table 3 identifies the various Recovery Sites, their regional representation, the organisation categories that manage the sites and pairs that are managed.

TABLE 3. PAIR PROTECTION AT RECOVERY SITES IN 2007.

SITE	REGION	ORGANISATION	NO. PAIRS (IN 2007)
Takaputahi	Eastern Bay of Plenty	DOC/Ngaitai Iwi	5
Pohokura	Central North Island	Private landowner	5
Egmont/Taranaki	Taranaki	DOC/community	12
Te Potae o Awaroa	Ruahine	DOC	5
Goulard Downs	Nelson	DOC	2
Flora	Nelson	Community	2
Pearse	Nelson	DOC	4
Moonlight/Blackball/Roaring Meg	West Coast	Community	1
Mingha/Deception	West Coast	DOC	3
Landsbourgh	West Coast	DOC	1
Dart/Caples	Otago	DOC	2
Hollyford	Southland	DOC	9
Murchison Mountains	Southland	DOC	14
Tongariro River	Tongariro/Taupo	Community	5
Iris Burn	Southland	DOC	1

Issues

Issue 2.1: The natural range of whio is not fully protected. New Recovery Sites for whio management need to be identified within the under-represented parts of their former range.

Issue 2.2: Recovery Sites do not have operational plans consistent with this recovery plan. Operational plans for Recovery Sites need to be written to provide operational detail consistent with this plan.

Issue 2.3: The population trend of whio at Recovery Sites is unknown, making it impossible to measure the effectiveness of these sites.

Objectives and actions

Objective 2.1: To complete a national inventory of potential whio management sites that documents population size, potential population size and management required. This report will include a qualitative ranking of sites.

Objective 2.2: To write clear operational objectives for each Recovery Site in accordance with this recovery plan and best practice.

Objective 2.3: To annually monitor whio abundance to ensure the population is increasing to meet targets.

ACTION	ACCOUNTABILITY	PRIORITY
2.1 Complete a national inventory of potential whoio management sites by 30 June 2012.	Recovery Group	High
2.2 Prepare a template for new Recovery Site proposals by 30 June 2012.	Recovery Group	High
2.3 Prepare proposals for new Recovery Sites using the template.	Area Managers	High
2.4 Annually assess proposals for Recovery Sites and make recommendations to General Manager Operations (Northern) on the best sites to be set up.	Recovery Group	High
2.5 Prepare an operational plan for each DOC-run Recovery Site within 1 year of site establishment.	Area Managers/ Site Managers	High
2.6 Monitor whoio abundance at all Recovery Sites annually using the walk-through survey method as a minimum.	Area Managers	High

5.1.3 Topic 3—Didymo and disease

The invasive alga didymo and avian diseases pose a potential, but relatively unmanageable, risk to whoio. The most practical way of minimising the likelihood of incursions by these organisms is through effective quarantine and advocacy.

Issues

Issue 3.1: Didymo and avian diseases could cause dramatic declines in whoio populations.

Issue 3.2: The impact of didymo on whoio is unknown.

Objectives and actions

Objective 3.1: To minimise the likelihood of invasion by didymo and avian diseases as a result of human activity at whoio sites or the back country.

Objective 3.2: To assess the likely impact of didymo on whoio.

ACTION	ACCOUNTABILITY	PRIORITY
3.1 Manage all staff and volunteer activities at whoio sites to minimise the risk of introducing or spreading didymo and avian diseases, and incorporate preventative measures into operational plans annually.	Area Managers	Essential
3.2 Advocate that all back-country users minimise the risk of introducing or spreading didymo.	General Manager Operations (Northern and Southern)/ Conservators/ Area Managers	High
3.3 Research the potential impacts of didymo on whoio ecosystems, and the effect that didymo has on habitat quality, productivity and survival at the first incursion of didymo in a whoio-occupied system.	General Manager Research and Development Group	Essential

5.1.4 Topic 4—Whio Nest Egg (WHIONE)

The harvesting of eggs from whio nests, raising of them in captivity, and subsequent release of fledglings into managed sites (Whio Nest Egg—WHIONE) has proven very effective at rapidly increasing whio numbers. Since there is limited capacity for raising ducklings, this technique will only be utilised at priority sites that are most in need of a rapid whio population gain. This tool is largely used in the South Island, where there is no captive-bred South Island stock of whio available for release.

Although WHIONE is effective, it has only been used by a small number of conservation managers, so the full benefits have yet to be documented.

Issues

Issue 4.1: WHIONE is not coordinated to fully maximise this tool and could be used at more sites.

Objectives and actions

Objective 4.1: To maximise the productivity of WHIONE and ensure that WHIONE ducklings are released at the highest priority sites.

ACTION	ACCOUNTABILITY	PRIORITY
4.1 Use WHIONE translocations to secure whio populations at Security Sites in the first instance (particularly in the South Island), and then for the wider recovery of whio at Recovery Sites.	Conservators	Essential
4.2 Ensure there are sufficient quality captive institutions capable of undertaking a WHIONE programme by 30 June 2013.	Recovery Group Captive Management Coordinator	Essential
4.3 Annually coordinate WHIONE to fully realise its benefit.	Recovery Group Leader	Essential

5.1.5 Topic 5—Captive breeding

Captive breeding is a proven tool that can assist the whio recovery programme in the re-establishment and rebuilding of populations. For example, the Mt Taranaki whio population has been re-established predominately through the release of captive-bred whio (Caskey & Peet 2005). Although whio recovery efforts will focus on *in situ* management, a captive population of whio can contribute to the recovery of the species in a number of ways:

1. Direct contribution:

- Breeding of captive pairs and release of young into the wild. In terms of supporting *in situ* management of North Island populations, captive breeding for release is a high priority for the recovery programme, contributing to two phases of recovery: 'secure from extinction' and 'recovery'. In terms of supporting *in situ* management of South Island populations, captive breeding for release currently plays no role because there is no captive breeding population. The establishment of a South Island captive breeding population is considered a medium priority for the recovery programme, which would only be activated if WHIONE

was unable to meet the current requirements or the threat to who became dire.

- Captive management to provide a potential insurance population. This is not a high priority for the recovery programme due to the current status of who and confidence in the proposed management actions. If the situation changed for the worse, however, this contribution could be a higher priority, particularly for the South Island who population, where it would be used to ensure that South Island stock are represented in the captive breeding programme.

2. Indirect contribution:

- Advocacy and education. This is considered to be of high importance for the recovery programme where who are already held in captivity for recovery purposes (e.g. breeding for release into the wild). Not every captive facility is set up to contribute to this action, but those that are should maximise opportunities for education and provide advocacy for who. Who should not be held purely for advocacy purposes, but where who are held on display, the facility must have an advocacy plan that is approved by the Recovery Group (as per DOC's Captive Management Standard Operating Procedure; DOC 2007).

In terms of supporting *in situ* management of North Island populations, captive breeding for release and WHIONE are of equal importance based on each tool's merits, requirements, application, resources and outcome. Both methods have proven effective at increasing who numbers in the wild.

Who have been held in captivity for many years, and their husbandry requirements are well understood and are documented in the Blue Duck Husbandry Manual (Bell 1999). The current captive population comprises only North Island birds distributed throughout a number of captive breeding facilities across the North and South Islands. It is managed through the New Zealand Species Management Programme (NZSMP), which is administered by the New Zealand Conservation Management Group: Australian Regional Association of Zoological parks and Aquaria New Zealand Branch Incorporated (CMaG: ARAZPA NZ Inc.) in accordance with species management principles that are internationally recognised as 'best practice'. NZSMP species programmes aim to maximise the sustainability of captive populations by minimising inbreeding and the loss of genetic diversity from the population.

The captive population will be managed, on behalf of the Recovery Group, by the captive management coordinator for who in accordance with the principles and procedures of the NZSMP and DOC policies, and standard operating procedures relating to captive management of protected species.

Issues

Issue 5.1: The current captive North Island population is highly inbred due to its small founder base. It is neither large enough nor sufficiently genetically diverse to allow the captive breeding programme to operate to its full potential.

Issue 5.2: Although South Island genetic stocks are not currently represented in the captive breeding programme, there may be a need to translocate them into captivity if WHIONE and *in situ* management are unable to provide who security.

Objectives and actions

Objective 5.1: To increase the size and genetic diversity of the captive North Island whio population.

Objective 5.2: To maximise the productivity of the captive breeding programme and ensure that captive-bred ducklings are released at the highest priority sites.

ACTION	ACCOUNTABILITY	PRIORITY
5.1 Assess and facilitate the translocation into captivity of sufficient new founder stock to meet captive programme goals (i.e. retain at least 90% of wild gene diversity in the North Island captive population) by June 2011, and repeat with each revision of the Captive Management Plan.	Recovery Group	Essential
5.2 Annually assess the need to develop a secure captive population of South Island stocks (if required) to provide a source population for future species recovery work.	Recovery Group Captive Management Coordinator	High
5.3 Ensure there are sufficient quality captive institutions that are capable of undertaking a captive breeding programme.	Recovery Group Captive Management Coordinator	Essential
5.4 Annually coordinate captive breeding to maximise its benefit.	Recovery Group Leader and Captive Management Coordinator	Essential
5.5 Provide the Recovery Group with NZSMP-format Annual Report and Recommendations for the captive population of North Island whio by 1 June each year.	Recovery Group Captive Management Coordinator	Essential
5.6 Update and complete revision of the Captive Management Plan by 1 June 2012.	Recovery Group Captive Management Coordinator	Essential
5.7 Review and update the Blue Duck Husbandry Manual by 1 June 2013.	Recovery Group Captive Management Coordinator	Essential
5.8 Ensure captive facilities that display whio have approved advocacy plans.	Recovery Group Captive Management Coordinator	Essential

5.1.6 Topic 6—Maintaining whio outcome monitoring standards

Monitoring of key populations is important for determining trends, indicating where management is most needed, and establishing the long-term effects of management. The minimum standard whio monitoring method is the walk-through survey, as described in the best-practice manual (Blue Duck (Whio) Recovery Group 2004).

Issues

Issue 6.1: Although there is a standard monitoring walk-through method, it is not always adhered to and does not provide comparable trends within a site or across sites.

Objectives and actions

Objective 6.1: To ensure that the standard monitoring method is universally adopted by project staff within the parameters of their site and that sufficient staff are trained in its use.

ACTIONS	ACCOUNTABILITY	PRIORITY
6.1 Facilitate training and skill-sharing opportunities for practitioners throughout the term of the plan.	Whio Recovery Group	Essential
6.2 Undertake whio monitoring to best-practice standards.	Area Managers	Essential

5.2 COMMUNITY RELATIONS

5.2.1 Topic 7—Communities

An increasing number of New Zealand communities are seeking involvement in threatened species conservation. Active involvement by New Zealanders in conservation programmes leads to increased understanding and support for these programmes. Efforts will be concentrated on involving individuals and groups in actions that secure whio from extinction and recover whio.

Issues

Issue 7.1: Opportunities for participation by individuals, communities, organisations, and local and regional government in the conservation of whio need to be proactively pursued.

Objectives and actions

Objective 7.1: To involve the public, community groups and organisations in the protection of whio at Security and Recovery Sites to maximise the benefits for protecting whio.

ACTION	ACCOUNTABILITY	PRIORITY
7.1 Ensure community groups, and local and regional authorities are aware of priority areas for management of whio, so efforts can be focused on these areas.	Conservators (as guided by operational plans)	Essential
7.2 Provide community groups with information on best-practice techniques to maintain standards and encourage engagement.	Whio Recovery Group/ Area Managers	Essential

5.2.2 Topic 8—Advocacy

Advocacy continues to be an important component of who protection projects throughout New Zealand, whether the project has been implemented by DOC, private groups, individuals, or a combination of these. Advocacy helps ensure broader public acceptance and buy-in, as well as actual support and funding. For the who recovery programme to succeed, the general public, communities and organisations need to understand the conservation issues facing who. Captive who institutions will be assisted in presenting high-quality advocacy and educational material.

Advocacy is important for:

- Encouraging public participation in who protection activities and maintaining momentum
- Gaining local project support
- Raising a project's profile to increase its resources
- Acknowledging sponsors' contributions
- Sharing knowledge and best-practice methods
- Providing motivation and support from other groups, peers and specialists
- Reducing the direct human threats to who

Issues

Issue 8.1: There is a lack of understanding around the plight of who, and limited local and national advocacy to raise public awareness.

Objectives and actions

Objective 8.1: To promote who conservation by sharing knowledge and best management practices among all individuals, community groups and organisations concerned.

ACTION	ACCOUNTABILITY	PRIORITY
8.1 Establish and maintain relationships with individuals and groups.	Area Managers	Essential
8.2 Develop an advocacy section in each operational plan that outlines methods and tools.	Area Managers	Essential
8.3 Continue to support captive breeders, educational institutions and trusts to produce high-quality who advocacy.	Who Recovery Group via Area Managers / Conservators	Essential

5.2.3 Topic 9—Tangata whenua

Tangata whenua (iwi or hapū that has customary authority in a place) are recognised as key participants in the whio recovery programme. Historically, tangata whenua have shared different views of whio. Ngaitai iwi highly revere whio and recognise them in whakatauki (proverb): *Te Whio, nobo awa, nobo kainga, he mokai na Ngaitai*—the blue duck, whose home and habitat is the river and surrounding lands, traditionally known as the pet of Ngaitai people (Young 2006). Whio were also recognised as an indicator of water that was rich and abundant with food (B. Maxwell, Ngaitai iwi kaumatua, pers. comm.). Ngai Tahu have a spiritual connection with whio, making reference to the yellow eye and the whio males' shrill whistling call in myth (S. Biddle, Tuhoë kaumatua, pers. comm.). Other iwi historically saw whio as a source of food when times were tough and food was scarce (Young 2004), though the bird still maintained a special taonga status (D. Para, Pou Kura Taiao Manager East Coast/Hawke's Bay, pers. comm.). There is a spiritual connection with whio, and their taonga status as an icon of our rivers and streams is a commonly shared view today.

In many different areas, Māori and iwi have embraced the principles or kaupapa of whio protection and are actively involved in the protection of whio. By empowering tangata whenua to take on the role of guardians or kaitiaki of whio, we can strengthen our partnership and maximise benefits to whio populations throughout New Zealand. Opportunities need to be provided for information exchange, skill sharing, and direct and indirect involvement in whio conservation. Tangata whenua involvement in the protection and preservation of whio is welcomed and encouraged.

DOC is committed to giving effect to the unique relationship that tangata whenua have with whio. This includes memoranda of understanding, partnerships, protocols and legal agreements such as under the Ngai Tahu Claims Settlement Act 1998.

Issues

Issue 9.1: Tangata whenua have yet to be fully engaged in partnerships that provide mutual benefits for iwi and whio, and that assist the whio recovery programme.

Objectives and actions

Objective 9.1: To foster and develop relationships with tangata whenua, and encourage their involvement in all levels of whio management.

ACTION	ACCOUNTABILITY	PRIORITY
9.1 Strengthen relationships with tangata whenua to ensure this culturally important taonga is managed appropriately.	Area Managers	Essential
9.2 Involve tangata whenua in management and research.	Area Managers / Ecosystem and Species Unit, Research and Development Group	Essential

5.3 RESEARCH

5.3.1 Topic 10—Testing *in situ* management prescriptions

The relative importance of the various agents of who decline has yet to be fully assessed. Predation by stoats has been identified as the main agent of decline in Fiordland (Whitehead et al. 2007), with video surveillance studies and stoat control regimes at several managed sites in both the North and South Islands having resulted in who population increases (Whitehead et al. 2007; Glaser & Allerby 2010). However, significant regional differences indicate that the relative importance of stoat predation needs to be verified at some sites, particularly in the North Island.

Two approaches can be used to assess the importance of agents of decline:

- Control the most likely agent of decline (stoats) and monitor who to assess the population response. This approach can be used at all managed sites that have sufficient baseline population monitoring data before stoat control is initiated (i.e. monitoring that has occurred over several years prior to stoat control to ensure the full variability of predator numbers (plague and non-plague years) is captured).
- Close-order monitoring of who at their most vulnerable times, i.e. during nesting and moulting. Nesting birds can be monitored by both radio telemetry and video surveillance, while moulting birds can only be monitored using radio telemetry. This approach requires extra effort and expense, and can only be undertaken at a few sites. Close-order monitoring has already been carried out in Fiordland on a very steep site, and this work is being replicated at gentler sites in the northern South Island and the North Island.

Information on abundance, productivity and survival of who is now available from a range of sites. While these data can be used to assess the effectiveness of *in situ* management at existing sites to develop prescriptions for new sites, we need a better understanding of who demographics. In particular, information is lacking on:

- Juvenile survival, dispersal and recruitment
- Carrying capacity and population dynamics at capacity
- Movement and survival during moult

The formulation of management prescriptions requires that information on who demography and pest control is integrated into predictive models.

Issues

Issue 10.1: The relative importance and extent of various agents of decline for who has yet to be fully assessed.

Issue 10.2: The lack of knowledge about juvenile dispersal, survival and recruitment, population carrying capacity, and movement and survival during moult prevents the formulation of management prescriptions for new sites.

Issue 10.3: Predictive models that inform cost-effective management regimes need information on productivity, recruitment rate and mortality rate in the presence/absence of pest management and through a range of densities of pest species, which has yet to be analysed.

Objectives and actions

Objective 10.1: To understand the relative importance of the agents of decline for whio at a range of managed and unmanaged sites.

Objective 10.2: To better understand whio population dynamics and demographics so that predictive models of whio populations can be constructed and pest-control prescriptions developed.

ACTION	ACCOUNTABILITY	PRIORITY
10.1 Examine agents of decline at nests using telemetry and/or video surveillance at Te Urewera Mainland Island, Wangapeka and non-treatment sites by 30 June 2012.	Area Managers and Whio Recovery Group	Essential
10.2 Control stoats and assess whio population trends at all managed sites.	Area Managers and Whio Recovery Group	Essential
10.3 Complete a comprehensive cost analysis of management prescriptions to secure whio populations by 30 June 2011.	Whio Recovery Group	High
10.4 Support and/or lead new initiatives that benefit whio, particularly predator-control technologies and techniques.	Threats Management Manager, Research and Development Group	Essential
10.5 Ensure information on predator-control technology is disseminated annually.	Threats Management Manager, Research and Development Group, and from managed whio sites	Essential
10.6 Monitor juvenile dispersal, recruitment and survival at Te Urewera Mainland Island by 30 June 2012.	Area Managers	Essential
10.7 Review existing banding and capture data by 30 June 2011.	Threatened Species Science Manager, Research and Development Group	Essential
10.8 Develop models of whio demography and the timing and spatial requirements of pest control to provide pest-control prescriptions at new sites.	Threatened Species Science Manager, Research and Development Group	Essential
10.9 Measure the carrying capacity of whio at all sites when their populations stop increasing using repeat walk-through surveys with dogs (refer actions 1.10 and 2.6).	Area Managers and Whio Recovery Group	High
10.10 Closely monitor the movements and survival of moulting ducks using radio telemetry at Te Urewera Mainland Island, Wangapeka and non-treatment sites by 30 June 2013.	Area Managers	Essential
10.11 Collaborate with other landscape-scale pest management programmes to adapt and integrate management to maximise synergies for protecting whio and other threatened species.	Area Managers and Whio Recovery Group	Essential

6. Acknowledgements

This plan was developed with considerable help and input from Nic Etheridge, Peter Williamson, Peter Russell, Gavin Udy, Alison Beath, Corey Bragg, Mary Cresswell, Dave Para, Rose Collen and Murray Williams. Thanks to Kerry Brown, Pam Cromarty, Shaun O'Connor and Emma Neill for their peer review and comments. Also thanks to all the submitters for taking the time to review the plan and provide helpful and constructive comments. Thanks to Greg Moorcroft for editing.

Special thanks must go to the groups and organisations who have made the whio recovery programme what it is today; we are forever grateful for your contribution (Appendix 1).

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Appendix 1

GROUPS AND ORGANISATIONS SUPPORTING WHIO RECOVERY

An official acknowledgement and recognition of the groups and organisations that have made a contribution to support whio recovery (as at 2009).

Contributors

Air New Zealand
Auckland University
BDG Synthesis
Bush and Beyond
Central North Island Blue Duck Conservation Charitable Trust
Ducks Unlimited
East Taranaki Environment Trust
Environment Bay of Plenty Regional Council
Fiordland Wapiti Foundation
Forest & Bird
Friends of Flora
Genesis Energy Ltd—TPD
Horizons Manawatu/Wanganui Regional Council
Isaac Wildlife Trust
Kerry Oates Enviro Research Ltd
Knuckey Bequest
Land owners of the Manganuioteao/Retaruke
Marleigh Farm Trust
New Zealand Deer Stalkers Association
Ngaitai Iwi Authority
On Track NZ Ltd
Ornithological Society of NZ
Paparoa Wildlife Trust
Pike River Coal Ltd
Private captive breeders
Queenstown Rafting Ltd
Real Journeys
Retaruke Farms
Solid Energy Ltd
Tamahaki/Tamakana Iwi
Tasman Environmental Trust—Cobb Dam Mitigation Fund
Tawaki Dive
Te Anau, Coast to Coast
The Franz Josef Guiding Company (Ngāi Tahu Tourism)
Tongariro Natural History Society
Tongariro River Rafting
Trips n' Tramps Te Anau
Wild West Adventure Company
Works Infrastructure

Appendix 2

TIMELINE FOR RECOVERY ACTIONS FOR WHIO

All actions in this plan have been placed in one of three priority classes: ‘essential’, ‘high’ or ‘medium’. These indicate the relative importance of each action in terms of its contribution towards achieving the recovery objective and goal. This classification is based on the following recommendations made during the development of this plan:

E—Essential: Recommended as essential for the recovery of whio. These actions should be carried out in the first 5 years of this plan, subject to resources being available and existing decision-making processes.

H—High: Recommended as necessary for achieving the long-term goal for whio recovery. These actions should be carried out during the 10-year term of this plan, subject to resources being available and existing decision-making processes.

M—Medium: Recommended to support the recovery of whio. Some progress should be made towards these actions during the 10-year term of this plan, subject to resources being available and existing decision making processes.

Actions have been abridged to include key points; see section 5 for full details. Shaded areas indicate the timing for the actions. RG = Recovery Group.

ACTION NUMBER	ACTION	PRIORITY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Topic 1—Security Sites												
1.1	Prepare templates for operational and strategic plans	E										
1.2	Prepare and implement operational plan for each site; update annually	E										
1.3	Prepare strategic plan for sites by conservancy; review annually	E										
1.4	Write operational reports annually to quantify progress towards targets	E										
1.5	Prioritise Area resources to meet requirements for each site	E										
1.6	Implement best-practice predator control at sites	E										
1.7	Refine pest-control methods to reduce costs and increase effectiveness	E										
1.8	Communicate predator-control improvements annually to RG	E										
1.9	Annually monitor who abundance at all sites, at least by walk-through	E										
1.10	Annually monitor stoat abundance at selected sites using best practice	E										
1.11	Analyse and review predator regime results to present annually to RG	E										
Topic 2—Recovery Sites												
2.1	Complete national inventory of potential who management sites	H										
2.2	Prepare template for new Recovery Site proposals	H										
2.3	Prepare proposals for new Recovery Sites using the template	H										
2.4	Annually assess proposals for sites & advise GM-Ops (Nthn)	H										
2.5	Prepare operational plan for DOC sites within 1 year of establishing	H										
2.6	Annually monitor who abundance at all sites, at least by walk-through	H										
Topic 3—Didymo and disease												
3.1	Minimise the risks of didymo and avian diseases	E										
3.2	Back-country users to minimise the risks of didymo	H										
3.3	At first incursion, research impacts of didymo on the who ecosystem	E										
Topic 4—Who Nest Egg (WHIONE)												
4.1	Use WHIONE translocations annually to secure who populations	E										
4.2	Ensure quality WHIONE is undertaken by sufficient captive institutions	E										
4.3	Annually coordinate WHIONE to fully utilise its benefit	E										
Topic 5—Captive breeding												
5.1	Translocate sufficient new founder stock into captivity.	E										
5.2	Assess need to develop secure captive population of SI stock	H										
5.3	Ensure sufficient quality institutions can undertake captive breeding	E										
5.4	Annually coordinate captive breeding to maximise its benefit	E										
5.5	Circulate NZSMP-format Annual Report for captive NI who by 1 June	E										
5.6	Update and revise Captive Management Plan	E										
5.7	Review and update the Blue Duck Husbandry Manual	E										
5.8	Ensure captive facilities displaying who have approved advocacy plans	E										
Topic 6—Maintaining who outcome monitoring												
6.1	Facilitate training and skill-sharing opportunities for practitioners	E										
6.2	Undertake who monitoring to best-practice standards	E										
Topic 7—Communities												
7.1	Ensure others are aware of who management priority areas	E										
7.2	Provide best-practice information to communities	E										

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ACTION NUMBER	ACTION	PRIORITY	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19
Topic 8—Advocacy												
8.1	Establish and maintain relationships with individuals and groups	E										
8.2	Include advocacy section in operational plans	E										
8.3	Support production of high-quality whio advocacy	E										
Topic 9—Tangata whenua												
9.1	Strengthen tangata whenua relationships to manage whio as taonga	E										
9.2	Involve tangata whenua in management and research	E										
Topic 10—Testing <i>in situ</i> management prescriptions												
10.1	Monitor nest success at sites including Te Urewera and Wangapeka	E										
10.2	Control stoats and assess whio population trends at all managed sites	E										
10.3	Undertake cost analysis of management prescriptions	H										
10.4	Support and/or lead initiatives such as predator-control technologies	E										
10.5	Ensure information on predator-control technology is distributed	E										
10.6	Monitor juvenile dispersal, recruitment and survival at Te Urewera	E										
10.7	Review existing banding and capture data	E										
10.8	Develop models to provide prescriptions for pest control at new sites	E										
10.9	Measure carrying capacity via dog surveys at all sites (see 1.10 & 2.6)	H										
10.10	Monitor survival of moulting ducks at Te Urewera and Wangapeka	E										
10.11	Collaborate with other landscape-scale pest management programmes	H										

