

9. OPTIONS FOR RECOVERY

Options for recovery presented here include four based on experience from past management techniques (1981-91), i.e. predator control, cross-fostering and egg manipulation, captive rearing and habitat protection and enhancement. Two further options are also considered, establishing a population elsewhere in Canterbury, based on the few individuals that may nest outside the Mackenzie Basin, or on a predator-free island.

9.1 Do nothing

If no management occurs it is likely that the black stilt population will decline through failure to produce sufficient young to offset adult mortality. Within 10-20 years it is expected that those genes peculiar to black stilt will be represented only in hybrids with pied stilts and the distinctive form endemic to New Zealand would be effectively lost.

9.2 Manage the population in the wild in the Mackenzie Basin

Within this option there are several techniques available as follows:

9.2.1 Control predators by trapping

Past predator trapping has involved a combination of large scale coverage of traditional breeding areas beginning prior to nesting, and ring-trapping around located nests.

Both methods are labour-intensive and have little if any carry-over benefit from year to year. Yet trapping has produced an increase in survival rates of eggs and chicks overall, breeding success at protected nests increasing to almost 11 % compared to the 1 % of unprotected nests (Pierce, 1987). This breeding success of 11 % is greater than that of unprotected natural pied stilt nests (8.4%).

The building and maintenance of predator-proof enclosures is a further option used (see 8.2.). The success of such enclosures relies on birds coming in to breed there, which in turn may depend on the habitats provided within them. No nesting has occurred in the present two enclosures since the 1985/86 season.

9.2.2 Take eggs, artificially incubate and return to wild pairs

Currently, added protection from predators is obtained by removing all eggs as soon as they are laid/found and artificially incubating them. Two possible sub-options follow:

1/ Some pairs are given dummy eggs to incubate while their eggs are protected within the incubator. The dummy eggs prevent parent birds deserting the nest. Their eggs are returned to the nest just before hatching. If their nest is lost to predators or flooding, the eggs are fostered to other black pairs or hand-reared in captivity.

2/ If more than one clutch of eggs is required from a pair, their nest is left bare and they will more than likely re-lay. This increases the total potential egg production for the season, from a limited number of pairs. Surplus eggs not returned to parent birds are given to foster parents. These foster parents have in the past been any stilt pairing from pied/pied to black/black. However problems of offspring migrating with pied or hybrid stilts lead to a reduction in the use of birds other than black stilts as foster parents. If such birds are unavailable, other options like rearing the eggs in captivity are now favoured.

The second option was used in the past (see 8.1.) but has been discontinued.

9.2.3 Protect and enhance habitats

Habitats currently available to black stilts are not necessarily optimal. In many cases river protection works, invasion of exotic vegetation, hydro-electric manipulation of rivers and lakes, and farming practises have reduced habitat quality.

Existing black stilt habitats and presently unused ones into which the population may expand can be protected. New habitats may be created in some areas by diverting water onto former (dry) river beds. It may also be possible to increase the food available in habitats by changing their nutrient status through such techniques as seasonal manipulation of water levels.

9.3 Manage the population in captivity

Within this option there are two possible approaches. One would be to maintain a self-sustaining captive population long-term, and the other is to use a captive population to produce young for release into the wild.

Techniques have been developed to allow eggs from the wild to be artificially incubated and the chicks produced to be hand-reared. Conversely eggs produced in captivity have been fostered to wild pairs eggs or in exceptional circumstances as 1-day old chicks. Juveniles reared in captivity have been released into the wild. Birds have been brought into captivity as adults and adjusted to confinement though none have yet had the opportunity to breed.

This flexibility should allow the maintenance of a productive captive population based on an even sex ratio. Each pair should potentially be able to produce more eggs than they would in the wild and this extra production can be moved as eggs or juveniles to supplement the wild population.

The ability to take adults from the wild into captivity may allow more productive use to be made of the considerable proportion of the wild population that are not productive. It may be possible to pair these in captivity and either release them in the hope that they will remain together or hold them as breeding stock.

9.4 Establish a population on the mainland outside the Mackenzie Basin

The nesting of two black stilts with pied-stilts at Lake Ellesmere in the 1986 season provided an opportunity to consider trying to establish a black stilt population in this area. (One pair lost it's eggs and the second reared several young to fledging.)

Options discussed were:

- 1/ leave the birds alone to perhaps allow a satellite population to establish naturally
- 2/ intervene to aid establishment by fostering black stilt eggs to these pairs
- 3/ attempt to prevent establishment by trapping and removing the black stilt to the Mackenzie or captivity (Andrew,J. Internal report 14/9/87, file 2/10/10/5).

The third option was favoured given the large management input needed to retain the one existing population. If the situation re-occurred the birds were to be placed in captivity rather than in the Mackenzie, because of the risk that they might fly back from the latter to the previous territory at Ellesmere.

9.5 Establish a population on a predator-free island

Any mainland population will require long-term maintenance unless an effective low-input predator control method can be devised. An alternative option might be to transfer birds to an island which:

- 1) contains no nesting pied stilts (to eliminate potential hybridisation problems), i.e. is outside their natural range;
- 2) provides suitable nesting and feeding habitat to support at least 5-10 pairs of stilts; and
- 3) is free of ground predators (the presence of kiore may be considered acceptable if no alternatives exist).

Preferred option

This plan advocates pursuing a combination of options 9.2, 9.3 and 9.5. The Mackenzie Basin population will continue to be managed in the wild through predator trapping, manipulation of eggs and habitat enhancement. A captive population will be maintained to assist management of the wild population, its primary focus being to produce young for release. The feasibility of transferring birds to a predator-free island will be investigated and actioned as soon as a suitable island can be found.

10. SOCIAL AND ECONOMIC EFFECTS OF MANAGEMENT OPTIONS

The Mackenzie Basin is an area sensitive to the consequences of some black stilt management techniques, particularly those of predator removal and the acquisition of land for wildlife use.

10.1 Predator control

10.1.1 Effect of predator removal on rabbit populations

Local pest destruction boards and several land-owners claim that trapping of feral cats and ferrets in black stilt nesting areas removes a "natural" form of rabbit control. This removal causes such a significant increase in the local rabbit population that additional poisoning must take place. The Department of Conservation has been held responsible for these extra costs. Government financial assistance to local boards is presently being reduced and farmers are having to pay a greater proportion of poisoning costs. Claims by the pest board have not yet been quantitatively substantiated, but the black stilt project team accept there may be some economic effect as a result of trapping.

In some seasons, especially following a recent poisoning when predators potentially have their greatest impact on rabbits (Pierce 1987), it may be necessary to compensate farmers for any demonstrated detrimental effect on rabbit numbers. However the recent finding that both ferrets and cats in the MacKenzie Basin may carry bovine tuberculosis (Allen, 1991) may alter farmer attitudes to their control.

Long-term changes in rabbit numbers, as would occur if myxomatosis was successfully introduced, could disrupt the delicate predator-prey ecological "balance" within the Mackenzie Basin. This could likely increase the level of predation on black stilts (Pierce 1987).

10.1.2 Gin traps

Gin traps are currently used to capture predators. There are rare occasions when domestic stock and farm dogs/cats are accidentally caught in these traps. The department is phasing out the use of gin traps and replacing them with more humane alternatives which may allow animals to be released unharmed. Farmers are compensated for any lost stock as a result of predator trapping.

10.1.3 Disturbance during trapping

When a trapline is in operation, it is necessary to service it daily, both from the point of view of maintaining maximum trapping effectiveness and minimising the suffering of trapped animals. Although stock disturbance is kept to a minimum, the daily presence of staff is in some cases, not welcomed by landowners.

10.2 Acquisition of pastoral lease land

The majority of habitats within the upper Waitaki river basin for which management agreements, acquisition or reservation are proposed are situated on pastoral lease farmland. Most are not highly productive agricultural areas, but the water present may be a valuable asset to the farmer. Wherever possible, reserves should be located and managed in such a way that continued use of water by stock is possible.

Grazing of wildlife habitats by sheep may be useful for maintaining black stilt habitat. In most cases where land is acquired or managed under agreement, controlled grazing may be given to the adjacent landowner. When new habitats are created on previously un-managed riverbed terraces, the areas will be fenced and neighbouring landowners may be offered controlled grazing options. A balance needs to be struck between positive effects of stock maintaining low vegetation and negative effects including eutrophication of waters, spread of weeds, and disturbance or trampling of nests. The potential importance of each effect will vary from site to site.

10.3 Recreational activities

Public recreational use of habitats utilised by black stilts need not be restricted unless it is evident that undue disturbance (particularly to nesting birds) is occurring. In the case of tarns and ponds, past experience suggests that seasonal gamebird hunting does not have any detrimental effects. In black stilt habitats reserved for wildlife purposes, gamebird hunting will be allowed by permit, with special conditions applied as necessary.

In braided rivers, off-road vehicles should be restricted wherever possible during the nesting season. This restriction would be publicly notified by signs at access points to rivers upon which black stilts are nesting. Signs would not specifically indicate black stilt presence as this may tend to attract "nuisance viewers", but would infer caution for nesting birds in general.

Anglers and other passive river-channel users usually pass through a section of river with a minimum of disturbance and in fine weather. Signs will be erected on main areas of stilt breeding/recreational conflict (eg. lower Ahuriri river, lower Ohau river) to warn people of the danger to nesting birds of prolonged disturbance.

The establishment of a black stilt captive breeding and rearing station near Twizel has already resulted in increased public interest in black stilts. The public viewing facilities built there as an educational facility and tourist attraction will relieve viewing pressure on the wild population, as well as recover some costs of management through charging admission.

10.4 Electricorp operations

During periods of heavy rain, spilling can occur onto the lower Ohau, Pukaki or Tekapo rivers. This is generally not a problem unless it occurs while birds are nesting. Close contact with control operators during the breeding season ensures that DOC is aware of any potential danger from spills. Appropriate action can then be taken, eg. take eggs or chicks from nests

for fostering or captivity or attempt to move nests.

10.5 Removal of birds from the Mackenzie Basin

Though management of black stilts may at times appear to conflict with the interests of other users of the Mackenzie Basin, the option of moving all birds to establish populations elsewhere would also have a significant social cost. Today black stilt are one of the 'identities' of the inland river valleys of south-Canterbury, giving their name to many local businesses, particularly in Twizel. They may also be regarded adversely elsewhere, e.g. as mainland intruders in an island environment.

11. RECOVERY STRATEGY: GOAL, AIMS AND OBJECTIVES

GOAL:

The long-term goal is to establish self-sustaining populations of black stilt to ensure the species' survival in the wild without a continuing need for intervention.

The short-term programme to progress towards this goal is defined by the following five aims. Within each aim there are several more specific objectives that are set out in the Work Plan.

Flexibility will be the key to implementing this plan. There are several different approaches that can be followed each season, varying the emphasis on managing nests in the wild, taking eggs for captive rearing and release, or bringing adults into captivity to breed there. Monitoring the success of the different approaches will determine which are favoured in the longer term.

AIM 1: Increase the productivity of breeding pairs in the wild on the mainland.

AIM 2: Increase the breeding population in the wild on the mainland from the current level of 10 pairs.

AIM 3: Maintain a captive population and improve its productivity to provide the maximum number of birds for release into the wild.

AIM 4: Establish a self-sustaining population on a predator-free island.

AIM 5: Encourage public interest in and support for the programme through advocacy and education.

In the long-term, if the wild population can be increased significantly, it should be possible to utilise active management techniques on a smaller scale. Manipulation and artificial incubation of wild eggs could cease in some years and predator trapping could possibly be replaced with a less labour-intensive technique.

It is difficult to predict at what stage of the growth of the population this reduction of active management can occur. Progress should be reviewed after the 5-year period of this plan.

12. WORK PLAN

AIM 1: INCREASE THE PRODUCTIVITY OF BREEDING PAIRS IN THE WILD

Past management of the wild population has largely been applied directly at achieving this aim. Egg manipulation and predator control have been the main techniques employed, supported by work to maintain quality habitat. This will continue in the short-term. It was hoped that improved productivity would lead to an increased breeding population but this has not yet occurred. This is thus given as a separate aim (aim 2) with a separate set of projects to work towards its achievement.

OBJECTIVE 1: Use egg manipulation and cross-fostering to increase the number of chicks produced.

Plan:

- 1.1 *Continue present management techniques through the short-term, i. e. take wild eggs, replace with dummies, incubate eggs artificially, place back out to parents at hatching. If nests are lost before chicks hatch, foster to wild parents or, if none are available, hand-rear.*
- 1.2 *Discourage migration of black stilt chicks from the Mackenzie Basin by cross-fostering only to parents which remain year around in Mackenzie.*

Explanation

Because of the limited recruitment through fostering to other than black parents, cross-fostering as a management technique has been scaled down to minimal use. Eggs should go back to parents, to another black pair or if necessary be reared in captivity.

There is still a possibility that some juveniles reared by pied stilts and hybrids, may return eventually to the Mackenzie Basin. There is no guarantee however, that these birds reared by non-black parents, will choose to nest with black mates when they reach maturity. They are likely to have become sexually imprinted and select mates that are similar to their parents.

All 'node F to 'I' stilts paired with pure blacks will have their eggs and chicks protected in a similar manner to pure black pairs. However, to minimise risks of increased hybridisation, pied stilts paired with black stilts will be shot and the nest destroyed, or the black stilt removed for captive breeding.

Target date for completion

Ongoing. The proportion of eggs to be returned to the wild, rather than retained for captive

breeding, will be determined annually based on a review of previous seasons. Performance measures will include the number of eggs incubated producing chicks in the wild and in captivity, survival of the chicks and the proportion of them that migrate.

1.3 *Manage sub populations in the wild to maximise productivity while monitoring inbreeding. Ensure that successful breeding pairs in the wild rear a good proportion of their own progeny, while monitoring the degree of relatedness of individuals within sub-populations.*

Explanation

The tendency of birds to remain and eventually breed in the river system in which they were reared has resulted in the establishment of major sub-populations on three rivers in the Mackenzie Basin (Table 1). Without knowledge of how genetic variation is usually distributed in black stilt populations, it is difficult to know whether this situation and the relatively high degree of inbreeding that may result from it is normal for the species.

A balance needs to be struck between returning to a known successful pair all its eggs which could result in many related individuals in the one area, and fostering these eggs to another pair where they may have reduced chance of surviving. At this stage in the programme maximising productivity must be the aim and successful pairs must be fully utilised. If rearing ability is an inherited trait, then the young of 'good' parents should be given every chance of survival. It will be necessary to monitor productivity of different sub-populations to detect any decline that could be related to inbreeding. New genes could then be introduced through cross-fostering of eggs from birds in another sub-population.

Target date for completion

Ongoing. Performance could be assessed by measuring the relatedness of the breeding population of different river systems.

OBJECTIVE 2: Control predators to minimise their impact on the wild population.

Plan:

2.1 *Carry out trapping in priority nesting areas from prior to stilt nesting until fledging. In addition, if resources allow, ring-trap around nests.*

Explanation

As trapping has been shown to increase fledging success of black stilt chicks and probably protects adults, it will generally continue in the short term. Trapping will be scaled down and applied largely to the maintenance of exclosures free of predators in those seasons when most eggs are collected for captive rearing (see Work Plan 2.4. and 7.2.) Trapping is time-consuming and labour-intensive and so must be replaced with a low-maintenance long-term method of predator control.

Current information indicates that predator trapping is most effective when applied over a relatively large area before and during the stilt nesting period, rather than ring-trapping around nests. If resources are limited, an assessment should be made early in the season as birds are setting up territories, to determine where widespread trapping will be most productive. In general, the Ahuriri and lower Ohau rivers should be the first priority and the lower Cass and Tasman the next priority, but this will depend on where birds are distributed each year. Additional intensive trapping around nests may be carried out if resources allow.

One factor that may be useful in determining which nests are to receive intensive trapping effort, if resources allow, is their assessed vulnerability to predation. Pierce (1987) gives some biological and physical factors which may determine vulnerability (Appendix 4) and it may be possible to apply these as criteria in the field.

Target date for completion

Continuing during the term of this plan, but the effort to be determined prior to the start of each season.

2.2 *Develop and use traps that are as humane as possible, providing they maintain a similar catch rate to existing traps.*

Explanation

The Department is currently working to phase out the Lanes Ace leg-hold trap and its Animal Ethics Committee has only approved Victor Soft-Catch traps for use in cat control.

2.3 *Investigate long-term methods for control of ground predators.*

1/ develop alternative baits and the use of attractants for predator trapping which require less preparation and handling than present baits (rabbit).

2/ develop chemical deterrents to apply in the vicinity of nests.

3/ Research predator inter-relationships and possible consequences of programmes aimed at long-term rabbit control (e.g. introduction of myxomatosis).

Explanation

For management staff to decrease expensive trapping effort in the medium to long-term, a more effective low maintenance method of predator control or deterrence must be sought. A study of rabbit and predator population dynamics, competitive exclusion and interactions between predator types at different levels of rabbit density and the effects of these factors on predation of ground-nesting birds is required. This study has been partially completed by Dr Ray Pierce but requires follow-up work on the best population level of rabbit for the least

predation impact of cats, ferrets, stoats and other predators on ground-nesting birds.

Overseas experience suggests that initially successful introduction of myxomatosis and an appropriate vector will result in a one-off dramatic decline in rabbit numbers (c90%). Predator numbers may go up with the increased availability of diseased rabbits that are easy to catch. However once the die-off of rabbits has occurred this high predator population is likely to put increased pressure on birds. Widespread predator control measures would need to be taken to prevent this. The longer-term impacts of a rabbit control measure like myxomatosis are difficult to assess. Research is needed to predict the new predator and prey regimes likely to be found in the Mackenzie Basin.

Target date for completion - December 1994

2.4 *Maintain predator proof exclosures and encourage their use by breeding black stilts.*

Explanation

The two exclosures at Micks Lagoon and Mailbox Inlet should be maintained, considering that relatively high numbers of black stilt chicks fledged successfully from them in the early 1980s. Fences need to be kept in good condition and checked regularly during the breeding season. The areas are opened to grazing outside the breeding season to control pasture growth, but need to be closed and then trapped thoroughly before the black stilt nesting period.

Measures to make these areas more suitable for black stilts are considered in the habitat enhancement section (Plan 6.1). Experiments should be undertaken on more direct methods of encouraging stilts to breed in them. One approach suggested would be to try and move a breeding pair with a nest into an exclosure, perhaps as the eggs were hatching when parents would have a strong attachment to them. Experiments could be undertaken using pied stilts, perhaps beginning with nest shifts over short distances. The idea is that any young produced from the nest would be protected from ground predators and be likely to return to the same area to breed themselves.

Target date for completion

Ongoing during the term of this plan. Performance can be measured by the number of pairs breeding in and the number of chicks fledged from the exclosures.

OBJECTIVE 3: Carry out research on factors other than predation that may affect productivity and evaluate means to counteract these.

The following three factors have been suggested:

- a/ **Food supply**
- b/ **Lead poisoning**
- c/ **Internal parasites.**

OBJECTIVE 4: Maximise the contribution of all adult birds to the breeding population.

Though 61 colour-banded juveniles have been reared in the wild between 1985 and 1988 only 4 have been recruited into the breeding population. During the 1990/91 season there were at least 36 birds not contributing as breeders. These may be one of the following:

- 1/ Paired to pied (6 birds) or hybrid 'nodes B to G' stilts (16 birds) and thus producing hybrid young that migrate and do not return to the Mackenzie.
- 2/ Paired with black stilts of the same sex (2 females).
- 3/ Unpaired - due perhaps to the absence of a suitable mate in their river system (12 birds).
- 4/ Paired with a black stilt but not nesting.

Plan:

4.1 *Catch and sex by laparoscopy or measurement of 'pelvic width' all unproductive birds of unknown sex, giving priority to those in the three major populations. Evaluate whether there are uneven sex distributions of birds that could be improved by transfers. (The effectiveness of analysis of feather pulp as a further non-invasive sexing method should be evaluated).*

4.2 *Take steps to minimise hybridisation and monitor its frequency.*

Explanation

Present management, which no longer involves fostering black stilt eggs or chicks to pied or hybrid pairs, should reduce the number of black stilt produced that may be mal-imprinted on pied stilts. Plan 4.1. (above) may lead to managers moving black stilt so that mates of their species are available to them in the wild. These initiatives, coupled with the tendency of black stilts to select their own kind as mates, should lead to a decrease in the frequency of hybridisation. This decrease should be more marked as the black stilt population increases. During past management, pied stilts mated to black stilts were occasionally shot to reduce hybridisation. This technique has now largely been phased out, to be replaced by 4.3. below.

Target date for completion

Ongoing. The frequency of hybridisation in the wild should be measured annually, both for the whole population and for the sub-populations on each river. Failure to demonstrate a reduction in hybridisation frequency with increasing numbers of black stilts would throw into question current management efforts on the mainland. Progress should be reviewed at the end of the term of this plan.

4.3 *Experiment by taking unpaired birds into captivity for flock mating and return of pairs to the wild.*

Explanation

Two wild-caught adult birds, a male and a female, did acclimatise to captivity but neither yet paired there (the female recently died of an injury). If the male can be successfully pairing, the next step would be to bring in further birds not contributing as breeders and release them again as pairs to ascertain if they remain together. Even if they then split up, a bird previously mated to a pied stilt in the wild, brought into captivity and paired and released with a black, might then be more likely to select a further black mate.

Target date for completion

Ongoing. The viability of this technique should be determined during the term of this plan.

4.4 *Study birds that are not nesting to identify possible causes, e.g. exclusion by territory holders.*

4.5 *Locate birds breeding outside the MacKenzie Basin.*

Surveys should be carried out of areas outside the MacKenzie Basin where birds have been recorded during the breeding season. The priority areas are as follows:

Tarras River (Lindis) and associated wetlands
 Matukituki River and associated wetlands
 Makarora River
 Rangitata and Rakaia Rivers
 Ashburton River and tributaries
 Lake Ellesmere
 Washdyke Lagoon and Lake Wainono
 Hunter River

Other sites that should be checked if visits are made for other purposes:

Waimakariri River	Taieri Lake
Manuherekea River (from falls down)	Dingle River
Ashburton Lakes	Opihi River

Any black stilts found breeding should be monitored (as a minimum), perhaps managed (eg. eggs collected and returned) in the same way that birds in the MacKenzie are, or caught and brought into captivity. The latter was the recommendation when birds nested at Lake Ellesmere in the past (see Option 9.5.), but each case should be considered by the Recovery Group on its own merits.

4.6 *Use DNA Hybridisation techniques to further clarify the relationship between black and pied stilts and determine appropriate management for hybrids.*

Explanation

If unique black stilt DNA sequences can be located using this technique, then their presence or absence in different hybrids can help to determine how these individuals should be managed. It would also serve to confirm the present hypothesis that gene flow has occurred in the one direction during hybridisation, from black stilts to pied (Daugherty, C. H. , pers. comm.).

OBJECTIVE 5: Census and monitor the wild population.

Regular censuses of the population are crucial to evaluate the success of management. Specific monitoring will be required to compare the value of different approaches, e.g. to compare the rates of recruitment from 'hard' and 'soft' releases.

Observations of Mackenzie Basin black stilts need to be supplemented with more from outside of the basin eg. L. Ellesmere, North Island harbours. At present, Ornithological Society of N. Z. (O. S. N. Z) members check harbours such as Kawhia during winter and locate several black stilts. It may be necessary for staff involved in the black stilt project to visit these northern and eastern areas during Autumn/Winter to assist with these counts.

Plan:

5.1 *Trap and band black stilts, hybrid and pied stilts on the nest.*

5.2 *Develop a trapping technique for capturing stilts for banding on North Island wintering areas.*

5.3 *From band recoveries, identify migration routes and destinations of NZ stilts.*

Conservancies responsible for wintering areas used by black stilts should allocate some financial and staff resources each year to aid with monitoring migrating birds. These are in particular:

Waikato (Kawhia, Aotea harbours, Firth of Thames particularly. Miranda, April-August);
Auckland (Manukau harbour, Mangere ponds, April-August);
Auckland/Whangarei (Kaipara harbour, particularly South, April- August).

Explanation

Little is known of pied stilt migratory routes. 10% of the black stilt population migrate with pied and hybrid stilts to North Island harbours each year. Some are known (from bands) to have come from the Mackenzie Basin. No information is available on nesting areas, mates and annual movements of most black stilts (unbanded) found on northern harbours in winter.

A study of pied migration could provide information for use with black stilt management. An OSNZ project co-ordinated by Ray Pierce is presently underway to study pied stilt migration.

Target date for completion - Ongoing

5.4 *Continue to monitor survival of banded fledglings. Evaluate use of radio-telemetry to follow juveniles and adults, trialling on pied stilt.*

Explanation

It is important that we find out as much as possible about juvenile dispersal before we can recommend management to increase recruitment to the breeding population. Radio transmitters may need to be placed on birds released from captivity as well as those in the wild. Transmitters could be placed on an individual of any black pair which cannot be located annually in spring but which are observed in summer or winter.

Target date for completion - Evaluation completed by December 1993.

OBJECTIVE 6: Increase and improve the habitat available to the black stilt population:

This work will be assisted by the Project River Recovery programme of wetland management being developed under a compensatory agreement between DOC and Electricorp for the Upper Waitaki Basin. This agreement includes the following elements:

- 1/ Restoration of lower Ahuriri River braided river habitat, primarily through control of Russell lupin, willow, broom and gorse.
- 2/ Restoration of Tekapo river delta, primarily through removal of willows (first phase completed).
- 3/ Specific habitat work, including re-shaping of Pattersons Ponds and Lake Poaka and protection of adjoining areas, and willow clearance from Lower Tekapo/Twizel/Ohau River area.
- 4/ Enhancement of braided habitat of Pukaki Riverbed and nearby wetlands.
- 5/ Construction of third black stilt aviary (completed) and predator-proof fencing. (See Work Plan 7.2.)

A wetland ecologist has been employed to supervise the research and management under this agreement.

Other specific work planned in the black stilt programme is as follows:

Plan:

6.1 *Enhance Micks Lagoon and Mailbox Inlets as black stilt habitat and complete their gazettal as reserves.*

- 1/ *Sample existing invertebrate fauna of these wetlands and research means of increasing the numbers of those species which are taken by stilts.*
- 2/ *Research other means of encouraging birds to nest in these areas, e.g. use of dummy birds.*
- 3/ *Trial different water management regimes. The drains at Mailbox Inlet may require clearing.*
- 4/ *Gazette as reserves.*
- 5/ *Increase area of wetland habitat used by stilts by earthmoving.*

Explanation

These have been important nesting areas for black stilts in the past, fledging many chicks from within the safety of the predator-proof fenceline. No black stilts have nested in the two exclosures since the 1985/86 breeding season. Pierce (pers. comm.) suggests that this is due to a decline in the invertebrate population. Numbers of pied stilts using the area have also decreased. The addition of straw onto wetlands has been shown to increase invertebrates by providing cover and releasing nutrients slowly into the water column (Street, 1982) and may be an option here.

The two areas have artificial controls holding water levels at desired heights. The past few years management has tended to flood the areas in winter and then slowly drop them from spring through summer. To better utilise the insect flush created when an area is flooded, the levels should be raised earlier (just before breeding in September).

Target date for completion

Gazettal: by December 1995; research: commenced at Ruataniwha Springs (6.2 below) and ongoing.

6.2 *Develop pastoral lease land adjacent to Ruataniwha Springs for black stilt feeding and nesting habitat.*

- 1/ *Finalise lease agreement with Electricorp and Omahau Station for the land required for management.*
- 2/ *Construct a series of ponds/weirs and divert water to flood as much of the 70 ha as possible.*
- 3/ *Monitor vegetation growth and insect colonisation.*
- 4/ *Erect predator-proof fence around developed area.*

Explanation

Water has been piped from Lake Ruataniwha to old riverbed channels below the captive breeding site. Black stilts presently feed on small existing ponds in this area. Both wild and captive-released birds use the area, but nesting has not occurred for several years. Released juveniles remain around the aviary ponds and on this area for several weeks after being placed in the wild. Developing more ponds should provide them with additional feeding

areas in a potentially safe habitat (once externally predator fenced). As this species generally returns to its natal catchment to breed, it is likely that captive-released juveniles could nest in the developed area (since the area is within 1km of the aviaries). Wild stilts are also attracted to captive birds held in the aviary, spending several weeks of the year in the area. An increase in available feeding habitat could induce them to stay longer.

The first choice of black stilts for nesting areas tends to be braided riverbeds. There is therefore no substitute for this type of habitat. In years of unstable river flows however, adjacent swamp habitats are utilised for nesting. For example, Airport swamp near the lower Ohau river was the nesting area for 2 black and 1 mixed pairs in the 1983/84 season, 1 mixed pair in 84/85 and has not had black stilts nesting on it since then.

In times of water spillage from the Ruataniwha dam, the 70 ha area would provide alternative feeding areas for wild stilts of the lower Ohau river.

When vegetation growth can be adequately controlled and stilts are feeding and/or nesting regularly within the area, a predator proof electric fence is to be erected around the developed area.

The development at Ruataniwha is to be covered under the Electricorp agreement.

Target date for completion

Lease agreement: by March 1994; habitat flooding: ongoing; fencing: by 1993; monitoring: ongoing.

6.3. *Manage key wetland areas for black stilts.*

Explanation

Wetlands in the Mackenzie Basin require different levels of management to maintain or increase their suitability for black stilt nesting or feeding habitat. The Department should seek a say in the management of such areas. It would have the greatest control if areas were under Crown ownership and gazetted as reserves and this may be achievable in some cases. However in many cases, the negotiation of covenants or management agreements with existing private owners will achieve the desired results.

1/ *Obtain management agreements or ownership of the following wetlands:*

2/ *Undertake appropriate management.*

Each wetland has its own desired management regime. This may include fencing (F), control of grazing (G) (note: grazing by sheep is the preferred method of control but safe chemical sprays may be used where necessary), control of water levels (W), control of vegetation (V),

control of predators (P), or control of recreational use (R). These are indicated alongside each.

It is difficult to set time-frames and priorities in this area for opportunities may need to be taken as they arise. The priorities given are intended as a guide based both on the relative importance of areas to stilts, an assessment of the relative ease with which management influence may be obtained, and the likely threats to each habitat.

Priority 1: Unoccupied Crown Land:

Obtain management rights or acquire as reserves.

Ahuriri Riverbed - (Note: a Conservation Order is in place which safeguards against major water extraction schemes).

Management: W V P

Cass Riverbed

Management: G W V P

Lower Tasman Riverbed

Management: V R

Godley & Macauley Riverbeds

Management: G W V P

Explanation

Riverbeds are the most frequently used stilt habitats and ones most likely to benefit from departmental management. Nesting may be threatened by cattle grazing, anglers and off-road vehicles. Recreational use of riverbeds is increasing and there may need to be agreement for this to be restricted over the short period in which nesting stilts are vulnerable.

Priority 2: Pastoral leases:

Obtain management agreements, covenants or acquire as reserves.

Areas are set out in three groups according to their existing or potential value to black stilts (high, medium or low).

High Value:

Ben Avon Wetland

Management: F G

Birchwood Wetlands - QEII Covenant under negotiation

Management: P

Big Tarn

Management: G W

Glentanner Swamp - QEII Covenant under negotiation

Management: P F G

Swamp adjacent to Lake Poaka

Management: V P

Cass Riverbed (part)

Management: V P G W

Macauley Wetlands

Management: F G P

Glenmore Tarns

Management: G

Medium Value

Godley Riverbed (part)

Management: G W V P

Macauley Riverbed (part)

Management: G W V P

Low Value

Airport Swamp

Management: F G W P

Lake Merino Wetland

Management: V W P

Joseph Swamp

Management: G

Explanation

Most of these areas are wetlands and they may have conservation values for many species. They are of most significance to stilts during years of frequent flooding of rivers when they may be used for nesting. Some may only be under threat if current farming practices are altered.

Priority 3: Ex-Electricity Reserves:

Obtain management rights or acquire as reserves.

Lake Poaka

Management: F V W G R P

Tekapo Riverbed - Flow rates were agreed during the negotiations over the renewal of Electricorp's water right.

Management: P (continuing) V W

Pukaki Riverbed - Flow rates were agreed during the negotiations over the renewal of Electricorp's water right.

Management: P (continuing) V W

Upper Ohau Riverbed - Flow rates were agreed during the negotiations over the renewal of Electricorp's water right.

Management: V W

Lower Ohau River Terraces

Management: P (continuing) W F G

Explanation

In general these areas are less under threat from changes of management than pastoral leases, so they are accorded lower priority. Management rights may however be easier to obtain.

Priority 4: Freehold Land**Homestead Tarn**

Management: P (continuing)

Note: This is an important post-breeding feeding habitat and is apparently not threatened by development under current ownership. A covenant or management agreement could be requested.

6.4. Carry out additional weed control work.

- 1/** *Ensure that weed control strategies are included in any management plans drawn up within the Mackenzie Basin.*
- 2/** *Undergo a public relation exercise alerting people to the problems caused by lupin plantings in particular and evaluate the need for lupin to be considered a noxious weed. (This work is also an integral part of the Project River Recovery programme).*
- 3/** *Investigate methods to control the spread of subsequent vegetation into newly developed wetland areas.*

Target date for completion - Ongoing.

6.5. *Attempt eradication of lupin on the Tasman river and prevent lupin establishment on the Cass, Macauley, Godley, Dobson, Hopkins, lower Ohau, Pukaki and Tekapo rivers.*

Strategies for lupin control are to be developed along with continuing research under the Electricorp agreement. Aerial photography should be used for early detection of spread into new river systems.

Target date for completion - Ongoing.

AIM 3: MAINTAIN A CAPTIVE POPULATION AND IMPROVE ITS PRODUCTIVITY TO PROVIDE THE MAXIMUM NUMBER OF BIRDS FOR RELEASE INTO THE WILD.

The main management aim for the captive population is to provide as many young birds as possible for release to supplement the wild population. A secondary aim is for it to at least become capable of sustaining itself - i.e. so that if no young birds were removed from it for release it would maintain itself or increase. The detail of the programme to achieve these aims will be set out in a captive management plan (currently in draft form).

The immediate goals of the captive breeding programme are:

- 1/ to release sufficient numbers of young birds (ideally 15-20 from 6 pairs) to ensure that at least 50% (7-10) survive and adapt to the wild each year. This level of production compares with the three of the past four years' wild management where 10-13 chicks have fledged each year.
- 2/ to develop the ability to readily form pairs and house them in captivity.
- 3/ to establish the facilities to hold six pairs at Twizel

The captive population of black stilts can provide an insurance against a catastrophe threatening total loss of the wild population. To achieve this, production in captivity must be sufficient to offset mortality, and expertise needs to be developed and documented to 'rescue' birds from the wild (as eggs, chicks or adults) and to pair and breed them in captivity.

OBJECTIVE 7: Complete the development of a captive management plan.

This plan sets out in detail how birds are managed between the different institutions involved, to achieve the agreed goals of the captive programme. Completion of this plan is the responsibility of the black stilt captive-breeding co-ordinator in liaison with other holders and the Threatened Species Unit.

The plan will adopt the following principles:

- 1/ All black stilts held in captivity will be part of the overall recovery project for the species. Transfers of individuals between holders will be based on the recommendations of the black stilt captive breeding co-ordinator.
- 2/ In general all spaces available to house breeding pairs at Twizel should be filled first, before pairs are kept at other captive locations. The most productive pairs should be held at Twizel. Stock over and above the 6 pairs that Twizel can accommodate may be housed at whichever facility is most suitable at the time. Unpaired stock will be flock-mated at other facilities (currently National Wildlife Centre (NWC) and Kiwi & Birdlife Park (Queenstown)) each winter. Any resulting breeding pairs will be housed at the NWC or Queenstown until chicks fledge, when the whole families will then be transferred to Twizel. The juveniles will be released into the wild at 9 months and the pairs retained at Twizel. When all captive spaces are filled, any eggs laid will be sent for fostering (transport by air) or parent-reared juveniles will be liberated at Twizel.
- 3/ Birds in the breeding programme may be held on public display if this is not considered likely to reduce their productivity.

The captive management plan identifies the following two major tasks:

- 1/ Bring in eggs from nests in the wild each breeding season; either hand-rear and house in captivity as future brood stock, or rear and house next to captive adults until 9 months of age then release.
- 2/ Hold breeding pairs and release their parent-reared offspring to the wild at nine months of age.

OBJECTIVE 8: Undertake research to improve captive rearing success.

Plan:

- 8.1.** *Observe behavioural interactions during flock-mating of captive stock.*
- 8.2.** *Identify steps taken to form successful breeding pairs.*
- 8.3.** *Develop artificial insemination techniques.*

Target date for completion - December 1993

Observations aimed at determining answers to these questions are all underway at present, being carried out by the resident aviculturalist at Twizel.

OBJECTIVE 9: Undertake research on release techniques to maximise recruitment of captive birds into the wild breeding population.

Plan:

9.1. *Experiment with different methods and timings of release of juveniles.*

Explanation

Restricting the human rearing contact to the time taken for chicks to fly could reduce taming. Housing next to family groups would allow these juveniles to hear parent alarm calls and experience behaviour of nearby stilts. One chick reared in 1988 in this way was very wary of humans and appeared "wilder" than a nearby parent-reared juvenile. Unfortunately the juvenile died before it could be released. Four black x 'node F' chicks were hand-reared in 1990/91 for release in the first trial of this technique. Research is planned to train the juveniles due for release in 1993 to recognise key predators.

9.2. *Monitor post-release survival. Investigate use of radio-telemetry. (See plan 5.4.).*

AIM 4: ESTABLISH A SELF-SUSTAINING POPULATION ON A PREDATOR-FREE ISLAND.

An assessment should be made of islands suitable for black stilt in the short-term. There are sufficient black stilts not contributing to the breeding population to supply founders for an island population. There may be advantages in using 'dark' hybrid stilts ('nodes F to I') to maximise the genetic variation available to the new population.

OBJECTIVE 10: Evaluate possible islands available for black stilt.

A preliminary assessment indicates the following islands may be priorities for consideration (B. D. Bell pers comm to R Pierce, DOC Northland 28/5/91):

1/ Pitt Island, Chathams

- pied stilts not present; weka and cats present.

2/ Main Chatham

- pied stilts present but not firmly established; cats, wekas, Norway and ship rats present.

3/ Great Barrier Island

- pied stilts present but not in great numbers; cats and rats present.

4/ Great Mercury Island

- privately owned; may not be sufficient suitable habitat; cats and ship rats present.

5/ Ruapuke

- Maori owned; may not be sufficient habitat; predators probably include cats and rats.

Further investigations are needed, including an assessment of the feasibility of predator eradications and possibly field visits, before a final recommendation can be made.

Target dates for completion

Habitat requirements defined and preliminary assessment of islands - January 1992; final assessment - January 1993.

OBJECTIVE 11: Undertake evaluation of methods for establishing an island population.

This evaluation should address means of minimising the risk of birds flying to the mainland. Incubating eggs and rearing chicks on site is one possible option.

Target date for completion - June 1993.

OBJECTIVE 12: Prepare a transfer proposal and, if accepted, carry out transfer.

The transfer guidelines for indigenous terrestrial fauna and flora produced by Protected Species Policy Division in 1990 provide a framework for assessing any transfer.

Target date for completion - 1995 (may depend on successful predator eradication programmes).

AIM 5: ENCOURAGE PUBLIC INTEREST IN AND SUPPORT FOR THE PROGRAMME THROUGH ADVOCACY AND EDUCATION.

The black stilt and its conservation have featured in several popular books and television documentaries and many New Zealanders may be aware of its existence. The difficulties of managing it on the mainland have been aired in popular articles, emphasising the problem of hybridisation with pied stilts. Advocacy on behalf of the recovery programme should emphasise the flexible and experimental approach being used to overcome several problems facing the species, of which hybridisation is just one. This approach involves careful integration of work in the wild and captivity. The public should be made aware of the progress that has been made, the population increase that has been associated with management. Publicity could be generated as a result of each breeding season so the public can share the 'ups' and 'downs' of the programme to better identify with it. Emphasis should be on factors people can relate to, eg the influence of a hard winter, major floods, the high or low rabbit population.

The target audiences for advocacy should be those with most potential influence over the programme. Local farmers and recreational users of riverbeds and wetlands would be two priority groups. Electricorp, local government planners and departmental managers would be others.

The black stilt should be used as a 'flagship' species to focus public interest on braided river and wetland habitats and the threats they face. Measures taken to conserve or improve these habitats for black stilt will benefit many other species of lower public profile.

OBJECTIVE 13: Increase the opportunities for the public to view black stilt in the wild together with supporting display material.

Plan:

- 13.1.** *Complete development of viewing hide and display room on existing captive management site, overlooking first breeding aviary.*

Explanation

A display room and adjacent hide for public and management viewing has been constructed on the terrace overlooking one of the breeding aviaries, in response to an increased demand to view black stilts. Small viewing aviaries nearby house birds for display. The project was funded by a \$112,000 NZTP CAPS Grant. Some displays still require completing and the site tidied.

Target date for completion - 1992.

- 13.2.** *Encourage public to view black stilts in a way that minimises disturbance to wild birds.*

Explanation

Because of the parlous state of the wild population, it may be necessary to attempt to restrict public access to view pairs during critical stages of the breeding season. People should be encouraged to view birds at the viewing hide (13.1. above). Requests by individuals or organisations to photograph or film nesting birds should be considered on their merits by the leader of the black stilt field programme. It is important that the reasons for any restrictions are fully explained to the public.

Target date for completion - ongoing.

- 13.3.** *Investigate potential sponsorship for a tourism/wetland development further down Ruataniwha Springs for public viewing of captive and wild black stilts.*

Explanation

This concept was developed by Boffa, Miskell and Partners, Christchurch as a more elaborate viewing and education centre than the present management site. It would look over the habitat created (Work Plan section 6.2.) and back to the aviary site. This development would require outside funding though DOC would need to retain some control over its operation, so that it could be closed to viewing for periods if required in the interests of the black stilt management programme. It would only be considered once the Ruataniwha habitat is fully developed and being used by black stilts.

Target date for completion - 1995.

- 13.4.** *Encourage active participation by schools - e.g. support of a black stilt nest or a captive bird.*

Target date for completion - ongoing.

13. CRITICAL PATH

The Critical Path outlines the relative effort to be put into each objective each season. However it should be treated as a guide only. The final programme will be based on recommendations made by the Recovery Group. The Group has recommended that in 1992/93 most eggs will be collected from the wild for captive rearing and release of juveniles (within Obj.7), leading to a reduced emphasis on egg manipulation and predator trapping (Objs. 1 & 2). It is assumed in the path below that this approach will be carried out every

second season, however it may be applied more frequently. This will depend on the results achieved which will be monitored within Objectives 5 and 9.

Objective	1992/93	1993/94	1994/95	1995/96	1996/97
1. Egg manipulation	----	██████	----	██████	----
2. Predator control	----	██████	----	██████	----
3. Research productivity	----	----	----	----	
4. Maximise breeders	██████	----	----		
5. Census/monitoring	██████	██████	----	----	----
6. Habitat management	██████	██████	██████	----	----
7. Captive management	██████	----	██████	----	██████
8. Research (captive)	----	----	----	----	----
9. Research (release)	----	██████	----	██████	----
10. Island evaluation	----	----			
11. Research (transfer)		----	----		
12. Island transfer				----	----
13. Public awareness	----	----	----	----	----

Key:

Level of effort: ---- Low ██████ High

14. RESEARCH PRIORITIES:

Research programmes are identified under several objectives within the critical path. The priorities recommended by the Recovery Group for 1992/93 are as follows:

Research impacts on predator regimes of different levels of rabbit abundance (Obj. 2.3).

Research methods of enhancing wetland habitats for black stilts (Obj. 6.1.) .

Research different captive rearing and release methods, including the training of birds to recognise predators (Obj. 5.4., 9.1).

Priorities in later seasons will be determined by the results to hand at that point.

15. STAFF RESOURCES AND COSTS

Three staff (2 salaried, 1 wage-worker) with a primary responsibility for black stilts are essential to the project throughout the year. One salaried staff heads the project and oversees breeding season management, general wildlife duties (water rights, habitat purchase (enhancement etc) during the entire year, supervision of new projects (eg. habitat development, fencing etc), writing of reports and information as requested from regional/head office.

A second salaried person is responsible for maintenance and development of the captive breeding facility, general duties, overseeing tourism activities and assisting with wild management throughout the year.

One full-time wage-worker monitors year-around survival and location of all wild black stilts, assisting with trapping, nest location and all other management activities in the breeding season, takes over salaried staff responsibilities when they are unavailable.

Two additional wage-workers are necessary during the breeding season, one largely to assist with predator trapping and general field management, and the other for the incubating and rearing facility.

Three vehicles are currently in use during the year by project staff. They travel up to 150 km each day during breeding season monitoring of nests. Vehicle running costs for this project total 8% of its operating budget, compared with a regional average of 5%. Two of these vehicles are 4-wheel drive, essential to completing field work through rivers, snow, riverbeds etc. In addition, 2 more vehicles are needed during the breeding season for seasonal wage-workers. To be useful to the project, each staff person must work independently. At least one of the 2 seasonal vehicle requirements could be a motorbike, for use with local trapping on the Ohau, lower Ahuriri. In some years where trapping is required in the Upper Ahuriri, Cass river etc, a truck would be more suitable. Vehicles should be replaced every three years.

A staff house is available in Twizel for accommodating seasonal staff, and a small building at the aviary site houses the aviculturalist in charge.

One part time or seasonal staff person is required to supervise public viewing of captive black stilts. This cannot be done using existing staff, except during winter and low demand periods outside of the breeding season.

Under the Electricorp contract the following additional staff will have direct or indirect involvement with the stilt programme:

- 1/ Wetland ecologist - carry out and supervise research programme
- 2/ Full-time technical assistant - assisting 1/.
- 3/ Two seasonal assistants - for seasonal surveys, monitoring, etc.

BUDGET - Capital and operating costs:

The following budget provides estimates of annual costs. It excludes the costs of the two salaried positions and defines no sum for habitat purchase or protection. The availability of important habitats for black stilt cannot be estimated from year to year but is dependent on landowners and other agencies.

Annual Costs:

Full-time wages:	\$27,000-33,000
Seasonal part-time wages:	\$20,000
General Operating:	\$40,000-50,000

Research:	\$50,000-100,000
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(Note: this plan identifies a number of research projects of varying priority (see comments under Critical Path). The operating costs of these depend on whether or not they are contracted to scientists outside the Department of Conservation. The sum outlined here would allow 2-3 full-time research programmes to be contracted out).

Captive breeding:

Per 3-flight aviary suitable for holding breeding pairs and juveniles for release - as those at

Twizel:	\$60,000
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Per aviary to house a single breeding pair:	\$25,000
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(Future expansion of the captive breeding population may depend on the support of New Zealand's zoos and wildlife parks.)

One-off Costs:

Replacement staff house at aviary site:	c\$200,000
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Landscaping at aviary/house site:	\$10,000
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Sealing of road to aviary:	\$12,000
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Survey of suitable islands:	\$2,000
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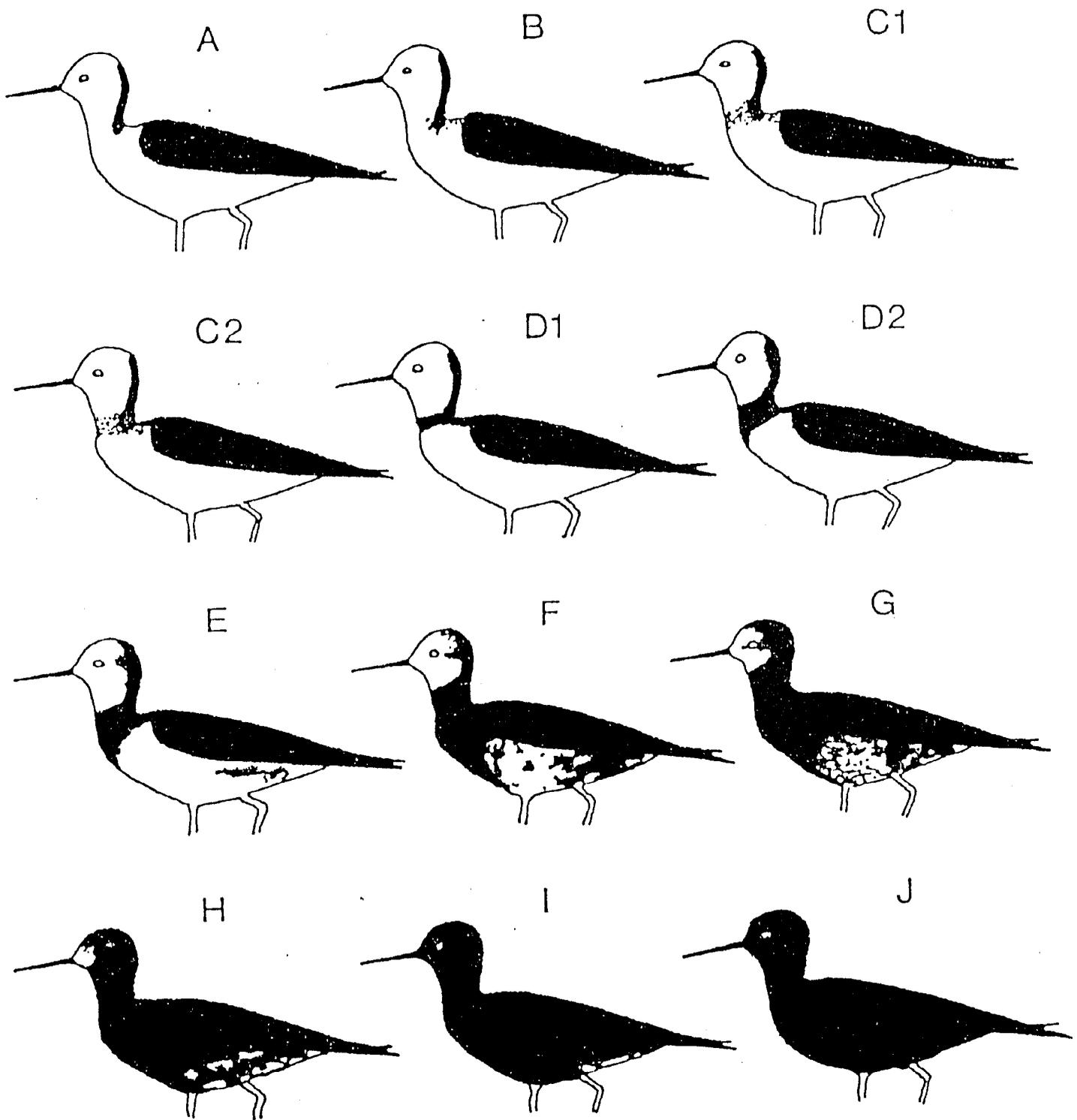
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APPENDIX ONE: PLUMAGES

Source: Pierce (1982b)



APPENDIX TWO: BAND RECOVERIES

TABLE 1: BAND RECOVERIES OUTSIDE THE MACKENZIE BASIN

BAND	DATE BANDED	PARENTS	DATE RECOVERED	PLACE
M-Y/W (node I)	late 1982	Pure? blacks	6.10.85 7.10.87 25.04.88	Rangitata Ashburton Kaipara
M-G/Y (node I) sibling to M-Y/W	late 1982	Pure? blacks	25.09.86 25.04.88	Ellesmere Kaipara
M - Y (black)	07.04.84	Node D x B	02.03.85	Hawera
R/G - (juvenile black)	18.11.86	Pure blacks	21.03.87	L.Ellesmere
R/W - (juvenile black)	18.11.86	Sibling to R/G -	21.03.87	L.Ellesmere
G - W (node I)	13.12.86 as an adult	Unknown 10.02.88	11.05.87 Ashley R. 02.05.88 27.05.88 12.07.89 06.05.90	Kawhia H. Kawhia H. Kawhia H. Kawhia H. Kawhia H.
W/B - W (black)	07.10.87 as an adult	Unknown	10.06.88	Wainono
W/G - W (juv black)	05.11.87	Black x G-W	10.02.88 27.05.88 09.05.89	Ashley R. Kawhia H. Kawhia H.
W/Y - W (juv black)	05.11.87	Black x G-W	10.02.88	Ashley R.
Y/R - W node H	08.12.87 as an adult	Unknown	27.05.88	Kawhia H.
Y/G - W node I	26.11.87	Unknown	27.05.88	Kawhia H.
R/B - W (juv)		G-W x M-B/W	12.07.89	Kawhia H.
Y/R - R (juv)		G-W X M-B/W	06.05.90	Kawhia H.
Y/G - R (juv)		G-W X M-B/W	06.05.90	Kawhia H.
R/R - W (node I) •		Unknown	19.07.90	Tauranga
W/W - G	09.11.90	Unknown	07.05.91	Kaipara H.

TABLE 2: BAND RECOVERIES (to April 1992) FOR BLACK STILTS FLEDGED IN THE MACKENZIE BASIN, 1981-1987 ACCORDING TO TYPE OF PARENT FOSTERED TO.

SURVIVAL	PARENT TYPE	
	Black x Black ^a	Hybrid Pair ^b
< 1 year	17	17
1-2 years	10	2
2-3 years	0	1
3-4 years	2	0
4-5 years	8	0
> 5 years	13	1
Total no. of chicks	50	21
No. re-sighted ^c	33	4
No. recruited to breeding population	5	1

a - Includes 1 non-migratory 'black x dark hybrid' pair

b - Black x pied, pied x pied, hybrid x pied, hybrid x hybrid, black x hybrid

c - Significantly more juveniles reared by 'black x black' pairs were re-sighted than those reared by hybrid pairs (Chi-square = 13.064, df = 1, p < 0.01).

APPENDIX THREE: BREEDING RESULTS.

NOTE: The increasingly complex interchanges of eggs and birds between the wild and captive populations mean that comparable data is only available for seasons from 1982 to 1990. For more recent data refer to section 4 or contact the authors at Twizel Field Centre.

**TABLE 1: BREEDING RESULTS 1982 TO 1990
MANAGED NESTS ONLY**

EGG PRODUCTION	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90
No.eggs from Mackenzie Basin	94	53	52	65	39	50	59	63
No.eggs from captivity	0	11	13	9	6	0	3	0
Total no.eggs artificially incubated	70	56	57	73	45	47	60	63
No.eggs left in the wild	24	8	8	1	0	3	2	0
No.eggs from predator exclosures	12	8	4	8	0	0	0	0
Total egg production	94	64	65	74	45	50	62	63
Number of eggs hatched	--	47	56	46	37	37	33	53
Hatching success of incubated eggs	51	77	84	63	82	79	53	84
Fertility of eggs incubated %	91	88	93	93	87	91	85	92
No. of breeding pairs managed	--	11	11	12	9	10	10	13
Number of pairs un-managed (found later in season with chicks)	--	0	0	0	1	1	2	1
Total number of breeding pairs	--	11	11	12	10	11	12	14

TABLE 1 (Copt.)

LOSS OF EGGS	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90
Infertile	6	7	4	5	6	4	9	5
Predated	12	4	0	1	0	3	1	0
Embryo died in incubation	--	--	--	16	0	4	13	4
Embryo died in hatching	--	2	2	6	0	2	5	1
Lost to human error	10	4	0	0	2+	0	0	0
Lost in blizzard	16	0	0	0	0	0	0	0
Unknown causes	9	0	3	0	0	0	0	0
Broken in nest	0	0	0	0	0	0	1	0
TOTAL EGG LOSS	53	17	9	28	8	13	29	10

+ one egg broken by incubator turning mechanism

CHICK PRODUCTION	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90
No. chicks produced from managed nests	37	47	56	46	38	37	33	40
No. chicks fledged from managed nests	18	27	15	21	16	13	10	10
No. chicks fledged from un-managed nests	0	0	0	0	1*	1*	3*	2
No. chicks captive reared	-	-	-	-	3#	3#	1#	16**
No. fledged and reared by blacks (managed nests)	6	9	8	17	15	11	8	10
No. fledged chicks reared by foster parents (1 being black)	3	7	5	3	1	2	2	0
(neither black)	--	12	2	0	0	0	0	0

TABLE 1 (Cont)

No. fledged and colour banded (managed nests)	10	18	11	12	13	10	10	10
% fledged chicks to eggs (managed nests)	20	42	23	28	40	26	16	32
% chicks fledged to chicks hatched (managed nests)	41	57	27	46	43	35	30	25

* 1988/89 3 fledglings produced from un-managed nests. All were reared by 2 black parents. One of the 3 was colour banded. Total fledglings in the wild 1988/89 = 13, 11 of which were banded.

* 1987/88 1 fledgling was located with an unknown pair at Ben Avon ponds, winter census 1988. Total fledglings in wild for 87/88 = 14.

1988/89 juvenile reared Twizel aviary, released into the wild.

1987/88 1 juvenile reared Twizel aviary, 2 reared NWC, all released

1986/87 3 juveniles reared NWC, all released

** 10 hand-reared, 6 parent-reared

LOSS OF CHICKS	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90
Probable predation	13	7	3	0	17	9	1	27
Snow/rain	2	0	1	0	0	1	0	0
Floods	2	1	15	0	0	13	0	3
During travel	0	0	6	0	1	0	0	0
Unknown causes	2	12	16	25	4	1	21	0
Incubator turner	0	0	0	0	0	0	1	0
TOTAL CHICK LOSS	19	20	41	25	22	24	23	30

TABLE 2: BAND RECOVERIES OF COLOUR BANDED BLACK STILTS

BREEDING SEASON	81/82	82/83	83/84	84/85	85/86	86/87	87/88	88/89	89/90
No. juveniles fledged	13	18	27	15	23	17	13	13	12
No. banded	6	10	20	11	12	13	10	11	10
No. alive at 6 months	3	4	6	0	11	10(*5)	5(*6)	6	8
No. alive at 12 months	3	4	6(*1)	0	10	9	4	6	n/a
No. alive at 18 months	2(*2)	4	3	0	10	8	4	6	n/a
No. alive at 24 months	2(*2)	4(*3)	2	1(*4)	9	7	4	n/a	n/a
No. recruited	0	2	1	0	1	0	(Not yet known)		

* 1 one not observed between banding and 2/3/85 (Hawea), not seen again
 one not observed between banding and 26/8/85 (Lake Poaka)
 two not observed between banding and 23/4/85 (Swan lagoon)
 one observed Spring/Summer 1985/86 only (Mackenzie Basin)

*2 one observed Spring 1982, 1983, 1984. Not known whether it spent winter in the Mackenzie Basin.

*3 one not observed between banding and 6/10/85 (Rangitata river)
 one not observed between banding and 26/10/84 (Ohau tarns)

*4 one not observed between banding and 25/9/86 (Lake Ellesmere)

*5 excluding one released from captivity Oct 87, alive March 89 aged 27 months

*6 excluding two released from captivity Oct 88, alive March 89 aged 15 months

**APPENDIX FOUR: FACTORS REDUCING PREDATION ON
GROUND-NESTING BIRDS (from Pierce 1987)**

PHYSICAL FACTORS

EFFECT

- | | |
|---|---|
| 1. River islands isolated by flows of about 3 + m ³ /sec | Barrier to adult ferrets and cats |
| 2. River islands or extensive flat shingle banks and fans lacking shrubs, trees, debris | Unattractive for hunting by ferrets and cats |
| 3. Lake islands as for 2. | Barrier and unattractive |
| 4. Nesting in mid-season (October-November) | Buffering by rabbits and other food, and before the dispersal of juvenile predators |

BIOLOGICAL FACTORS

- | | |
|--|--|
| 5. Factor 1 or 2 with no rabbits plus/minus lizards and large insects, but rabbits present on mainland. | Unattractive to ferrets and cats, but their presence on nearby mainland deters stoats on mainland and in 1,2 |
| 6. Factor 1 or 2 with no rabbits and no/few large insects and lizards | Unattractive to stoats regardless of ferret/cat status on nearby mainland |
| 7. Recovering or high populations of rabbits (as opposed to recently depleted rabbit populations) in the surrounding grassland | Ferrets and cats specialise on rabbits and deter stoats |