# THE RELATIONSHIP BETWEEN RIVERBED FLOODING AND NON-BREEDING WRYBILLS ON NORTHERN FEEDING GROUNDS IN SUMMER

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ABSTRACT

I investigated the relationship between floods on the riverbed breeding grounds of Wrybills (*Anarhynchus frontalis*) and the number of Wrybills censused on northern harbours the following summer. For the purposes of the study I assumed that most birds oversummering on northern harbours are first-year non-breeders and that flood flows of the Rakaia River are representative of most other Wrybill breeding rivers. A highly significant negative correlation ($r^2=0.69$; $p<0.01$) existed for the 1968-1982 period. The study's findings provide some support for the observation that by the early 1960s the Wrybill population, after many years of growth, had begun to stabilise. Serious flooding in the 1982 and 1983 breeding seasons may have again destabilised the population structure.

## INTRODUCTION

Several bird species breed only on the braided rivers of the eastern South Island, and recently there has been considerable research into these birds' behavioural ecology (Lalas 1977, Pierce 1979, 1982, Hay 1984) and habitat needs (Robertson *et al.* 1983, Hughey, in prep.). As many of these rivers are subject to existing or planned hydroelectric or irrigation development, we need to know how well these birds cope with natural hazards before we can try to assess the impact of human intervention.

The endemic Wrybill (*Anarhynchus frontalis*) relies on the braided rivers of Canterbury and the MacKenzie Basin (Fig.1) for breeding. If these rivers go on being developed by man, the entire population of about 5000 (Hay 1984) will be at risk. Most of these rivers have their headwaters in the main divide of the Southern Alps. They are partly glacially fed but also receive westerly storms that cause large floods in most of the Wrybill's spring and early summer breeding seasons. Flows in these rivers are highly variable during the breeding season, when average discharges are greater than at other times of the year. In contrast, the smaller rivers such as the Ashburton and Ashley, which drain eastern foothill catchments, do not receive the full effects of these storms and so are characterised by declining flows during the breeding season (Fig.2).

Wrybills, like most other riverbed nesting birds, require large areas of bare shingle for their nesting. The actively changing riverbeds of most high-country catchments are largely free of vegetation, but the lowland sections

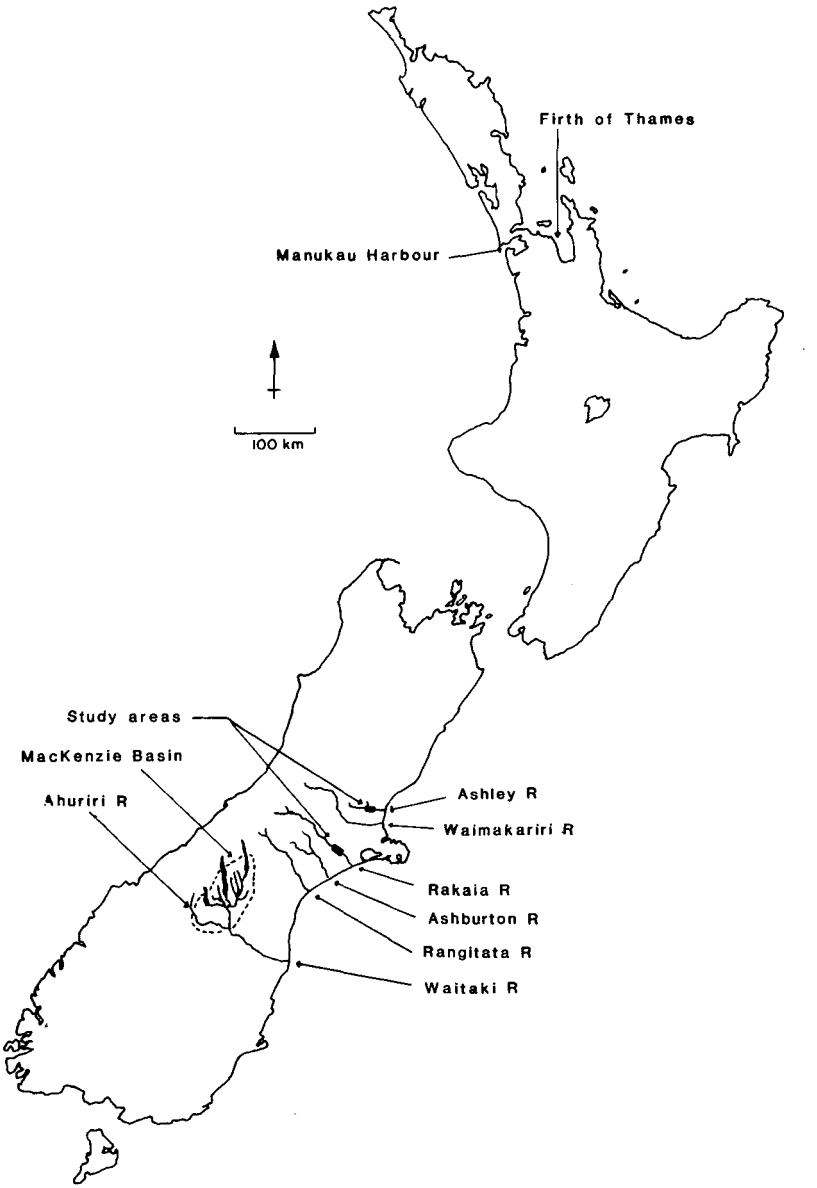


FIGURE 1 — Location map of the main Wrybill breeding areas (South Island) and winter feeding sites (North Island) discussed

of many rivers have been greatly modified by the invasion of exotic plants, including broom (*Cytisus scoparius*), gorse (*Ulex europaeus*), lupin (*Lupinus* spp.), and willow (*Salix* spp.). Stead (1932) thought that these modifications had reduced Wrybill numbers on the lower Rakaia River. However, the scouring action of floods helps maintain vegetation-free nesting areas.

The Rakaia River is the most important Wrybill river (O'Donnell & Moore 1983, Hughey, in prep.) with 1000-1500 breeding Wrybills (Cowie 1983). Only about 100 have been found on the whole Ahuriri River (Robertson *et al.* 1983), and similar numbers breed on several other MacKenzie Basin rivers (Pierce, pers. comm.). Although the Rangitata River has not been thoroughly surveyed, Wrybill numbers appear to be high on the upper reaches (Wragg, pers. comm).

Wrybills depend on aquatic and riparian habitats for their invertebrate food (Pierce 1979, Robertson *et al.* 1983) However, flooding causes a temporary but spectacular decline in available food (Pierce 1979, 1982, Sagar 1983), which affects breeding success (Hughey, in prep.). Furthermore, Hay (1984) considered floods to be the major cause of nest and egg losses. A flood on 7 December 1976 destroyed almost every Wrybill nest in his upper Rakaia study area. The peak instantaneous discharge (the absolute flood peak) on this date (2271 $m^3s^{-1}$) was slightly above the estimated bankful discharge (i.e. the flow equalling or exceeding the bank-to-bank capacity of the river) of 2200 $m^3s^{-1}$ (Hughey, in prep.) that is predicted to flood all riverbed nests.

After breeding, Wrybills migrate northward to wintering grounds, mostly in the northern half of the North Island. At two especially important areas, Manukau Harbour and the Firth of Thames, summer and winter counts of Wrybills have been made annually since 1961. After their late summer and winter stay on these northern places, most Wrybills migrate south for riverbed breeding. Hay (1984) found a mixture of first- and second-year birds, and even some adults, among remaining oversummering Wrybills. Proportions of each varied, but it seems likely that birds spending the summer on northern harbours are predominantly first-year non-breeders, although this has yet to be proven. If so, summer counts are likely to reflect the breeding success of the previous nesting season. The object of my study was to see if summer counts of non-breeding Wrybills and the flood regime of the previous breeding season were related.

## METHODS

I used the summer counts of Wrybills in the Manukau Harbour and the Firth of Thames, from the Ornithological Society of New Zealand records cited in O'Donnell & Moore (1983), and peak instantaneous flow data for the Rakaia and Ahuriri Rivers, from the Ministry of Works and Development. All the important Wrybill rivers, except the Ahuriri, have their headwaters within the 'Eastern Alps' hydrological region (Toebes & Palmer 1969). I therefore assumed that the flooding of these rivers would be similar in relative size, frequency, and timing. This assumption is supported by Waugh (pers. comm.), who found a generally good correlation between the Rangitata and Rakaia Rivers. Since the Rakaia is the most important Wrybill breeding river, I decided

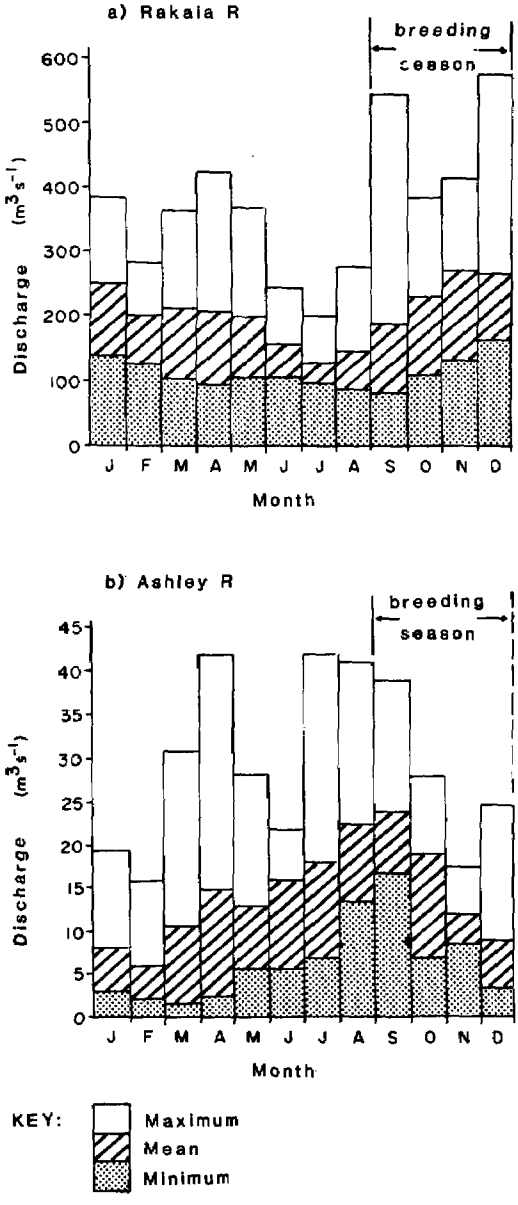


FIGURE 2 — *Annual variations in the flow regime of a mountain catchment river (the Rakaia) compared with a foothill catchment river (the Ashley)*

to use the flood flow data from this river as representative of all other major Wrybill rivers. To test this assumption I compared the flood regime of the Rakaia with that of the Ahuriri River by plotting the flows of both rivers for the 1980 season (Fig. 3). This comparison shows only minor variations in the pattern of flows. Using only Rakaia River flow data for the rest of this analysis is therefore reasonable.

I attempted to correlate summer counts of non-breeding Wrybills against the Rakaia River's peak instantaneous discharge of the previous breeding season. I selected the seasonal floods as follows:

1. I included floods that occurred only between 10 September and 10 November, when most first clutches are laid, incubated, and reared (Hay 1984, Hughey, in prep.).
2. If no medium to large floods ($> 700\ m^3s^{-1}$) occurred between 10 September and 10 November, I assumed that most breeding would be successful. To allow some margin for late-chick growth, I extended this period to 20 November. Moreover, because Hay (1984) found that only about 20% of pairs attempt to rear two broods and because I did not record any Wrybills trying to rear two broods, I omitted flood peaks after 20 November.
3. If large flood peaks occurred between 10 September and 10 November, I extended the period for flooding to 20 December to allow time for attempted renesting.

Although Wrybills have been counted in each summer since 1960, I included only the 1968-1982 counts in this analysis for the following reasons:

1. The Wrybill population on northern harbours is considered to have risen markedly from 1940 to the late 1950s or early 1960s (Sibson 1963).
2. The early 1960s seem to mark the beginning of a population plateau, perhaps because the population was nearing the capacity of its breeding habitat. The spread of Wrybills into Otago in the 1960s (Child 1971, 1973) seems to support this view.
3. After two years of non-breeding status, Wrybills have a breeding life of around five years (Hay 1984). If the population did reach the capacity of its breeding habitat in 1961, it would have taken until 1968 for each year class to adjust to this plateau level and for the age structure of the population to become stable.
4. When the population reached this stable structure, its migratory behaviour was also likely to stabilise within the limits of natural population fluctuations. We have to be confident that the annual migratory events were consistent before we can establish any long-term relationship between flooding and birds spending the whole summer on northern harbours.
5. 1982 and 1983 are the first years since 1966-1968 with summer counts in the north of fewer than 100 birds. The low numbers in 1982 and 1983 may be associated with a population decline caused by large and frequent flooding, which is supported by a low Wrybill fledging success rate on the Rakaia River for the 1982 season at least (Hughey, in prep.) Such a decline may change existing patterns of migration. Thus, the apparently stable population plateau in 1968-1982 is the best period to study.

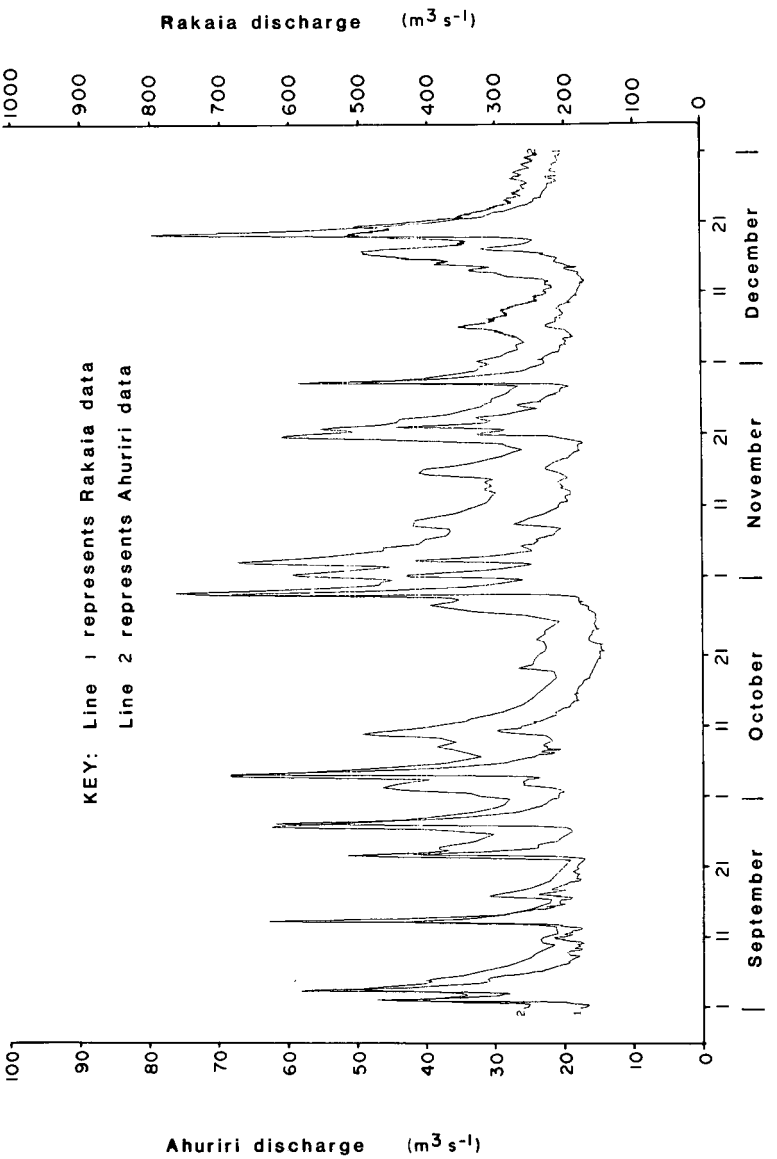


FIGURE 3 — Instantaneous discharges of the Ahuriri and Rakaia Rivers compared for the 1980 breeding season

## RESULTS AND DISCUSSION

I found a highly significant negative correlation ($r^2 = 0.69$; $p < 0.01$) between summer Wrybill counts on northern harbours and the peak instantaneous discharge for the Rakaia River from the previous breeding season (Fig. 4). As the Rakaia is representative of most other Wrybill breeding rivers, it appears that over the period 1968-1982, summer counts of Wrybills were high whenever only small floods had occurred in the previous breeding season but were low whenever large floods had occurred.

These findings provide important clues to population changes of Wrybills, but these clues can be misleading. With breeding success being inversely correlated with flooding, development projects such as damming or irrigation, which harvest or level out flood peaks, might be expected to improve Wrybill breeding success and so lead to a higher population. Certainly, on the Ashley River, where flows characteristically decline in late spring and summer, Wrybill breeding success was very high in 1983 (6 pairs produced at least 6 fledglings) whereas on the flood-dominated Rakaia it was very low (30 pairs produced 2 fledglings — Hughey, in prep.). Thus, development projects that stabilise flow might also be expected to lead to an increased number of Wrybills on the river.

Although floods do limit Wrybill breeding success, they also keep the river shingle free of vegetation, which Wrybills require for suitable nest sites. Without these floods, exotic vegetation would soon spread over many Wrybill habitats (Hughey, in prep.), jeopardising the survival of the species.

The bankful flow of the Rakaia (about 2200 $m^3s^{-1}$) occurs about once in every 2.2 breeding seasons (Hughey, in prep.). If this flow occurs between early September and early November, it destroys many first clutches. Furthermore, if these flows were to occur in several successive seasons and more than once each season, Wrybill numbers could be seriously reduced.

Wrybill rivers are, hydrologically, broadly classified into

1. Rivers with their sources in mountain catchments such as the Ahuriri, Rakaia, Rangitata and Waimakariri, which have high breeding-season flows and are where most Wrybills breed; and
2. The smaller and less braided rivers of the eastern foothills such as the Ashburton and Ashley, which have flows that decline during the breeding season and are where only a few Wrybills breed.

However, if conditions such as the Southern Oscillation which influenced the New Zealand climate in 1982, resulting in more westerly storms, were to continue for several years, conditions on rivers like the Rakaia might become marginal for Wrybills. In the meantime, flows in rivers like the Ashley seem to have remained suitable for successful breeding. Thus, concentrating conservation efforts only on rivers that at present support large numbers of Wrybills may not be wise. The habitats of secondary rivers should also be conserved.

An important assumption of this study relates to the age structure of the Wrybills that remain for the whole summer on northern harbours. Hay

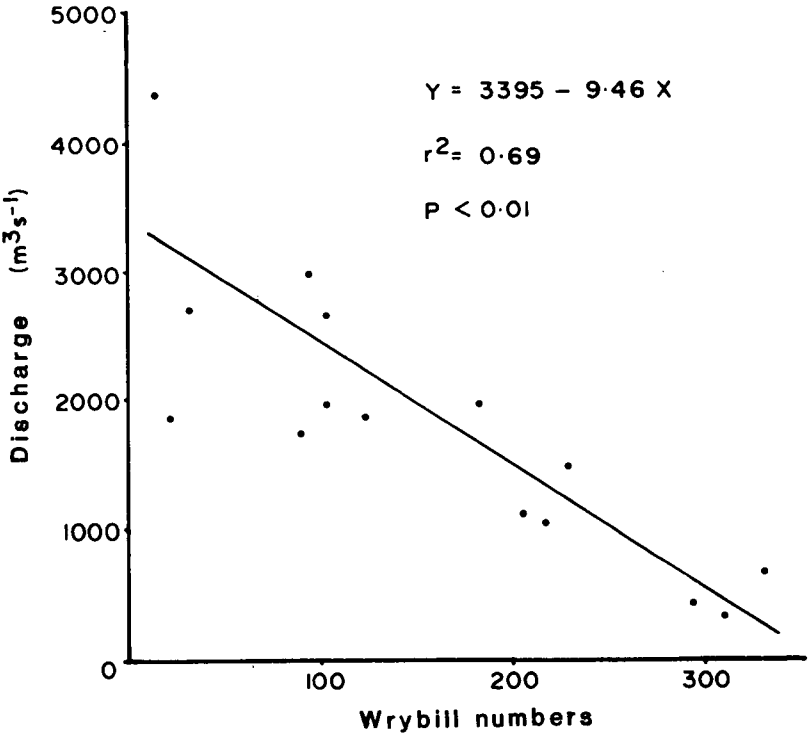


FIGURE 4 — The relationship of each summer count of Wrybills in the Manukau Harbour and the Firth of Thames to the peak instantaneous Rakaia River discharge of the previous breeding season (1968-1982)

(1983) found that about 90% of overwintering Wrybills leave the harbours for their South Island breeding grounds in August and that most of the rest leave later. This second departure appears to be of immature non-breeders, some of which return to their natal areas midway through the breeding season (Hay 1983). However, even after this second migration, some Wrybills remain on the northern harbours for the whole summer. In addition, Wrybills probably do not breed until their third year (Hay, pers. comm.). Therefore, the birds remaining in the north after the main migration are probably mostly first- and second-year non-breeders. It seems logical to expect that the secondary migration reported by Hay (1983) is mainly of second-year non-breeders, perhaps in association with a few first-year and adult birds, and that any birds staying in the north are mostly first-year birds. The high correlation between the numbers of Wrybills spending the summer on northern harbours and flood events from the previous breeding season supports this last suggestion. If the apparent relationship between flood events and birds summering in the north is true, summer counts may eventually be a useful warning of any population decline of Wrybills.

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