The diet of the Wrybill (*Anarhynchus frontalis*) and the Banded Dotterel (*Charadrius bicinctus*) on two braided rivers in Canterbury, New Zealand

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ABSTRACT

The diet of the Wrybill (*Anarhynchus frontalis*) and the Banded Dotterel (*Charadrius bicinctus*) was investigated on two New Zealand braided riverbeds using faecal analysis. There was high overlap in terms of taxonomic composition between the two species' diets, but large variability between individuals. Foods of aquatic and terrestrial (but near-aquatic) origin were consumed; mostly adult beetles (Coleoptera), bugs (Hemiptera) and flies (Diptera). Availability of these prey species relies on a suitable river flow regime.

KEYWORDS: Wrybill, Banded Dotterel, faecal analysis, diet

INTRODUCTION

Braided riverbeds of the eastern South Island of New Zealand provide a special habitat for birdlife. These wide (often ranging from 0.5-5 km), shingle substrate and multiple channel riverbeds are fragile environments. Their catchments are in the Southern Alps or foothills and often receive intense rainfall, resulting in large and destructive floods. The water is in demand for energy generation and for irrigating agricultural land.

The beds of these braided rivers are highly unstable. Water often flows in one or two major channels and several minor channels; the pattern of flow changes frequently. The temporary islands between these channels sometimes last only a few days and occasionally for many years. Recently formed islands have no vegetation, but older ones, especially on the lower sections of these rivers, are colonised by exotic plants, mainly lupins (*Lupinus* spp.), broom (*Cytisus scoparius)*, gorse (*Ulex europaeus)* and willow (*Salix* spp.). Rates of colonisation are much quicker than in some upper catchments where native prostrate mat and cushion plants are the early colonisers. Nest sites on the islands in the riverbeds are vulnerable because of variable river flows, encroachment by introduced plants, introduced mammalian predators, shingle extraction and recreational use.

A range of bird species uses this braided riverbed habitat, including two threatened species, the Wrybill (*Anarhynchus frontalis*) and the Black-fronted Tern (*Sterna albostriatus*), and the endangered Black Stilt (*Himantopus novaezelandiae*). These three species as well as the Pied Stilt (*Himantopus himantopus leucocephalus*) feed on invertebrates of aquatic and terrestrial origin (Lalas 1977, Pierce 1979,

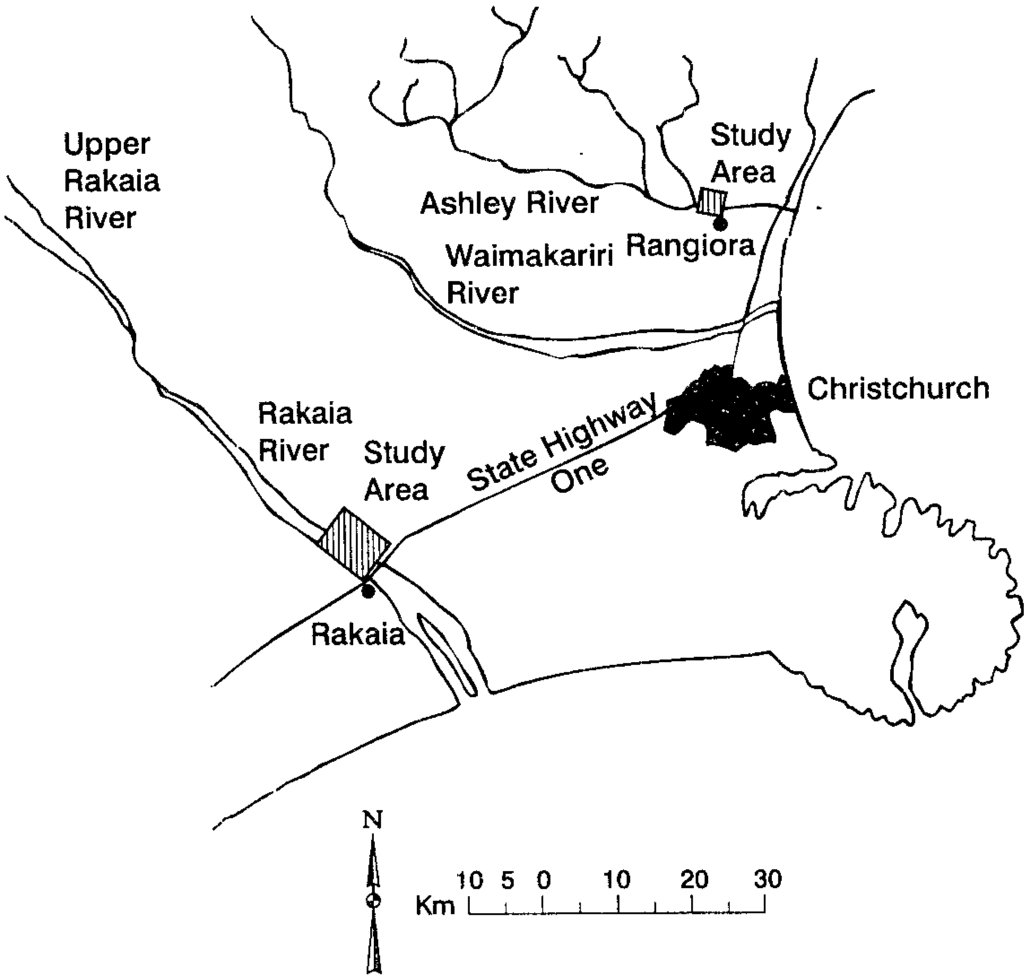

FIGURE 1 – Location of the two study areas.

1982). The Banded Dotterel (*Charadrius bicinctus*) also nests on braided riverbeds; it feeds on invertebrates and eats fruit (Bomford 1978, Stead 1932). Apart from direct observation of feeding, no quantitative analysis of the diet of these riverbed-nesting species has been published.

This paper examines the food of the Wrybill and the Banded Dotterel. The Wrybill was selected because it has been shown to be of use as an indicator species of habitat needs of other specialist riverbed bird species (Hughey 1985). The Banded Dotterel was selected because it is sympatric with the Wrybill on many braided rivers (O'Donnell & Moore 1983).

This work had two aims:

(i) to determine the food of the Wrybill and the Banded Dotterel during the breeding season;

(ii) to assess the extent of dietary overlap between Banded Dotterels on the Rakaia and Ashley Rivers and between Wrybills and Banded Dotterels on the Rakaia River.

STUDY AREA AND METHODS

The study was carried out on the Rakaia and Ashley Rivers. The Rakaia River is the most important Wrybill breeding habitat (O'Donnell & Moore 1983) containing more birds and habitat than any other river, with birds found along much of its length.

The Rakaia River (length = 140 km), with its headwaters in the Southern Alps, has a mean flow of 203 m^3s^{-1} (G. Horrell, pers. comm. 1995) and is up to 5 km wide in the lower Rakaia study area. The 10 km long study area (Fig. 1) contained about 30 pairs each of Wrybill and Banded Dotterel. The smaller Ashley River (length = 90 km), with its source in the foothills of the Southern Alps, has a mean flow of 13 m^3s^{-1} (G. Horrell, pers. comm.). Six pairs of Wrybill and 40-50 pairs of Banded Dotterel nested in the 5 km long and <1 km wide study area (Fig. 1).

During the 1982 and 1983 breeding seasons (September-December), faecal samples from adult Banded Dotterels and Wrybills were collected near nest sites during capture and colour-banding. This handling often resulted in the dropping of fresh faeces under the trap. Further samples were collected during feeding and time-budget observations. All samples were placed in labelled vials containing 70% alcohol. Twenty-three samples were collected from different Wrybills on the Rakaia, and three from Wrybills on the Ashley; 11 samples were collected from different Banded Dotterels on the Rakaia, and 14 from Banded Dotterels on the Ashley.

To assist with prey identification, all faecal remains were subdivided and mounted on microscope slides within lactaphenol medium. Each slide was examined under a binocular microscope. Most prey items were fragmented and/or partially digested, and were identified to the order level. For some prey, e.g., *Deleatidium* sp. larvae which have characteristic mouthparts, more exact identification was possible. Diagnostic features identifiable for most orders were: mandibles, elytra and femurs from beetles (Coleoptera); head capsules, wings and femurs from bugs (Hemiptera); wings from flies (Diptera), wasps (Hymenoptera), mayflies (Ephemeroptera), and stoneflies (Plecoptera); mandibles from the larvae of mayflies, stoneflies, beetles, and moths and butterflies (Lepidoptera); and legs of spiders (Arachnida), and moths and butterflies.

A reference collection established from pitfall trapping on the Rakaia and Ashley Rivers (Hughey 1985) assisted in the identification process. Final identification was confirmed by experienced entomologists.

Faecal remains were assessed by two methods:

(1) Per cent occurrence, calculated from the number of faecal droppings in which each food type was found;

(2) Per cent abundance, calculated from the numerical abundance of each food type, expressed as the total number of prey items, in each dropping. Diagnostic features for each taxonomic unit were used to determine total numbers in each dropping. For instance, beetle mandibles were paired to determine the number of beetles in each of the faeces. Where possible, mandibles of differing size and structure were separated because each represented a different species, and/or therefore another individual.

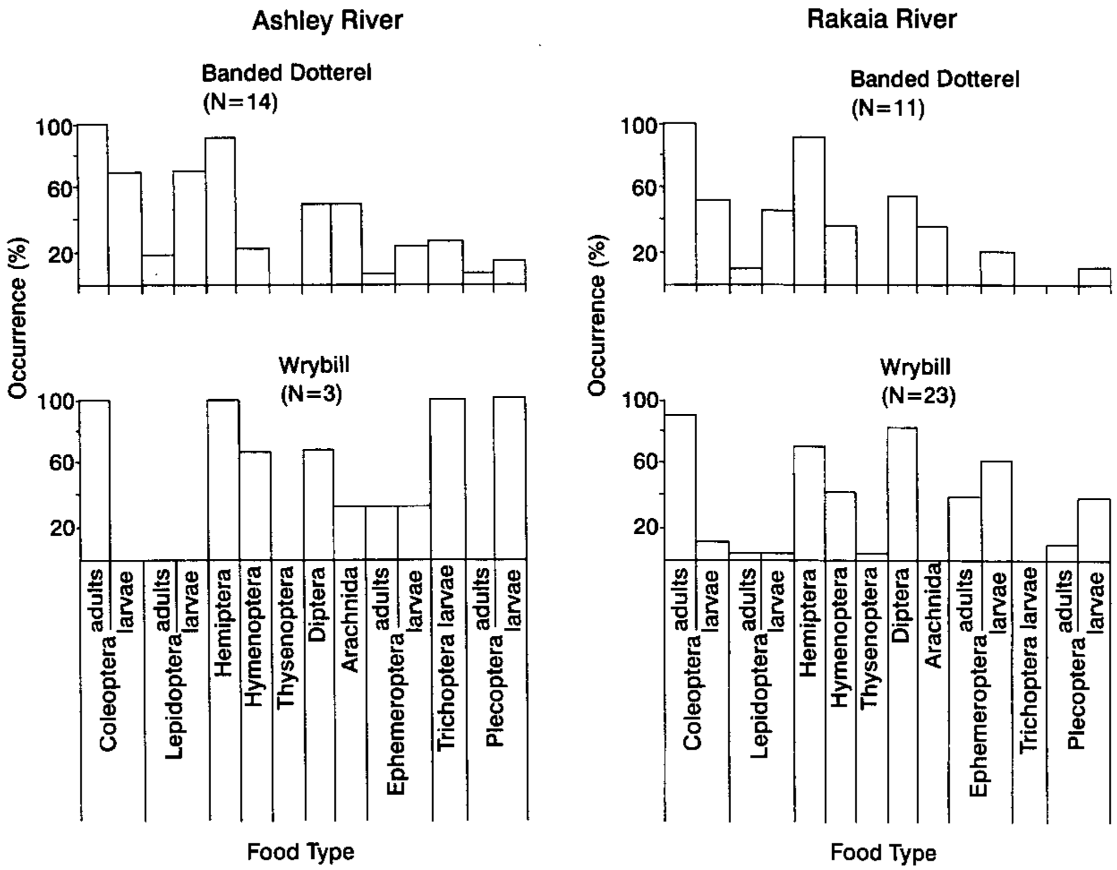

FIGURE 2 – Percent occurrence, by taxonomic unit, of animal remains (body parts identificiable to order level) in Wrybill and Banded Dotterel faeces from the Ashley and Rakaia Rivers.

The Sorensen Index (Sorensen 1948), based on the number of taxonomic units whether common or rare, was used to determine the extent of similarity between taxonomic composition of the samples. Smith (1986 cited in Spellerberg 1991) favoured it as a good binary indicator of community similarity. It is calculated by:

$$C = 2w/A+B$$

where C is the index of similarity, w is the number of units common to both samples and A is the number of units in sample one and B is the number of units in sample two (Spellerberg 1991). A zero value indicates complete dissimilarity between samples while a value of one indicates that the two samples are identical.

RESULTS

The results from the Wrybill and Banded Dotterel faecal analysis have been presented as summarised means for each sample (Table 1), percent occurrence (Figure 2) and percent abundance (Figure 3).

Numbers within each taxonomic unit recorded in the samples varied greatly, especially for the dominant terrestrial invertebrates. For example one Wrybill sample from the Rakaia contained the remains of 77 Hemiptera and a Banded Dotterel

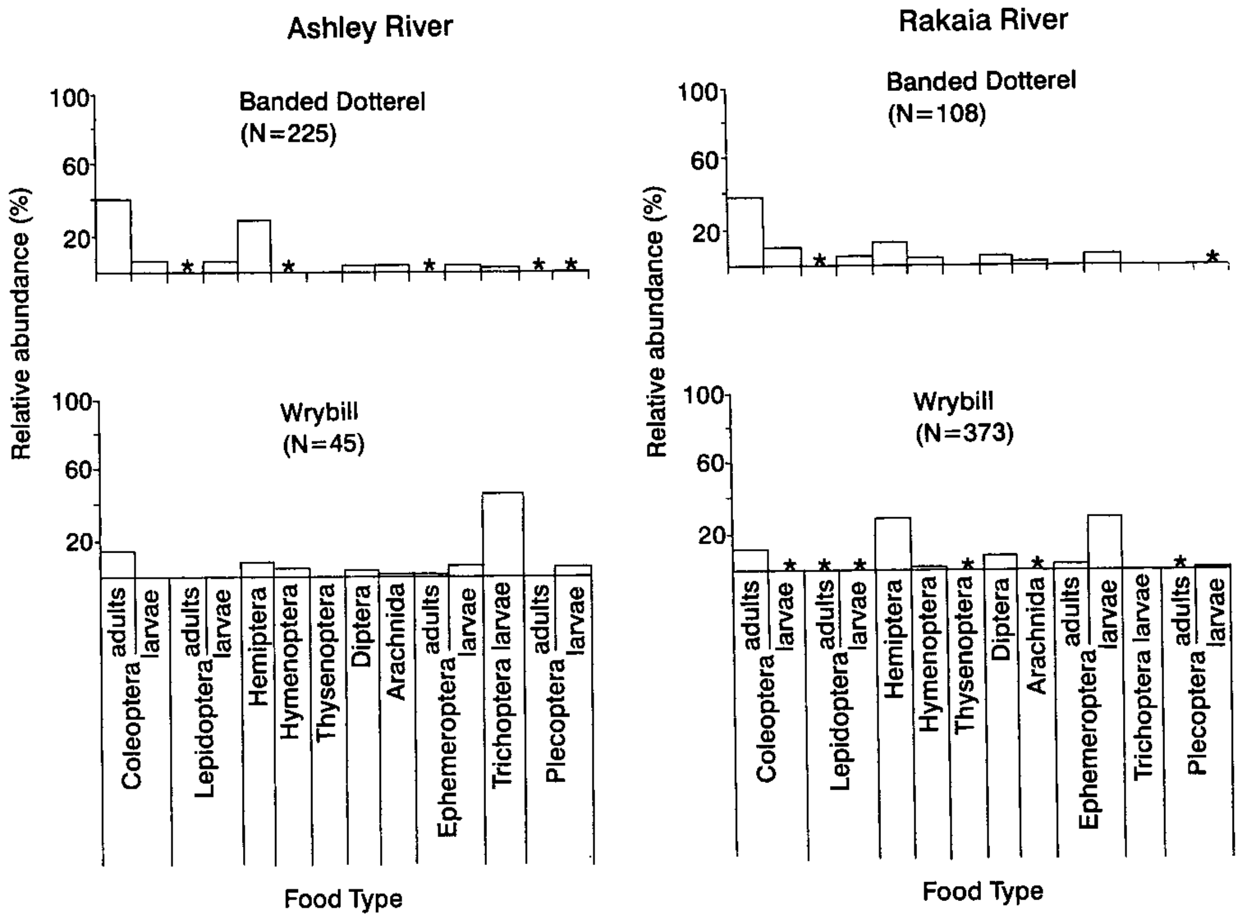

FIGURE 3 – Relative abundance, by taxonomic unit, of animal remains (body parts identificiable to order level) in Wrybill and Banded Dotterel faeces from the Ashley and Rakaia Rivers. * indicates occurrence < 2%.

sample from the Ashley contained 32. Most of the other samples contained only 1-2 Hemiptera. By contrast, beetles, which were also frequent dietary items, for both species, had highest counts of 6, 3 and 7, respectively, for Wrybills on the Rakaia and Ashley and Banded Dotterels on the Rakaia, although one Banded Dotterel sample from the Ashley contained 17 beetles.

Adult beetles, bugs and flies occurred in most of the Wrybill and Banded Dotterel faeces. Mouthparts of mayfly (*Deleatidium* sp.) larvae occurred in 60% of Wrybill faeces collected from the Rakaia River, but only in about 20% each of Wrybill and Banded Dotterel faeces collected from the Ashley River. All Wrybill faeces from the Ashley River contained caddisfly and stonefly larvae but no caddisfly larvae were recorded in Rakaia River samples.

In terms of relative abundance, adult beetles made up approximately 40% of the samples collected from Banded Dotterels but less than 15% of the Wrybill samples on both rivers. Bugs (Hemiptera) made up almost 30% of the Banded Dotterel samples on the Ashley River, and of the Wrybill samples on the Rakaia River, yet fewer than 20% of either species' on the other river. Mayfly larvae comprised over 30% of the Wrybill samples on the Rakaia River, whereas on the Ashley, caddisfly larvae made up approximately 50% of the samples.

TABLE 1 – Average numbers of each taxonomic unit identified in all faecal samples of Wrybills and Banded Dotterels collected on the Rakaia and Ashley Rivers.

		Wrybill				Banded Dotterel			
		Rakaia R.		Ashley R.		Rakaia R.		Ashley R.	
Taxonomic unit		Mean	Range	Mean	Range	Mean	Range	Mean	Range
Diptera		1.52	0 - 10	0.67	0 - 1	0.73	0 - 2	0.5	0 - 1
Coleoptera	Adult	2.09	0 - 6	2	1 - 3	3.91	1 - 7	6.5	2 - 17
	Larvae	0.22	0 - 2	0	0	1.09	0 - 6	0.71	0 - 1
Hemiptera		4.61	0 - 77	1.33	1 - 2	1.45	0 - 4	4.86	0 - 32
Lepidoptera	Adult	0.04	0 - 1	0	0	0.09	0 - 1	0.21	0 - 2
	Larvae	0.04	0 - 1	0	0	0.82	0 - 4	0.93	0 - 4
Hymenoptera		0.43	0 - 1	0.67	0 - 1	0.45	0 - 2	0.21	0 - 1
Thysanoptera		0.09	0 - 2	0	0	0	0	0	0
Arachnida		0.3	0 - 2	0.33	0 - 1	0.36	0 - 1	0.5	0 - 1
Ephemeroptera	Adult	0.78	0 - 6	0.33	0 - 1	0	0	0.07	0 - 1
	Larvae	5.22	0 - 21	1.33	0 - 4	0.82	0 - 8	0.71	0 - 5
Trichoptera		0	0	7.33	2 - 15	0	0	0.57	0 - 4
Pleco ptera	Adult	0.13	0 - 1	0	0	0	0	0.07	0 - 1
	Larvae	0.7	0 - 4	1	1	0.09	0 - 1	0.21	0 - 2
No. of faecal samples		23		3		11		14	

The Sorensen Index of similarity was 0.87 for Banded Dotterels between the two rivers and 0.96 for Wrybills and Banded Dotterels on the Rakaia River.

DISCUSSION

Pierce (1979) used direct observation and responses of birds to the experimental provision of different invertebrates to determine the food of Wrybill on the upper Rakaia. These methods gave an indication of general food preferences. Wrybills took a variety of prey from the diverse aquatic fauna which led Pierce (1979) to conclude that they were opportunistic feeders. Nevertheless on the basis of his experiments and direct observation he also concluded mayfly larvae appeared to be the staple diet of the Wrybill at each high country study area.

Wrybill faeces on the Rakaia River mostly contained remains of mayfly larvae (*Deleatidium* sp.) and bugs (Hemiptera). Other common insect orders were beetles (Coleoptera) and flies (Diptera). On the Ashley River, the presence of caddisflies, never recorded in faecal remains from the Rakaia, was notable. Caddisflies are almost totally absent from the main-river aquatic fauna on the Rakaia River (Sagar 1983).

The Wrybill's diet in this study was consistent with Pierce's (1979) conclusions that Wrybills are opportunistic feeders. This opportunism occurs within a narrowly defined range of preferred habitats, primarily within or near to shallow water edges (Hughey 1985).

Limited research and observation has been undertaken to determine the food of Banded Dotterel. Stead (1932) observed that on Canterbury riverbeds, Banded Dotterel consumed mainly fruits of *Coprosma petrei* and *Muehlenbeckia axillaris*.

The stomach contents of a five-week-old chick from the Cass River delta supported this conclusion (Bomford 1978). However, Bomford (1978) also recorded Banded Dotterel feeding in both aquatic and terrestrial habitats, with mayflies being eaten at the former. Although Bomford took aquatic and terrestrial invertebrate samples, she did not make any direct analysis of diet. Pierce (1976) observed Banded Dotterels feeding on moths, mayflies and cyclorrhaphan flies on the shingle banks of the upper Rakaia and Cass Rivers, concluding that the normal diet of Banded Dotterel was very similar to the terrestrial diet of Wrybill.

Based on the faecal samples, Coleoptera and Hemiptera may be the major part of Banded Dotterel diet on both the Ashley and Rakaia Rivers, while Diptera and Lepidoptera may be of less importance. The Banded Dotterel has a broader range of habitat preferences than the Wrybill. It feeds primarily within or at the water's edge, but also feeds on land (Hughey 1985). Pitfall trapping on both rivers indicated a wide range of prey species were available on land near the water edge (Hughey 1985).

This study was done at the lower sections of two braided rivers, which have a warmer climate than the mountain catchment areas of the previous dietary research undertaken by Bomford (1978) and Pierce (1979, 1982). My study areas also contained significantly different vegetation from theirs (see for example Balneaves & Hughey 1990). The beds of lowland braided rivers are either bare shingle, or areas of exotic and upright vegetation in various stages of succession. The upland sections of braided riverbeds are typically vegetated with prostrate cushion and mat-type vegetation (except where Russell lupin *L. polyphyllus* is invading). Some of this upland vegetation provides fruits and invertebrates not present on lowland braided riverbeds.

These differences in habitat may help explain the differences between the high degrees of similarity calculated for the Sorenson Index and the great differences in prey abundance shown in Table 1 and Fig. 3. The Sorenson Index is based only on species (taxonomic unit) presence or absence in the diet. With both Wrybills and Banded Dotterels being opportunistic feeders this high degree of similarity is expected. However, the index would probably be lower if applied in upper catchments where different habitats and different food items are available. By contrast the means and ranges shown in Table 1 and variations demonstrated in Fig. 3 indicate there is only moderate to low similarity in terms of the proportions of each prey species (taxonomic unit) found within the total faecal sample composition. This finding, however, is to be expected for these two species in the two lowland study areas. Hughey (1985) showed that while there is a high degree of similarity in microhabitats used, Banded Dotterels spend significantly more time feeding on land than do Wrybills. This finding is supported by Table 1 and Fig. 3: beetles of terrestrial origin were a greater proportion of the Banded Dotterel faeces on both rivers, whereas Wrybills on both rivers had a higher proportion of food growing in aquatic habitats, e.g. mayflies.

Evaluation of the relative abundance of different food types in the total diet shows that Pierce's (1979) results on the upper Rakaia are not universally applicable to Wrybill habitats. Pierce (1979) concluded that although opportunistic, mayfly larvae appeared to be the staple diet of Wrybill on the Rakaia River. Others, including O'Donnell & Moore (1983) and Sagar (1983), have adopted this conclusion for other rivers and sections of rivers. Although mayfly larvae was the dominant single food, the relative contribution to the total diet was only about 30% on the Rakaia River, and 10% on the Ashley River.

Both the Wrybill and the Banded Dotterel are opportunistic feeders, relying heavily on invertebrates of aquatic and near-aquatic sources. The Wrybill, as well as the Black-fronted Tern and Black Stilt, are considered threatened or endangered species. Consequently, in terms of feeding, habitat management needs to focus on sustaining a flow regime in these rivers which will provide these sources of food. Hughey (1985), Hughey, Fraser & Hudson (1989) and Hughey & Duncan (unpubl. manuscript) report separately on these flow requirements for bird feeding, while Sagar (1986) has considered habitat requirements for aquatic invertebrates.

The relationship between the habitat preferences of Wrybills and various river flows was modelled (Hughey 1985, Hughey & Duncan, unpubl. manuscript) in order to make recommendations about flow regime management for the Rakaia River. They concluded, in relation to feeding habitat requirements alone, that on large rivers like the Rakaia, reduced flows which still retained the total number of channels in any one cross section would not be detrimental to the Wrybill or other opportunistic feeders. This study which confirms the reliance of Wrybills and Banded Dotterels on foods of aquatic and near-aquatic origin, support this other work. Together this work may help provide for the conservation management of these and other bird species on braided riverbeds.

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LITERATURE CITED

BALNEAVES, J.M.; HUGHEY, K.F.D. 1990. The need for control of exotic weeds in braided river beds for conservation of wildlife. pp103-108. Proc. 9th Australian Weeds. Adelaide, South Australia.

BOMFORD, M. 1978. The behaviour of the Banded Dotterel, *Charadrius bicinctus*. Unpublished MSc Thesis, University of Otago, Dunedin:

HUGHEY, K.F.D. 1985. Hydrological factors influencing the ecology of riverbed breeding birds on the plains' reaches of Canterbury's braided rivers. Unpublished PhD Thesis, University of Canterbury, Christchurch.

HUGHEY, K.F.D.; FRASER, B; HUDSON, L.G. 1989. Aquatic invertebrates in two Canterbury rivers - related to bird feeding and water development impacts. Science and Research Series No.12. Department of Conservation, Wellington.

LALAS, C. 1977. Food and feeding behaviour of the black-fronted tern, *Chlidonias hybrida albostriatus*. Unpublished MSc Thesis, University of Otago, Dunedin:

O'DONNELL, C.F.J.; MOORE, S.M. 1983. The wildlife and conservation of braided river systems in Canterbury. Fauna Survey Unit Report 33. New Zealand Wildlife Service, Department of Internal Affairs, Wellington.

PIERCE, R.J. 1976. The feeding ecology of Wrybills in Canterbury. Unpublished Dip. Sci. Thesis, University of Otago, Dunedin.

PIERCE, R.J. 1979. Foods and feeding of the Wrybill (*Anarhynchus frontalis*) on its riverbed breeding grounds. Notornis 26: 1-21.

PIERCE, R.J. 1982. A comparative ecological study of pied and black stilts in South Canterbury. Unpublished PhD Thesis, University of Otago, Dunedin.

SAGAR, P.M. 1983. Benthic invertebrates of the Rakaia river. Fisheries Environmental Report No. 36. Ministry of Agriculture and Fisheries, Christchurch.

SAGAR, P.M. 1986. The effects of floods on the invertebrate fauna of a large, unstable braided river. N.Z. J. Marine Freshw. Res. 17: 377-386.

SMITH, B. 1986. Evaluation of different similarity indices applied to data from the Rothamsted Insect Survey. Unpublished M.Sc. Thesis, University of York.

SORENSEN, T.A. 1948. A method of establishing groups of equal amplitude in plant sociology based on similarity of species content, and its application to analyses of the vegetation on Danish commons. K. dan. Vidensk. Selsk. Biol. Skr. 5:1-34.

SPELLERBERG, I.F. 1991: Monitoring ecological change. Cambridge Univ. Press, Cambridge.

STEAD, E.F. 1932. The life histories of New Zealand birds. Search, London.

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