The Wrybill *Anarhynchus frontalis*: a brief review of status, threats and work in progress

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The Wrybill is a threatened plover endemic to New Zealand and unique in having a bill curved to the right. It is specialized for breeding on bare shingle in the braided riverbeds of Canterbury and Otago in the South Island. After breeding, almost the entire population migrates north and winters in the harbours around Auckland.

The species is classified as Vulnerable. Based on counts of wintering flocks, the population currently appears to number 4,500–5,000 individuals. However, counting problems mean that trends are difficult to determine.

The main threats to the Wrybill are believed to be predation on the breeding grounds, degradation of breeding habitat, and flooding of nests. In a recent study in the Mackenzie Basin, predation by introduced mammals (mainly stoats, cats and possibly ferrets) had a substantial impact on Wrybill survival and productivity. Prey-switching by predators following the introduction of rabbit haemorrhagic disease in 1997 probably increased predation rates on breeding waders. A recent study of stoats in the Tasman River showed that 11% of stoat dens examined contained Wrybill remains. Breeding habitat is being lost in some rivers and degraded in others, mainly by water abstraction and flow manipulation, invasion of weeds, and human recreational use. Flooding causes some loss of nests but is also beneficial, keeping nesting areas weed-free.

The breeding range of the species appears to be contracting and fragmenting, with the bulk of the population now breeding in three large catchments.

Research is currently being undertaken on longevity, survival to breeding age, and natal dispersal. Further data on these aspects are required to assist in modeling trends in the population. Nearly all of the recent demographic data have been collected in the Mackenzie Basin, where the population is almost certainly in decline. There is reason to believe that the data may not be typical, and demographic data are required from other parts of the breeding range.

INTRODUCTION

The Wrybill *Anarhynchus frontalis* is a small grey and white plover unique in the bird world, being the only species with a laterally curved bill. In breeding plumage, it shows slight sexual dimorphism—males have a narrow black frontal bar between the forehead and crown which the females lack (Marchant & Higgins 1993).

Wrybills are endemic to New Zealand, where they breed only on braided river systems east of the Southern Alps between 43 and 45°S (Marchant & Higgins 1993, Fig. 1). Braided rivers are rare globally, but are characteristic of South Island, New Zealand. They developed during glacial melt when vast water-flow carried gravels into the valleys. They consist of numerous linked channels spread across gravel-filled floodplains, often several km wide. Wrybills appear to be well adapted to breeding on the greywacke shingle of these riverbeds; eggs and chicks are highly cryptic, and incubating adults are secretive and well-camouflaged. The bill, the distal third of which curves to the right by 12–26° (Hay 1984), is used on the riverbeds to probe under stones for insects, particularly mayfly *Deleatidium* spp. larvae (Pierce 1979). On the mudflats of northern harbours it is effectively used in a "scything" motion (Turbott 1970). Largely because of its unusual bill, the Wrybill is currently placed in the monotypic genus *Anarhynchus* (Turbott 1990). However, other features of the skull are typical of *Charadrius* (Burton 1972), and Holdaway *et al.* (2001) have suggested that the Wrybill should be placed in that genus.

After breeding, most of the population migrates to the large harbours of the Auckland region in North Island (Sibson 1963), in particular the Manukau Harbour and Firth of Thames, which together appear to support about 85% of the population (Davies 1997, Sagar *et al.* 1999, Fig. 1). Individual adults tend to be faithful to a wintering site, but there are no apparent links between breeding and wintering areas (Hay 1984) About 90% of birds leave the North Island harbours in August and migrate south. Some non-breeding adults and first-year birds migrate south later (October–November) and a few (mostly first-year birds) remain in the northern harbours for the entire breeding season (Marchant & Higgins 1993).

The breeding biology of the species was studied in detail by Hay (1984), and further information on breeding ecology was provided by Hughey (1985a). Wrybills normally first breed at two years, but breeding in the first year has been

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recorded (Dowding *et al.* 1999). They nearly always breed as monogamous pairs in well-spaced territories (Hay 1984), and the laying season extends from late August to December. Replacement clutches are laid after loss and double-brooding occurs regularly – the number of pairs double-brooding varied from 11 to 32% during three consecutive seasons on the upper Rakaia River (Hay 1984). Birds begin leaving the breeding grounds from late December, and nearly all have left by early February.

Since 1979, the New Zealand Wader Study Group (NZWSG) has metal-banded more than 5,000 Wrybills on the wintering grounds, studying longevity, recruitment and movements, particularly within the Auckland region. Since 1987, a colour-banding study has been in progress, primarily in the Tasman and Tekapo Rivers of the Mackenzie Basin, central South Island.

In this paper, we briefly review current knowledge of the species and the threats it faces, report on some recent findings and research in progress, and identify areas of research that would assist with conservation of the Wrybill.

STATUS AND POPULATION

Status

The Wrybill (see Fig. 2) is classified as "Vulnerable" by BirdLife International (2000), and is considered threatened by habitat loss, invasive species, native species and human disturbance. In New Zealand, the Department of Conservation has recently ranked the species as "Nationally Vulnerable"; the two rankings are equivalent (Molloy *et al.* 2001).

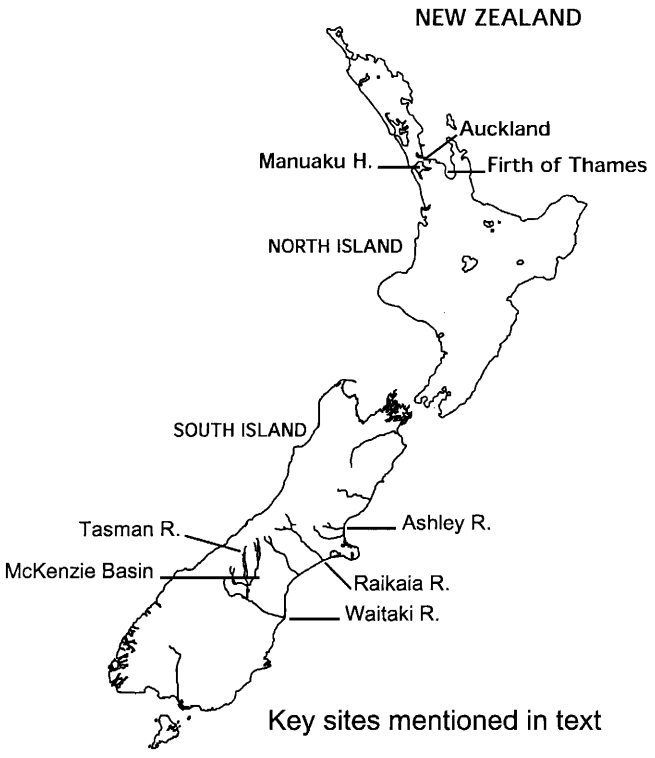

Fig. 1. Location map showing the main Wrybill breeding sites on the rivers of South Island, New Zealand, and the main wintering sites around Auckland on North Island.

Population size

During breeding, the population is widely and thinly spread on South Island riverbeds. Many areas are difficult of access, and the species is highly cryptic in this habitat. An accurate census under these conditions is virtually impossible. Population size has therefore been estimated by counting wintering flocks in the North Island harbours.

There are few quantitative data from before 1940; counts from the 1950s suggested a population of about 5,000 birds (Sibson 1963). Counts of Wrybills (and other waders) have been undertaken in the Manukau Harbour and Firth of Thames each winter since the early 1960s (Veitch & Habraken 1999). Combined totals for the two harbours averaged 3,770 during the 29 years, 1962–1990. On the basis that 85% of the population is found on these harbours (Sagar *et al.* 1999), the national population averaged about 4,500 over those years. The Ornithological Society of New Zealand (OSNZ) also conducted national wader counts between 1983 and 1994. These showed a wintering population ranging from a minimum of 2,807 in 1987 to a maximum of 4,418 in 1988. Based on these counts the population was estimated at 3880 (Sagar *et al.* 1999).

Because these estimates varied considerably, a national Wrybill census was undertaken in May 1994 (Riegen 1994). Winter Wrybill flocks are normally very dense and counting can be difficult. Flocks containing >300 birds were therefore photographed and counted from the photos. The census appeared to have had good coverage and resulted in a total count of 5,111 birds, of which 83% were in the Manukau Harbour and Firth of Thames (Davies 1997).

A second national census was undertaken in May 2001, when a count of 4,143 birds represented an apparent decline of 19% in seven years (Riegen & Dowding 2001). Because this was of considerable concern, a further count was undertaken in May 2002. This included flocks that together traditionally held about 95% of the population and resulted in a total of 4,650 and estimated population of about 4,900.

Some of the variation apparent in these counts may be due to annual differences in productivity, but sightings of colour-banded birds in the Auckland flocks also suggest that there may be considerably more local movement between roost sites in winter than previously thought (J.E. Dowding, unpubl. data). Auckland's location on a narrow isthmus, with harbours on both sides, may also create problems – high water differs by about three hours on the two coasts and at least two flocks are known to commute between the harbours, feeding on the falling tide on both (Dowding 2001).

Population trends

Because of the difficulty in obtaining accurate estimates of population size from the winter counts, it is clearly also difficult to detect overall trends. Veitch & Habraken (1999) noted that the Wrybill may be declining, but high variability in the counts they analysed for Manukau/Firth of Thames (a minimum of 2,120 in 1963 and a maximum of 7,807 in 1969) obscured any clear trend.

Nevertheless these counts (and the national Wrybill censuses) do suggest a change in winter-site allegiance in recent years, with numbers falling in the Firth of Thames and rising in the Manukau Harbour. The reason for this is not yet clear. There still appears to be abundant feeding habitat in the Firth of Thames (wintering Wrybills favour areas of soft wet

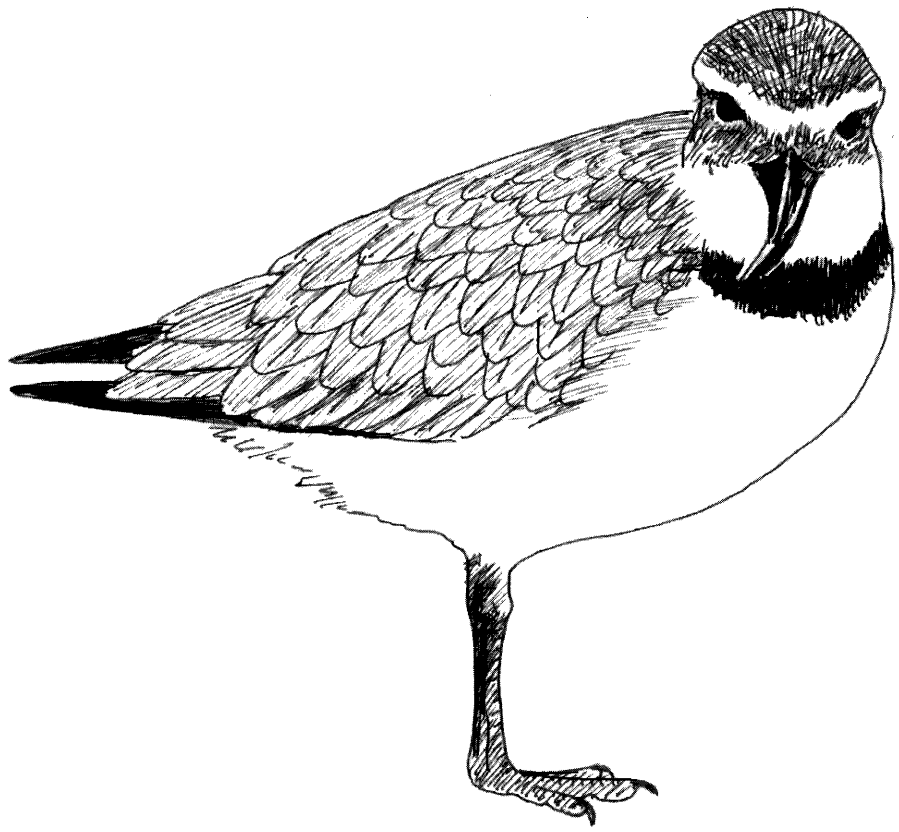

Fig. 2. The Wrybill *Anarhynchus frontalis*.

mud for foraging). However, one obvious change has been the spread of mangroves *Avicennia marina resinifera* (Veitch 1978), which are increasingly covering shell banks traditionally used as high water roosts by Wrybills and other waders.

Relatively little attention has been given to the threats facing the Wrybill on its wintering grounds. As noted above, there has been some loss of traditional roost sites in the Firth of Thames, but nothing is known of the possible impacts of such habitat degradation on Wrybills at the population level in the longer term. However, Auckland is the most densely populated part of the country, and there will inevitably be growing human pressure on local harbours from development, recreational use, and pollution from agricultural and industrial run-off. Mortality of Wrybills from collisions with power-lines and aircraft strikes has been recorded. While further work on these topics is clearly desirable, current knowledge suggests that the important and immediate threats to the species are on the breeding grounds.

THREATS TO THE BREEDING POPULATION

The main threats to Wrybills on the breeding grounds currently appear to be predation, degradation of riverbed habitat, and flooding. The relative importance of these factors almost certainly varies between and within rivers (Dowding & Murphy 2001).

Predation

New Zealand's endemic birds evolved in the absence of terrestrial mammals, and many of them (including the Wrybill) display features that render them vulnerable to introduced predators (Dowding & Murphy 2001). In particular, the Wrybill has a lowered reproductive rate; it lays only two eggs (the modal clutch for most *Charadrius* plovers is three or four), incubation and fledging times are extended, and reproductive maturity is delayed (two years instead of one). It is ground-nesting and may also be behaviourally naive towards mammalian predators—incubating birds perform distraction displays very close to human intruders near the nest, and will often return to the nest with a person only 3–4 m away.

In his 1975–77 study in the upper Rakaia River, Hay (1984) found little impact of predation on nest or chick survival. Over the three seasons, productivity averaged 0.79 chicks fledged per pair per season, and annual adult survival averaged 0.83 (Hay 1984). In contrast, the results of a study in the Tasman and Tekapo Rivers (Mackenzie Basin) from 1997–2000 suggested that predation did have an impact (Dowding & Murphy 2001). Productivity was much lower than in Hay's study. Adult survival was similar overall at 0.80, but there was a difference between areas with and without predator control, with adult survival significantly lower in the absence of control. Preliminary modelling of these data indicates that the Mackenzie Basin Wrybill population must be in decline (E.C. Murphy & J.E. Dowding, unpubl. data). A recent radio-telemetry study of stoats *Mustela erminea* in the Tasman River, Mackenzie Basin, has shown that they are an important predator of Wrybills and other waders. Of 128 stoat dens that contained identifiable prey remains, no fewer than 14 (11%) contained Wrybill remains (J.E. Dowding, E.C. Murphy & M.J. Elliott, unpubl. data). One of these dens, used by a female stoat, contained the remains of at least seven Wrybills.

One factor that may account for the differences between

the Mackenzie Basin study and that of Hay (1984) is an indirect effect of rabbit *Oryctolagus cuniculus* control (see Dowding & Murphy 2001). The arrival of rabbit haemorrhagic disease (RHD) in New Zealand in 1997 appears to have induced prey-switching by predators in the Mackenzie Basin, which was estimated to hold at least 15% of breeding Wrybill population (Maloney *et al.* 1997). With their primary prey (rabbits) much reduced, predators switched to eating more birds, lizards and invertebrates (Murphy *et al.* submitted).

In other parts of the Wrybill's breeding range, RHD has been less successful at reducing rabbit densities. Further insights into the impact of predation on the population as a whole is now likely to come from data on survival and productivity of birds outside the Mackenzie Basin, in areas where the potential impacts of prey-switching on Wrybills have not been studied. With the Mackenzie Basin population in decline, these data are now urgently needed.

Habitat degradation

Wrybills require large, bare areas of shingle on which to nest, with shallow riffles and backwaters nearby in which to feed (Hughey 1985a). Such areas are part of a dynamic, unstable system subject to regular flooding and to which the Wrybill is highly adapted (Robertson *et al.* 1984). Braided rivers are subject to a wide range of impacts, many of them human-induced, that can cause loss of these features.

Hydro-electric schemes, notably in the Mackenzie Basin, have flooded some Wrybill breeding habitat permanently (e.g. part of the Tasman River flooded by Lake Pukaki), and removed water almost entirely from other areas (e.g. Pukaki River). Releases of water may also change flow regimes suddenly and unnaturally.

Water abstraction for irrigation on the Canterbury Plains reduces the flow rates of many rivers, and may even cause total drying of some reaches (Cromarty & Scott 1996). At lower flow rates, predators have easier access to islands, gravel areas become less dynamic and weed growth is encouraged. Water quality has also been affected, mainly by agricultural discharge. Most of Canterbury's braided rivers are now highly modified by exotic weeds, notably gorse *Ulex europaeus*, Spanish broom *Cytisus scoparium*, willows (mainly *Salix fragilis*) and tree lupin *Lupinus arborea* (Cromarty & Scott 1996). Weed growth reduces nesting habitat, stabilizes islands and deepens channels, and provides cover for mammalian predators.

Recreational use of riverbeds by people may also reduce habitat quality in a number of ways. People, vehicles and dogs may crush nests or small chicks and disturb breeding and foraging birds; prolonged disturbance (e.g. by picnickers or anglers) may result in temporary abandonment of incubation and death of the eggs by chilling or over-heating. The wash from jet-boats may swamp low-lying nests or small chicks foraging at the water's edge.

While the impact of habitat degradation on total population size is not clear, there can be little doubt that it is causing changes in breeding distribution. Growth of weeds, water abstraction, the construction of flood-protection works and disturbance from recreational use have had their greatest impacts on the lower sections of Canterbury's larger rivers (Cromarty & Scott 1996). Outside the Mackenzie Basin, high densities of Wrybills are probably now present only on the upper reaches of the two or three largest river systems.

Flooding

The larger braided rivers are snow-fed, and peak flows occur in spring and early summer during breeding (e.g. Hughey 1985a). Flooding causes the loss of many Wrybill nests in some years, and was the major cause of breeding failure in Hay's (1984) study. However, the species appears to be adapted to flooding, with some pairs re-laying very quickly after loss (Hay 1984). Flooding also has a benefit – the scouring action of floods is important in maintaining weed-free nesting areas (Hughey 1985b). While flooding is a natural phenomenon, it should be remembered that losses to flooding are now additional to losses to predation and other causes.

Changes in breeding range

The breeding range of Wrybills has contracted southwards in the past century, with the species no longer breeding in Marlborough or northern Canterbury (see Dowding & Murphy 2001). There may have been some expansion to the south, but overall the breeding range appears to have contracted. The northern-most breeding site is now the Ashley River, but this population is small, with six pairs in the early 1980s (Hughey 1985a) and only three pairs in 2002 (J.E. Dowding, unpubl. data). Although Wrybills have been recorded breeding on many rivers in the past 30 years (e.g. Hay 1984, Marchant & Higgins 1993), anecdotal evidence suggests that most of the smaller, narrower rivers now have very few or no Wrybills, possibly because their flows have been reduced and they are now extensively invaded by weeds. It appears likely that the breeding range of the species is becoming increasingly reduced and fragmented, with the large majority of the population now confined to three areas – the rivers of the upper Waitaki (Mackenzie) Basin, the upper Rangitata and its tributaries, and the Rakaia and its tributaries. This distribution was already emerging during the 1970s (Bull *et al.* 1985), when the Rakaia appeared to be the only river with a sizable Wrybill population on its lower reaches. The OSNZ atlas project currently under way will provide a much-needed update on the breeding distribution of the Wrybill.

RESEARCH IN PROGRESS

Since 1979, the NZWSG has banded 5,014 Wrybills and retrapped 1,245 of them. Davies (1997) recorded the minimum ages of birds caught during 1987–1996 and found the oldest to be at least 16 years. Since 1996, six birds are known to have reached a minimum of 18 years (A.C. Riegen, unpubl. data). Further analysis of these data is in progress.

Data are being gathered on survival from fledging to one year of age, using birds colour-banded as juveniles in the Mackenzie Basin; preliminary results suggest that survival is not high, at about 0.45–0.50 (J.E. Dowding, E.C. Murphy & M.J. Elliott, unpubl. data). This is consistent with the suggestion of Davies (1997), based on the proportion of juveniles in winter flocks, that post-fledging survival may be low. Further data are required to assist with the modelling of population trends.

Preliminary results suggest that fidelity to natal site is high in Wrybills, with most young birds returning to breed on their natal river and within about 10 km of their natal site (J.E. Dowding, M.J. Elliott & E.C. Murphy, unpubl. data). Again, further data are required, but if this finding is con-

firmed there are obvious conservation implications – once the species is lost from a river (or possibly from one part of a larger river), it is less likely to re-colonise naturally. This process would inevitably lead to contraction and fragmentation of the breeding range.

RECOMMENDATIONS FOR FURTHER STUDY

If the long-term conservation management of the Wrybill is to be based on a sound footing, further research is required on both the breeding and wintering grounds. Estimating the size of the Wrybill population accurately and reproducibly from winter flocks has proved difficult, but it currently appears to be in the range 4,500–5,000 individuals. The absolute number of individuals is less important than the trend in the population. However, without an accurate and reproducible counting protocol, the determination of trends from winter counts is not possible. Counts of the main winter flocks should continue annually; further study of local movements around Auckland (using colour-banded birds) may assist in refining survey procedures.

Modelling demographic data to determine trends might prove invaluable, but, as noted above, there is reason to believe that survival and productivity in the Mackenzie Basin population – from which most recent data have been collected – may not be representative of the population as a whole. Detailed data should therefore be collected elsewhere, preferably in both the Rakaia and Rangitata Rivers, which together probably now hold a large majority of the breeding population outside the Mackenzie Basin. Further data are also required on survival from fledging to breeding age, and on natal-site fidelity and its implications.

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