Blue Duck (Whio), *Hymenolaimus malacorhynchos* Recovery Plan

1997-2007

THREATENED SPECIES RECOVERY PLAN NO. 22

Department of Conservation
Te Papa Atawhai

Blue Duck (Whio), *Hymenolaimus malacorhynchos* Recovery Plan

Threatened Species Recovery Plan Series No. 22

Department of Conservation
Biodiversity Recovery Unit
PO Box 10-420
Wellington
New Zealand

Prepared by:
John Adams, Duncan Cunningham,
Janice Molloy, Stephen Phillipson
for the Biodiversity Recovery Unit

July 1997

ISSN 1170-3806
ISBN 0-478-01917-3

Cover photo: Blue duck at Newton Creek, West Coast. Photo:A. Reith.

CONTENTS page

CONTENTS continued

Appendices

1. Summary

This document sets a long term goal for the blue duck recovery programme, and outlines the objectives which must be met over the next ten year period in order to make progress towards the goal. Actions which must be undertaken to achieve each objective are described. The distribution, abundance, and ecology of the species are also briefly described, and the range of threats which may be affecting blue ducks are outlined.

The emphasis over the next ten year period will be to clarify the status of blue ducks nationally, to protect existing populations, to develop techniques for the establishment of new blue duck populations, and to undertake research that will assist in achieving the long-term goal.

This is the second planning document prepared for blue duck. The outcomes achieved during the term of the first plan are described in section 6.

2. Introduction

The blue duck or whio *(Hymenolaimus malacorhynchos)* is one of New Zealand's ancient endemic species. It is the only member of its genus and its taxonomic relationships with other waterfowl are uncertain. It lives year-round on rivers, a mode of life it shares with only three of the world's other 159 waterfowl species.

In pre-human times, blue ducks were widely distributed throughout both main islands of New Zealand at which time they appear to have occupied more diverse habitats than those of today (Worthy & Holdaway, 1994). Although the initial impact of human settlement and the arrival of ground-dwelling mammals on blue ducks will remain conjectural, a significant reduction in blue duck numbers and range has occurred over the past 150 years (Butler, 1888: Williams, 1964). Using the IUCN conservation criteria (IUCN 1994), the species is classified as "Vulnerable" in Collar et al (1994) and "Endangered" in Green (1996). The Department of Conservation's working document which ranks all New Zealand biota for conservation action (Molloy & Davis, 1994) currently lists blue duck as a "Category B" species - the second highest priority for conservation action by the Department of Conservation.

Blue ducks occupy an ecological niche which places them at the upper trophic level within New Zealand riverine ecosystems. In this respect they serve as an indicator of riverine ecosystem health and of the completeness of ecological relationships within that ecosystem. In the process of restoring and/or maintaining species diversity in New Zealand riverine ecosystems, the presence and persistence of blue ducks will be a recognisable indicator of success.

This plan is the second Department of Conservation operational plan for the species, and builds upon the objectives and achievements of the first document, *Conservation Strategy for blue duck* (Williams, 1988) which covered the period 1988-1992. This plan is intended to guide conservation actions for the ten-year period 1997-2007; however, a review after five years is recommended with supplementary programmes being appended as required.

3. Distribution and Abundance: Past and Present

3.1 HISTORICAL

In early European times blue ducks were widespread throughout both main islands of New Zealand, except in Northland, and possibly coastal parts of Canterbury and Otago. There are no fossil records from the Chatham Islands, Stewart or Great Barrier Islands, or other smaller islands. Early naturalists refer to the duck's presence in alpine rivers and tarns, as well as some lowland rivers.

There are strong indications that blue ducks occurred in higher densities than today, with each pair holding a 300-400m stretch of river (Potts, 1946; C. Douglas cited in Pascoe, 1957) and that the species may have been a flocking bird at particular times of the year (Layard, 1863).

3.2 RECENT

Today the species has a restricted and disjunct distribution. Unfortunately, the published reports of former blue duck distribution (318 records to 1969 - D. Cunningham pers. comm.) and data from collected specimens give little direct evidence of rates and timing of blue duck decline. Large sections of New Zealand no longer support the species, or only support relic populations. Such areas include the Coromandel Peninsula, Mt Pirongia and surrounds, the King Country, Taranaki, Tararua and Rimutaka Ranges, Wairarapa and Marlborough. More secure but fragmented populations still exist in forested catchments in parts of the eastern and central North Island, Nelson,West Coast and Fiordland.

Because of the variable intensity of survey effort throughout New Zealand, it is difficult to estimate the total blue duck population. It is estimated that 1200 different blue duck pairs have been recorded in the Department of Conservation blue duck distribution scheme database between 1980 and 1994 (see Appendix 1 for methods used to derive this figure).

4. Blue Duck Ecology

4.1 HABITAT

Blue ducks are a river species, mostly confined to headwater catchments of rivers over parts of both the North and South Islands. Its presence in these sites should not be regarded as an indication of habitat preference. Rather it should be viewed as the result of a restriction to generally unmodified environments whose relative quality as blue duck habitat has yet to be determined. The river sections in which blue ducks are found today have high water quality, stable stream banks, low transport of fine or suspended sediments, standing (mostly) native riparian scrub or woodland, and a wide diversity and abundance of aquatic invertebrates (Collier et al. 1993).

Blue ducks principally occupy a habitat in which food is available in adequate quantity year-round and other essential resources (shelter, nesting sites, brood-rearing habitat) are present. Adult blue ducks are a sedentary and territorial with pair bonds maintained throughout the year and over several years. The male contributes active parental care.

4.2 FOOD

The main foods of blue ducks are freshwater invertebrates, principally the larvae of caddis fly, mayfly and stone fly (Collier, 1991; Kear and Burton 1972;Wakelin, 1993). Freshwater snails and chironomid larvae are also eaten and there is one report of South Island birds eating fruits of stream-side plants (Harding, 1990). Most feeding occurs by dabbling or up-ending in riffles (Veltman & Williams, 1990) and occasionally by diving in white water areas. Blue ducks also feed for short periods during the night (Douglas & Pickard,1992).

Patterns of prey selectivity varied for blue ducks living on Manganui a te ao River, but Tricoptera larvae in the family Hydrobiosidae and in the genus *Aoteapsyche* (Hydropsychidae) ranked highly in the diet (Veltman et al. 1995).

4.3 BREEDING

Females have been observed to breed at 12 months of age, while the majority of males first attempt breeding in their second year. The breeding season commences as early as August, when the female begins to feed more avidly and for longer periods each day. The previous seasons nest site may be reused, especially if young were successfully fledged. Five or six white eggs are usually laid, although clutches as large as nine and as small as three have been found. Eggs weigh about 70g each, which is close to 10% of the females body weight and there is often a two day interval between laying of consecutive eggs of the clutch.

Nests have been found in river-side caves, beneath clumps of flax or grass, in holes in the river bank and in hollow logs. Only the female incubates throughout the 35

day incubation period. While his mate incubates, the male defends the territory from intruding birds, usually locating himself at a site close to the nest. The female normally leaves the nest to feed with her mate during the early morning and late afternoon.

When ducklings hatch they are immediately capable of battling strong currents and feeding themselves. Both adults guard the young throughout their 70-82 days of development to fledging. The adults have distinct roles; the female is always close to the young ducklings while the male often trails behind the brood, constantly on the alert for predators. When the ducklings are near fledging their parents interest in them starts to wane. At the same time the adults normally commence their annual moult, during which time they are flightless.The adults generally hide during the day and only emerge to feed under the cover of darkness.

Throughout the late summer and early autumn the juveniles range up and down the river in search of living space. Many initially try to force their way in between the territories of established pairs. If they are not successful, they will disperse more widely within their natal catchment. Some movement of juveniles to adjacent catchments has also been recorded, e.g. in Hawkes Bay, birds have been recorded moving from the Apias River to the Makaroro River Q. Adams pers. comm.), and on the South Island, birds have crossed the main divide (Harding 1994). Generally, blue ducks appear to be a reluctant dispersers, and settlement and breeding beyond the natal catchment appears to be rare.

4.4 DEMOGRAPHY

Territory-holding blue ducks are long-lived with an average lifespan of 7-8 years although about a quarter of all birds will live longer than 10 years. On the Manganui a te ao, as many as 40% of nesting attempts failed over a ten year period because nests were either flooded or predated. Duckling survival is affected mostly by the water flows and weather, both at hatching and over the subsequent two weeks. High floods and heavy rain can lead to brood fragmentation and ultimately duckling death. However 50-60% of the ducklings hatched usually survive to fledge.

Productivity is low and variable but generally about one fledgling per pair per annum. In some years total breeding failure may occur throughout the whole or part of a catchment, which means the production from any one year may need to compensate for adult deaths over previous years.

Sightings of solitary birds (generally males) and non-breeding `pairs' have been made in streams and tarns distant from known breeding populations. The period of occupation of these sites is highly variable, from a few weeks to a few months.

5. Threats

5.1 INTRODUCTION

It is generally accepted that blue ducks were more widely distributed in both the North and South Islands prior to European occupation. Recent studies have shown that blue ducks inhabiting middle-river stretches of catchments are the most productive, and reside at their highest densities (Williams, 1991, Collier et al. 1993). There is also some evidence to suggest that, historically, they occurred in far higher densities than they do today.

Perceived known threats to the remaining blue duck populations are: habitat loss/ disturbance, direct human impact, competition, predation, and population fragmentation.

5.2 HABITAT LOSS/DISTURBANCE

This includes:

- Flow modification, either by reduction, altered periodicity or total abstraction
- Large scale loss of riparian vegetation as a result of forestry and pastoral farming development rendering waterways unsuitable habitat for blue ducks and degrading catchment stability and water quality.

Past land development has resulted in the loss of blue duck habitat on the lower and middle reaches of many major rivers.The historical presence of blue ducks on these sections, and the higher productivity and survival of birds inhabiting middle as opposed to upper sections of the Manganui a te ao River (M. Williams, K.Oates, unpubl.data) or other high altitude sites (e.g. Ruahine Range - J. Adams; Arthur's Pass - M.Harding, unpubl. data) suggests that many blue ducks may currently occur in less productive habitat.

On the Manganui a te ao River, there is strong evidence to show that the persistence of birds in the upper reaches is very dependant upon the surplus production of pairs well down river (M.Williams, unpubl. data). If this is a widespread phenomenon (as yet unproven), the most productive and important pairs within existing populations may be those at lower altitudes. This means further loss of habitat in lower and middle reaches of rivers would have a severe impact on blue duck populations.

While direct loss of riverine habitat has a clear and obvious effect on the birds residing in the affected area, the consequences may be felt more widely throughout the catchment should the degraded section be large enough to be a barrier to dispersal. The effects of river flow variation are considerably more insidious and more difficult to appraise in the short term. A small and gradual lowering in pair density and greater annual variation in pair productivity can lead, over the medium to long term (>20 years) to the demise of the affected population. The loss or absence of a diverse, and principally native, riparian scrub or woodland can render sections of river uninhabitable by blue ducks, a species which spends much of its day under dense overhead cover.

5.3 DIRECT HUMAN IMPACTS

These include:

- white water recreational activities such as jet-boating, rafting and canoeing.
- disturbance and harrying by dogs.
- deliberate and accidental shooting
- road kills

Use of sections of rivers for frequent and multiple white-water rafting or canoeing trips, especially during that part of the breeding season when small ducklings are on the river (approx. September-November), can create considerable disturbance and lead to fragmentation of broods and loss of young. Similarly, frequent use of rivers as training areas for some endurance or multi-sport events probably affect numbers and breeding of blue ducks in the affected areas.

An effect of (especially) pig-hunting, where dogs are used, has been the loss of dogs and their subsequent impact as a predator on blue ducks. Although these disturbance events may be limited in time and location, their long-term influences on a wider population can be considerable.

There have been eight road kills of blue ducks recorded in the last five years.

5.4 COMPETITION

From studying blue duck droppings, Kear and Burton (1971) showed that caddisfly, mayfly and stonefly nymphs were important prey for blue ducks on several North Island rivers. Kear (1972) then pointed to a similarity with the diet of trout, and suggested that blue ducks were more common on streams where trout were scarce.

The hypothesis that competition from trout may contribute to the decline of blue ducks has not been directly tested, but Towers (1996) studied the potential for competition by measuring diet overlap between blue ducks and trout in the North Island. Trout and blue ducks on four rivers showed similar prey selection patterns that varied between rivers and between seasons. The relative importance of prey to blue ducks was correlated with relative importance of prey to trout, and diet overlap (using Schoener's Index) between the two species ranged from 0.22 to 0.89 depending on river and season. On average, blue ducks captured smaller prey than that captured by trout. Towers (1996) therefore confirmed Kear's (1972) suggestion that trout are eating blue duck food.

When Towers (1996) penned some trout into enclosures on the Tongariro River, he found they reduced the diversity of stream insects. Trout are also known to alter the insect community in artificial stream channels (Flecker and Townsend 1995). However, when Towers (1996) gave captive male blue ducks the challenge of foraging in artificial stream channels with or without trout, the birds chose channels with the larger abundance of prey whether or not trout were present. Also, blue ducks living above waterfalls (where trout were absent) had similar diets to blue ducks co-existing with trout below waterfalls on the same rivers.

Thus, while there is the potential for trout to compete with blue ducks for prey, blue ducks may be able to obtain hidden prey not available to trout (who feed mainly from the drift) and find rich prey patches even when trout are present.

5.5 PREDATION

Known predators of blue ducks include rats (eggs), stoats (adults, young, eggs), ferrets, feral cats and dogs (adults), gulls, hawks, eels and shags (young) and falcon (adults and chicks). The impact of predation on blue duck population dynamics is not clear, and requires further investigation.

Williams (1991a) in his study of blue duck social behaviour on the Manganui a te ao River between 1980-89 recorded 3 instances of nest desertion due to mustelid predation (from 61 nesting attempts) and 1 instance of a nesting female being killed by a wild cat. Five other nesting females disappeared during the study period, including three in one year. Because the eggs are incubated by female blue ducks, they are more likely to be vulnerable to predation than are males. A population viability analysis (Henderson, 1994) based upon information from the Manganui a te ao study (Williams 1991 a) indicated that female adult death rate has the potential to significantly influence population dynamics.

5.6 POPULATION FRAGMENTATION

Population fragmentation and the gradual extinction of small and isolated populations has been a conspicuous feature in the process of decline of many native bird species over the past 150 years. The present known distribution of blue duck shows that the population is fragmented although the long-term viability of these isolates is uncertain. Henderson (1994), as part of his population viability analysis of blue duck, calculated that an isolated population of 9 pairs with demographic characteristics of the birds inhabiting the Manganui a te ao "study area" has an 87% probability of surviving for 100 years. However, the productivity of Manganui a te ao study area birds are considerably higher than those from other sections of the same river or from any other blue duck population studies in New Zealand. Thus, the long-term persistence of many population isolates is doubtful.

6. Past Conservation Efforts

The 1988 Blue Duck Conservation Strategy had six objectives. The objectives, and a summary of work that has occurred in relation to those objectives, are outlined in the sections below.

6.1 DETERMINE THE PRESENT STATUS AND DISTRIBUTION NATIONALLY

DOC has established a database of blue duck sightings and published a distribution report based on these sightings (see Cunningham, 1991). Some survey has been undertaken over the period of the strategy but significant areas remain to be surveyed.

6.2 MONITOR REPRESENTATIVE POPULATIONS REGIONALLY ACCORDING TO A NATIONALLY AGREED TIMETABLE AND TECHNIQUE

Monitoring has been undertaken at a number of sites, with varying intensity, duration and using several methods. Sufficient information to draw conclusions on trends has been obtained from six North Island rivers.These are briefly summarised below.

6.2.1 Tongariro River

Data collection from the 12.9 km Rangipo reach of the Tongariro River started in 1983 and 1984, and standardised monitoring continued from 1991 to 1996. The results of this work suggest the blue duck population declined dramatically in 1983 after the commissioning of the Rangipo Power Station. The population appeared to be recovering between 1991 and 1993 but in 1995 and 1996 Mt Ruapehu erupted and the population has been at its lowest recorded level over this period. Multi-year comparisons between the other monitored populations in the region suggest this Tongariro population has performed relatively poorly, even before the 1995-96 eruption.

6.2.2 Whakapapa River

Monitoring of the Whakapapa River, on the 7 km reach between the Whakapapa hydro intake and the Otamawarua confluence has taken place from 1989 to 1995, and will be ongoing. The numbers of territorial pairs initially decreased, then increased to greater numbers than recorded at the commencement of the study, and pair density now appears relatively high. Annual productivity appears to be variable as is typical for the species but average productivity over the period is relatively high. Up until 1995, a lower proportion of pairs normally bred compared to the Manganui a to ao River study population. In 1995 seven pairs bred to produce 20

chicks on this river section; this is the maximum productivity recorded here to date. Although fledging rates are not known, the available data indicates that this river can be managed sustainably for both blue ducks and hydro-electric generation if a suitable minimum flow regime is in place.

6.2.3 Wanganui River

A total of 4-6 pairs of blue ducks have been monitored on a 3 kin stretch of river at the Wanganui/Mangatepopo/Okupata confluence from 1990 to 1995. This stretch of river has the highest density of territorial pairs known in the Tongariro/Taupo Conservancy. The population has fluctuated over this period. The proportion of pairs breeding and the numbers of juveniles produced per pair vary greatly from year to year. Evidence of unsuccessful breeding (i.e. an absence of juveniles) has been recorded here more often than on other rivers monitored in the conservancy. It seems likely that this is due to environmental factors such as flooding in this very channelised river system.

6.2.4 Manganui a te ao River

Lower Section

A 9.3 km stretch of the lower section of the Manganui a te ao River has been monitored from 1980 to 1995 as part of an intensive study of blue duck biology and population dynamics. Results of the first 10 years study are reported in Williams (1991a) and record an increase in resident pairs from 4 to 10 as the population recovered from the effects of the 1975 lahar. A loss of 4 females at their nests in 1989 was followed by a slow recovery with the settlement of young pairs (1 year olds) which did not always attempt nesting in their first year on territory. Population and productivity details are:

YEAR	NO. TERRITORIAL PAIRS	NO. SINGLE MALES	PAIRS BREEDING	PAIRS FLEDGING YOUNG	TOTAL FLEDGED YOUNG	FLEDGLINGS/ BREEDING PAIR	FLEDGLINGS/ PAIR
1990	5	1	5	3	11	2.2	2.2
1991	7	0	7	6	15	2.1	2.1
1992	8	0	8	2	12	1.5	1.5
1993	10	0	8	3	10	1.25	12.67
1994	8	1	7	1	1	0.2	0.14
1995	8	0	not collected				-

The 1995 season was affected by the September eruption of Mt Ruapehu and the resulting lahar down the Mangaturuturu River and into the Manganui a te ao. The lahar arrived when most females were at their nests which they subsequently abandoned. Over the 15 years of study there is strong evidence of a density-dependent effect on fledgling production i.e. lowest per pair production at highest pair densities.

The population within the entire Manganui a te ao catchment has been assessed at irregular intervals throughout the study period. These surveys indicate that about 36-40 pairs reside on the river and its tributaries from below SH 41 and that this wider population is heavily reliant upon the productivity of pairs in the lower sections of the river to maintain its numbers.

Upper Section

Blue ducks on two sections of the upper Manganui a te ao River have also been monitored. A 6km section, 4km east of S.H.4 to 2km west of S.H. 4 (Study Area 1) has been monitored from 1986 to the present, while 3km up each of the Makatote and Manganui a te ao Rivers from their confluence (Study Area 2) has been monitored from 1994 to the present. Ninety five percent of the birds in both study areas have been colour banded and their age at banding recorded as either adult, juvenile or yearling.

STUDY AREA 1

YEAR	NO. TERRITORIAL PAIRS	NO. SINGLE BIRDS	TOTAL FLEDGED YOUNG	FLEDGLINGS/ PAIR	TOTAL NO. OF BIRDS
1986	3	1	2	0.67	9
1987	3	0	4	1.3	10
1988	3	2	0	0	8
1989	3	2	1	0.3	9
1990	2	0	1	0.5	5
1991	1	1	2	2	5
1992	1	1	0	0	3
1993	0	1	0	0	1
1994	0	1	0	0	1
1995	1	0	0	0	2
1996	1	in progress	in progress		

STUDY AREA 2

YEAR	NO. TERRITORIAL PAIRS	NO. SINGLE BIRDS	TOTAL FLEDGED YOUNG	FLEDGLINGS/ PAIR	TOTAL NO. OF BIRDS
1994	4	6	1	0.25	15
1995	4	5	4	1.0	17
1996	6	1	2	0.33	15

In Study Area 1 during the first 4 years, 3 pairs produced 7 fledglings (0.58 per pair per year). Since 1990, occupancy of the area has been spasmodic, with a rapid decline occuring between 1990 and 1993. In Study Area 2, the number of pairs has increased from 4 to 6 over the period, and productivity has varied from 0.25 to 1.0 fledgling per pair per year.

6.2.5 Apias River

Banding and monitoring of blue ducks has been undertaken in the Apias River, Hawkes Bay between 1991 and 1996. Forty one ducks (24 adults and 17 juveniles) were banded over this period. This population was found to be increasing; eight pairs were resident on the 13km of river monitored in 1996, compared to five in 1991 and juveniles were found to have settled within the catchment, and in other catchments. While the timing of the visits did not enable accurate assessments of productivity, the data collected suggest that survival rate of young per pair to breeding age may be higher than the death rate of adults.

6.2.6 Makaroro River

As with the Apias River, the Makaroro River was monitored for the period 1991 to 1996. Twenty two birds (18 adults and 4 juveniles) were banded over this period, and the number of resident pairs increased from 2 to 5. As with the Apias River, it appears that productivity may be higher than adult mortality.

6.2.7 Motu River

The Whitikau, Takaputahi and Ngaupokotangata tributaries of the Motu River have been monitored annually for blue duck adult distribution and juvenile production since 1992. The habitat comprises broad valley bottoms in pasture with slopes and crests in tawa-podocarp forest. The walk-through surveys were undertaken in January and February over a two to three day period. The blue ducks were not banded. The length of stream covered varied from year to year but a core area of 26 km was always surveyed for year to year comparability. The results of the surveys were:

YEAR	NO. TERRITORIAL PAIRS	NO. SINGLE MALES	PAIRS BREEDING	PAIRS FLEDGING YOUNG	TOTAL FLEDGED YOUNG	FLEDGLINGS/ BREEDING PAIR	FLEDGLINGS/ PAIR
1992	6	2	-	5	16	-	2.7
1993	11	4	-	5	12	-	1.1
1994	7	2	-	5	24	-	3.4
1995	9	1	-	8	10	-	1.1
1996	5	0	-	3	6	-	1.2

Because nests were not looked for, the number of breeding pairs was not ascertained for each year and therefore the proportion of pairs breeding successfully

is also unknown. Some blue duck losses are known from wire-strikes and from hunting. The destiny of the majority of fledged juveniles, is unknown. The overall trend of the population appears to be a slow decline but the variation between years means that this is not yet certain.

6.3 IDENTIFY LOCATIONS AT WHICH NEW VIABLE POPULATIONS COULD BE ESTABLISHED AND ATTEMPT THAT ESTABLISHMENT.

Re-establishment

Twelve blue ducks were released in Egmont National Park in three separate liberations. In 1987 three male and three female captive reared birds were released on the Manganui River. In 1989 a single captive male was released as a potential mate for an unbanded juvenile female in the same area. In 1991 five wild birds (two pairs and a single male), were transferred from the Manganui a te ao river, to the Waiwhakaiho River. During a search for blue ducks during April 1996 eight male birds, five banded and three unbanded, were sighted. The presence of unbanded birds indicates that breeding may have occurred.

Captive breeding

The number of blue duck pairs held in captivity over the term of the Blue Duck Conservation Strategy increased from 11 to 18. Breeding success between 1989 and 1994 was variable, and ranged from 0 to 9 ducklings fledged per annum (X = 5.2). Between 5 and 9 captive pairs produced eggs in any one year, with 15 - 50 % of these being fertile.

6.4 PROTECT, BY WHATEVER MEANS, THE EXISTING VALUES OF RIVERINE ECOSYSTEMS IN WHICH BLUE DUCK OCCUR, OR COULD OCCUR, AND ENHANCE THESE WHERE POSSIBLE.

Persistent and frequent use of a productive stretch of the Manganui a te ao River by rafting companies during the breeding months had an effect on productivity in the years in which the rafting occurred. Amicable agreement was reached with the companies to restrict their activities to non-breeding periods thus eliminating the disturbance to broods at a time when they are most vulnerable to separation from the adults.

Apparent disturbance to blue ducks in the Mingha and Deception rivers (Waimakariri Field centre) due to endurance running (independent recreationalists and individuals training for and competing in the Coast to Coast event) has raised concerns about the impact of these activities on resident blue duck. Alternative track routing options are being investigated.

National Water Conservation Orders have been issued for several rivers where blue ducks are in significant numbers, e.g., Motu and Manganui a te ao Rivers. Modifications to artificially lowered flows and flow regimes may have improved blue duck productivity and increased population density e.g.,Whakapapa River.

6.5 CONDUCT RESEARCH AIMED AT IDENTIFYING METHODS OF POPULATION AND HABITAT ENHANCEMENT AND POPULATION ESTABLISHMENT AND APPLY THE RESULTS OF THAT RESEARCH

A significant amount of research has been undertaken on the biology of blue ducks in recent years. This work has provided managers and others involved in blue duck conservation with an improved understanding of the ecology and demography of the species. Areas of research include:

- Food and feeding studies: Bramley 1991 (unpubl.), Newton 1991, Collier 1991, Collier and Lyon 1991, Wakelin 1993, Veltman et al. 1995, Mason et al. 1992 (unpubl.), the dietary overlap of trout and blue ducks (Towers 1996),
- Dispersal studies: Cunningham 1993 (unpubl.), Williams 1991a, Triggs et al. 1991, genetic studies Triggs et al. (1991, 1992)
- Demographic studies: Williams 1991 a
- Behaviour and habitat requirement studies: Veltman and Williams 1990, Noda and Stanton 1986 (unpubl.), Moralee 1990 (unpubl.), Collier 1993, Collier and Wakelin 1996, Collier et al 1993, McDonald 1991 (unpubl.))
- Population modelling: Craig 1991 (unpubl.), Henderson 1994, Williams and McKinney 1996.

6.6 ESTABLISH A BLUE DUCK MANAGEMENT/LIAISON GROUP TO COORDINATE AND FOCUS REGIONAL MANAGEMENT ACTIVITIES AND RESEARCH AND TO PROMOTE IMPLEMENTATION OF THE BLUE DUCK CONSERVATION STRATEGY

A blue duck management/liaison group was established and met three times during the five year period of the blue duck conservation strategy. These meetings provided individuals involved in blue duck conservation during this period with the opportunity to report on the results of their work, and to plan future work programmes.

6.7 SUMMARY

During the life of the 1988 Blue Duck Conservation Strategy:

- Progress has been made on determining the distribution and abundance of blue duck, but several large tracts of forest remain unsurveyed.

- The population trends of blue ducks in several North Island rivers have been well documented but the present national population trend remains unclear.
- Translocation attempts have increased understanding of the techniques needed for re-establishment programmes.
- Success with breeding blue ducks in captivity has been variable.
- Publicity through the blue duck sighting card scheme, a blue duck poster and local publicity initiatives have promoted public awareness of blue duck.
- There have been several initiatives where advocacy efforts have resulted in the protection of blue duck populations from human disturbance, or protection of their habitat.
- A significant amount of research has been undertaken resulting in improved knowledge of blue duck ecology and demography, however there are still several important gaps in our knowledge that may limit the effectiveness of blue duck management.

7. Recovery Strategy: Goals and Objectives

7.1 LONG-TERM GOAL

Maintain blue ducks in the wild in sufficient numbers and in sufficient secure catchments so that the species shifts from the IUCN category of "Endangered" (C2(a)) to "Vulnerable", and from Category B to Category C of the Department of Conservation's publication "Setting Priorities for the Conservation of New Zealand's Threatened Plants and Animals".

7.2 OBJECTIVES FOR THE TERM OF THIS PLAN

Objective 1

Determine the number of populations, mean population size and size of the largest population of blue duck.

Objective 2

Monitor short-term fluctuations and long term trends of key populations, to guide management at a national level.

Objective 3

Protect as far as practicable existing blue duck habitat through legal protection and advocacy.

Objective 4

Undertake research on blue duck which will assist in achieving the objectives of this plan.

Objective 5

Re-establish at least one blue duck population.

Objective 6

Manage the existing captive population of blue duck for the followig purposes in priority order: to provide juvenile blue duck for the re-establishment programme, to develop captive breeding techniques, and to fulfill an education and advocacy role.

8. Recovery Strategy: Work Plan

Objective 1: Determine the number of populations, mean population size and size of the largest population of blue duck

Explanation

Knowledge of the distribution and abundance of blue ducks in some parts of New Zealand is unclear due to lack of adequate survey. These areas are mainly the large, more remote forested regions of New Zealand. Completion of survey work in these areas would provide a clearer picture of the national status of blue ducks and a baseline for future comparisons of their distribution and abundance.

The three parameters which this objective aims to determine (the number of populations, mean population size and size of the largest population) are also criteria used in the Department's threatened species priority ranking system. The objective is framed in this way to link it back to the long term goal.

Actions

1. Develop standard blue duck survey techniques and ensure that people involved in blue duck surveys are trained, fully aware of, and adhere to, the standard survey techniques by the end of 1998.
2. Annually prioritise locations where survey work will be undertaken.
3. Collate, analyse and report results of surveys by 2003.
4. Continue to collect records of blue ducks from backcountry users and enter this data in to the relevant DoC database.

Key Personnel

Field Centre and Conservancy staff, DOC; Science, Technoloy and Information Services staff, DOC.

Objective 2: Monitor short-term fluctuations and long term trends of key populations, to guide management at a national level

Explanation

Ongoing monitoring is required to determine population trends, so that decisions relating to future management can be made. Monitoring programmes must be designed to detect annual variability as well as medium and long term changes.

Actions

1. Appoint a Monitoring Co-ordinator from within the recovery group who is responsible for:

- Developing a monitoring plan
- Ensuring the monitoring is undertaken in a way which allows the objective to be met.

- Ensuring the data is collated
- Ensuring the data is analysed, interpreted and reported

Key personnel

Conservancy staff, DOC; Science, Technology and Information Services staff, DOC, NGOs.

Objective 3: Protect as far as practicable existing blue duck habitat through legal protection and advocacy

Explanation

Growing numbers of blue duck rivers are used for white water recreation activities and endurance or multi-sport events. The disturbance to blue ducks caused by these activities, particularly when they occur during the breeding season is likely to be significant. In several instances, agreements have been drawn up between DOC and river operators or events organisers to minimise the impact of such activities on blue ducks. More effort in this area will be needed over the next ten year period.

Other activities which effect blue duck habitat and consequently have a deleterious effect on the species include hydro developments, deforestation, riverbed disturbance and changes in landuse. A number of river stretches which support blue duck, or are in proximity to blue duck populations and could potentially be utilised by blue ducks in the future, do not have formal protection. Statutory advocacy will be required to ensure an appropriate level of protection is achieved at all blue duck sites.

Actions

1. Continue advocacy involvement in resource consent renewal process for the Tongariro Power Development, and other hydroscheme consent renewals as necessary.
2. Prioritise sites which have no formal protection, in terms of their importance to continued viability of blue ducks nationally and degree of threat to the habitat.
3. Implement appropriate protection for at least five sites by the year 2007.
4. Utilise all available opportunities to protect blue duck habitat through statutory and non-statutory advocacy.

Key Personnel

Conservancy Staff, DoC; NGOs

Objective 4: Undertake research on blue duck which will assist in achieving the objectives of this plan

Explanation

Some aspects of blue duck breeding biology, habitat use and threats are still not yet fully understood. This puts managers in the position of having to make decisions based on incomplete knowledge. In addition, some management techniques require refinement.

Listed below are research needs which have been identified at the time of writing of the plan. These, along with any additional research needs which arise will be regularly reviewed and prioritised by the recovery group.

Research Needs

1. Determine the nature and extent of juvenile dispersal and settlement, to help define the extent of populations. This is a test of the prevailing hypothesis that, although juveniles may disperse beyond their natal catchment, they show a very high level of natal and breeding philopatry, sufficient to inhibit the widespread natural establishment of new populations or the recolonisation of a former range. This will support objectives 2, 3, and 5.
2. Viability of blue duck populations. This comprises PVA. analyses based upon the full range of demographic data drawn from all population and monitoring studies undertaken over the past 15 years. This will support objectives 2, 3, and 5.
3. Comparative assessment of field energetics of blue ducks in rivers of differing altitudes and physical/biological characteristics. This seeks to differentiate the relative "quality" of a range of habitats, using as a measure, the direct costs (in energetic terms) which the birds experience living there. Present interpretation of habitat requirements is based on birds presence or absence, and there remains the strong likelihood that this species is now confined to relict and sub-optimal habitat, not to prime habitat. This study would support objectives 2 and 3.
4. Determine the impact of predation on blue duck populations. This supports objective 2 and 5.
5. Determine the time in juvenile life when the characteristics of the natal range are imprinted upon the young.This seeks to support the establishment of new populations using unfledged or newly-fledged juveniles. This will support objective 5.
6. Determine the short and long-term effects of human disturbance on blue duck populations. Anecdotal evidence supports the contention that high levels of human disturbance lowers both productivity and density on some rivers. A more rigorous appraisal is necessary, especially in advance of attempts to limit human impacts on blue ducks at particular times of year. This will support objective 3.
7. Trial alternative transmitter attachments. A necessary testing of new fittings so that radios may be more effectively and extensively used as a field monitoring technique. This supports objective 5.

Key Personnel

Banding office staff, Science, Technology and Information Services staff, universities, NGOs.

Objective 5: To re-establish at least one blue duck population

Explanation

Fulfilling this objective will contribute to achieving the long-term goal of this plan by increasing the number of blue duck populations, and increasing the overall number of blue ducks in the wild.

Both wild caught and captive bred blue ducks have been used in past releases. Further trials, comparing the suitability of these differently sourced birds need to be undertaken. Monitoring the results of releases is an important aspect of the programme.

Actions

1. Establish release site criteria, and criteria to assess the success of the release programme.
2. Design and undertake a release programme, using both captive bred and wild caught juvenile blue duck.
3. Design and undertake a monitoring programme which enables the fate of released birds to be determined, and which enables the success of the programme to be determined according to the criteria in action 1.

Personnel

Conservancy staff, DOC; Science, Technology and Information Services staff DOC; NGOs.

Objective 6: Manage the existing captive population of blue duck for the following purposes in order of priority: to provide juvenile blue duck for the re-establishment programme, to develop captive breeding techniques, and to fulfill an education and advocacy role

Explanation

As described under Objective 5, an experimental blue duck re-establishment programme is planned. The primary purpose of the captive management programme over this period will be to provide juvenile blue ducks for this programme.

In meeting this objective, husbandry techniques will continue to be improved. The ability to breed blue ducks in captivity is a useful skill to have `in the bank', in case of a major disease outbreak in the wild, or some other event which threatens blue ducks at all localities. Blue ducks held at public viewing facilities as part of the re-establishment programme also provide an advocacy and education role. However, this is of secondary importance to the programme, and should not jeapordise the primary objective.

Actions

1. Prepare a Captive Management Plan (CMP) which places no reliance on the use of wild birds, and appoint a Captive Management Co-ordinator to oversee the implementation of the CMP by 1998.

2. Appraise the results of the captive breeding programme over the past 10 years and identify factors that may be limiting the productivity of captive blue ducks by 1999

3. Prepare a Husbandry Manual by 1999.

Key Personnel

Ducks Unlimited, DOC

9. Role of the Blue Duck Recovery Group

The implementation of this plan will be facilitated by the Blue Duck Recovery Group which will have the following composition:

Recovery Group Leader

Captive Management Co-ordinator

Monitoring Co-ordinator

2 North Island representatives

2 South Island representaives

Biodiversity Recovery Unit representative

Science and Research representative

NGO representative

The primary function of the Recovery Group is to recommend tasks which need to be done in order to achieve the objectives of this plan, and to report on progress in meeting the objectives of the plan.

As necessary throughout the duration of this plan, the Recovery Group should prepare such plans and protocols as are required under Department of Conservation policies to guide the plan's implementation. Examples of these include a captive management plan, criteria for selection of release sites, transport and release methodologies, and research plans.

Annually, the Recovery Group shall

i Review the outcomes of tasks prescribed for and performed in the previous year;

ii Identify and prioritise tasks under each objective to be undertaken in the forthcoming year and define appropriate performance measures for those tasks;

iii Recommend to appropriate agencies and individuals (e.g. Department of Conservation Conservancies, DU, blue duck breeders) tasks that support the recovery programme;

iv Develop funding applications to support research and management programmes and forward them to appropriate agencies and individuals with recommendations for submission;

v Review its own performance as a co-ordinating and liaison body and modify its operations as necessary;

vi Prepare an annual report of progress of the blue duck recovery programme which shall include, at least, the record of Recovery Group meeting(s), reports of all significant research and management activities undertaken, and an outline of tasks planned for the year ahead. This report is to be submitted to the Biodiversity Recovery Unit, Department of Conservation and made

available to all agencies and individuals contributing to the recovery programme.

Nothing in the list above is intended to limit the operation and initiative of the Recovery Group. The operational philosophy that underpins this recovery plan is one of encouraging contributions to the conservation of blue ducks from all interested agencies and individuals, and the creation of widespread ownership of the recovery programme.

References Cited

Bramley G. 1991. Dietary energy values and nitrogen digestibility in captive blue ducks. Unpubl. dissertation, Dept Botany/Zoology, Massey University.

Buller, W L. 1888. A history of the birds of New Zealand. 2nd edition. The Author, London.

Collar, NJ.; Crosby M.J. and Stattersfield, A. J. 1994. Birds to Watch 2. The World List of Threatened Birds. Birdlife Conservation No. 4. Birdlife International, Cambridge.

Collier, K.J. 1991. Invertebrate food supplies and diet of blue duck on rivers in two regions of the North Island, New Zealand. New Zealand Journal of Ecology 15(2); pp 131-138.

Collier, K.J. 1993. Flow preferences of aquatic invertebrates in the Tongariro river. Science and Research Division report No. 60. Department of Conservation, Wellington.

Collier K.J.; Lyon G.L. 1991. Trophic pathways and diet of blue duck *(Hymenolaimus malacorhynchos)* on the Manganui a te ao river: a stable carbon isotope study. In Williams (1991); pp 100-104.

Collier K.J.; Wakelin M.D. 1996. Instream habitat use by blue duck *(Haemenolaimus malocorynchus)* in a New Zealand river. Freshwater Biology 35:277-287.

Collier, K.J.; Moralee, S.J.; Wakelin, M.D. 1993. Factors affecting the distribution of blue duck *Hymenolaimus malacorhynchos* on New Zealand rivers. Biological Conservation 63:119-126.

Craig, C. 1991. Homogeneous and non homogeneous population models with special reference to the blue cluck. Unpubl. Bsc (Hons) dissertation, Dept Botany/Zoology, Massey University.

Cunningham, D.M. 1991. Distribution of blue duck in New Zealand from 1980 - 1991. Science and Research Series No. 36, Department of Conservation, Wellington.

Cunningham, D.M.; McCallum, R. (in prep.) Pilot study report: natal dispersal of blue duck.

Douglas, M.E., Pickard, C.R. 1992. Telemetry of body tilt for automatic data logging of blue duck diet behaviour. Priede, M. & Swift, S.M. (Des), *Wildlife Telemetry.- Remote Monitoring and Tracking of Animals,* Proceedings of the Fourth European International Conference on Wildlife Telemetry Aberdeen, Scotland. Ellis Horwood, Chichester.

Flecker,.A.S.,Townsend, C.R., 1995. Community wide consequences of trout introduction in New Zealand streams. Ecological Applications 5: 41-51

Green, A.J. 1996. An assessment of which Anatidae taxa qualify for globally threatened status. In: Proceedings of the Anatidae 2000 Conference, Strasbourg, France, 5-9 December 1994 (M.Birkan, J.van Vessem, P.Havet,J.Madsen, B.Trolliet & M.Moser eds.). Gibier Faune Sauvage, Game & Wildlife, Vol 13 (special issue) pt. 1.

Harding, M.A. 1990. Observations of fruit eating by blue duck. Notornis 37: 150-152.

Harding, M.A 1994. Blue duck dispersal at Arthur's Pass. Notornis 41: 293-295

Henderson, I.M. 1994. Population viability analysis of blue cluck *(Hymenolaimus malacorhynchos)*. Conservation Advisory Science Notes No. 104. Department of Conservation, Wellington.

IUCN 1994. IUCN red list categories. IUCN, Gland, Switzerland

Kear, J. 1972. The blue duck in New Zealand. Living Bird 11: 175-192.

Kear, J; Burton, PJ.K. 1971. The food and feeding apparatus of the Blue Duck *Hymenolaimus.* Ibis 11-3: 483-493.

Layard, E.L. 1863 Ornithological notes from the Antipodes. Ibis 5: 245.

Mason, K.M.; Collier, K.J.; Henderson, I.M.; Veltman, C.J. 1992. Selection for large *Hydrobiosidae* prey by blue ducks in the Manganui a te ao river. Unpubl. BSc (Hons) dissertation. Dept. Ecology, Massey University.

McDonald, N.J. 1991. Blue duck responses to playbacks of male and female vocalisations. Unpubl. student dissertation, Dept. Botany/Zoology, Massey University.

Molloy, J.; Davis, A. 1994. Setting priorities for the conservation of New Zealand's plants and animals. Department of Conservation, Wellington.

Moralee, S.J. 1990. Some aspects of behaviour and physical requirements of blue duck. Unpubl. report, Dept. Conservation, Wellington.

Newton, L. 1991. Seasonal changes in the invertebrate diet of the blue duck. Unpubl. Bsc (lions) dissertation, Dept. Botany/Zoology, Massey University

Noda, D.K.; Stanton, PA. 1986. Blue ducks on the Manganui a te ao. Unpubl. report, Dept. Botany/ Zoology, Massey University.

Pascoe, J. 1957. Mr Explorer Douglas. A.H. and A.W Reed,Wellington.

Potts, N. 1946. Blue cluck in the Bay of Plenty. New Zealand Bird Notes 2:7,

Potts,TH. 1870. On the birds of New Zealand (Part 11). Transactions of NZ Institute 3:103.

Towers, D.J 1996. Diet overlap between coexisting populations of native blue ducks *(Hymenolaimus malacorhynchos)* and introduced trout (Family: Salmonidae): Assessing the potential for competition. Massey University. Unpublished PhDThesis.

Triggs, S.J.; Williams, M.J.; Marshall, S.J. Chambers, G.K. 1991. Genetic relationships within a population of blue cluck. Wildfowl 42: 87-93.

Triggs, S.J.; Williams, M.J.; Marshall, S.J.; Chambers, G.K. 1992. Genetic structure of blue duck *(Hymenolaimus malacorhynchos)* populations revealed by DNA fingerprinting. The Auk 109:80-89.

Veltman, C.J.; Collier, K.J.; Henderson, I.M.; Newton, L. 1995. Foraging ecology of blue ducks on a New Zealand river: implications for conservation. Biological Conservation 74: 187-194.

Veltman, CJ.; Williams, M.J. 1990. Diurnal use of space and time by breeding blue duck *Hymenolaimus malacorhynchos.* Wildfowl 41:62-74.

W ikelin, M.D. 1993. Contents of blue duck faeces from the Tongariro River. Notornis 40: 205-212

Williams, G.R., 1964. Extinction and theAnatidae in New Zealand. The Wildfowl Trust Annual Report 15:140-146.

Williams, M.J. 1988. Conservation strategy for blue duck, 1988-1992. Science and Research Internal Report No. 30. Department of Conservation,Wellington.

Williams, M.J. 1991. Minutes of the 3rd annual meeting of the Blue Duck Liaison Group. Science and Research Internal Report No. 116. Department of Conservation,Wellington.

Williams, M.J. 1991x. Social and demographic characteristics of blue duck *Hymenolaimus malacorhynchos.* Wildfowl 42:65-86.

Williams , M. and McKinney E 1996. Long-term monogamy in a river specialist - the blue duck. Pp 73-90. In: Black, J.M. (ed) Partnerships in birds: the study of monogamy Oxford University Press, Oxford.

Worthy, TH., R N Holdaway, 1994. Quaternary fossil faunas from caves in Takaka Valley and on Takaka Hill, North-West Nelson, South Island, New Zealand. Journal Royal Society of NZ 24:297-391.

Recommended Reading

Cunningham, D.M. 1989. Summarised notes of the Blue Duck Liaison Group meeting held at Ohakune, 6-8 June 1989. Science and Research Internal Report No. 54, Dept Conservation, Wellington.

Cunningham, D.M. 1991. Distribution of blue duck in New Zealand from 1980-1991. Science and Research Series No. 36, Dept Conservation,Wellington.

Eldridge J.L. 1985. Display inventory of the blue duck. Wildfowl 36:109-121

Eldridge J.L. 1986. Territoriality in a river specialist: the blue duck Wildfowl 37:123-135.

Kear J.; Steel,TH. 1971. Aspects of social behaviour in the blue duck. Notornis 18:187-98.

Veltman, C.J., Triggs, S., Williams, M., Collier, K.J., McNab, B.K., Newton, L., Haskell, M. and LM Henderson 1991. The blue duck mating system - are river specialists any different? Acta XX Internationalis Ornithologici 860-867.

Williams, M.J. 1990. Minutes of the 2nd annual meeting of the Blue Duck Liaison Group. Science and Research Internal Report No. 89. Department of Conservation, Wellington.

Appendix 1: Method used to derive number of blue duck pairs recorded in the National Distribution Scheme database

The analysis has been based on the assumption that clumps of grid references represent territories or at least, foci of activity within territories. The program to do this was written by Ross Pickard (DOC) and thoroughly tested by Duncan Cunningham (DOC) using rivers and catchments in which numbers of pairs are already known. The program clumps all the grid references that are within a defined distance from one another and then breaks these clumps into segments equivalent to a predefined territory length. This simulates the lumping and splitting one would do when manually plotting grid references onto a map and assigning territories by eye.

Testing the program against known areas led to lumping grid references within a 650m radius of each other. In some cases this formed a continuous string of several kilometres in length. To counter this a maximum length for a territory was specified, and, after some juggling, 1500m was found to give the best fit. Thus, the counts for each catchment were lumped around 650m radii and split according to a maximum territory length of 1500m.

Records which were excluded from the analysis were:

- records of single birds many of which could have been half of a pair but not proven.
- records of counts between two points along a stretch of river.

All other records from 1980-1994 qualified for analysis if they were of two or more birds, in the knowledge that a small, unknown, percentage of `pairs' would be of non-breeders seen together. To minimise this error DC analysed the percentage of `qualifying' records which occurred in the months of May, June, and July. It is during these months that there is a higher than usual proportion of non-breeding birds on the rivers, many of which could be mistaken for territory-holding pairs. For the North Island the `winter correction' figure is 14.25%, for the South Island it is 15.88%. If this is a fair assumption, then the lower figures in the ranges given are more realistic.

Appendix 2: Numbers of blue duck pairs in North Island catchments from records in National Distribution Scheme database

CATCHMENT	PAIRS
Wairoa (Bay of Plenty)	9
Kaituna	5
Rangitaiki	37
Whakatane	30
Waioeka	30
Otara	7
Motu	45
Raukokore	8
Waiopu	7
Waipaoa	13
Wairoa (Hawkes Bay)	111
Mohaka	92
Ngaruroro	23
Sub-total	417

CATCHMENT	PAIRS
Tukituki	6
Manawatu	14
Rangitikei	46
Whangaehu	14
Wanganui	130
Waitotara	10
Waitara	2
Waikato	25
Waihaha	14
TaurangaTaupo	15
Tongariro	37
LTaupo	15
Sub-total	328

TOTAL	745
Minus winter correction (14.25%)	106
	639
Estimated number of pairs:	640

Appendix 3: Numbers of blue duck pairs in South Island catchments from records in National Distribution Scheme database

CATCHMENT	PAIRS
Aorere	7
Takaka	25
Motueka	12
Riwaka	5
Waimea	6
Pelorus	11
Wairau	13
Waiau	4
Hurunui	2
Wai makariri	21
Rakaia	11
Rangitata	9
Orari	4
Ophi	6
Otaio	0
Clutha	6
L Wakatipu	14
Catlins	2
Oreti	1

CATCHMENT	PAIRS
Juno	1
Two Thumb Bay	3
Hollyford	8
Cascade	5
Arawata	0
Okuru	2
	3
Moeraki	2
Paringa	3
Karangarua	20
Cook	2
Waiho	5
Omoera	2
Ohinetamatea	2
Whataroa	27
Poerua	7
Wanganui	17
Waitaha	18
Mikonui	5

Waiau	1
L Te Anau	82
L Manapouri	18
L Hauroko	6
Big	1
Dusky Snd	9
Bradshaw Snd	14
Doubtful Snd	3
Charles Snd	4
George Snd	6
Caswell Snd	1
Bligh Snd	4
Sutherland Snd	7
Milford Snd	14
Sub-total	329

Hokitika	55
Taramakau	46
Grey	20
Fox	3
Buller	32
Mokihinui	5
Punakaiki	4
Bullock	2
Little Wanganui	3
Karamea	42
Oparara	10
Heaphy	4
Big	2
Sub-total	360

TOTAL	689
Minus winter correction (15.88%)	109
=	580
Estimated number of pairs:	580-689

Appendix 4:
Published Recovery Plans

Blue duck	($15)	Approved 1997
Kakapo	($15)	Approved 1996
Stitchbird	($15)	Approved 1996
Brown teal	($15)	Approved 1996
Native frogs	($15)	Approved 1996
New Zealand (Hooker's) Sea Lion	($15)	Approved 1995
Dactylanthus taylorii	($15)	Approved 1995
Bat (Peka peka)	($15)	Approved 1995
Otago and grand skinks	($15)	Approved 1995
Giant land snail	($15)	Approved 1995
South Island saddleback	($15)	Approved 1994
Takahe	($15)	Approved 1994
New Zealand Dotterel	($15)	Approved 1993
Tuatara	($15)	Approved 1993
Mohua(yellowhead)	($15)	Approved 1993
Subantarctic teal	($15)	Approved 1993
Kowhai ngutukaka	($15)	Approved 1993
Chevron skink	($15)	Approved 1993
Black stilt	($15)	Approved 1993
Whitaker's and robust skinks	($15)	Approved 1992
North Island kokako	($15)	Approved 1991
Kiwi	($15)	Approved 1991
Yellow-eyed penguin*	-	Approved 1991
Kakapo	Out of print	Approved 1989

Available: from Otago Conservancy, Department of Conservation, Dunedin

Copies may be ordered from:

DOC Science Publications
Science & Research Division
PO. Box 10420
WELLINGTON, N.Z.