Aquatic Birds of the Waiau River November 1993 and March 1994

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prepared for Southland Regional Council

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EXECUTIVE SUMMARY

The purpose of this study was to determine the aquatic bird populations of the Waiau River between the Mararoa weir and the sea to:

- assess the habitat requirements of target species - Pied Oystercatcher, Pied Stilt, Banded Dotterel, Black-fronted Dotterel, Black-billed gull, Black-fronted Tern, White-fronted Tern;
- assess how the distribution and abundance of the target species may have been affected by hydro electric power development;
- determine the flow requirements necessary to maintain habitats for aquatic birds.

Three unconfined reaches were surveyed twice, during the breeding and post-breeding seasons. The most upstream reach, in the Redcliff area, supported the fewest birds. This was probably the result of the predominantly large substrates which do not provide suitable habitat for breeding and feeding.

The Clifden-Wairaki reach provided large areas of suitable feeding and breeding habitat for all the target species, and with the exception of Black-fronted Dotterels, this was reflected in the numbers recorded of each species. As expected, the lagoon and lower river supported the greatest abundance and diversity of birds, with coastal and freshwater species represented. Large colonies of breeding Black-backed Gull, Black-billed Gull and White-fronted Tern occurred in this area, as well as a large roost of the marine Spotted Shag. However, with the exception of Black-billed Gull and White-fronted Tern few target species were recorded in this downstream area, primarily because vegetation had encroached on suitable habitats. Reduced flows as a result of hydro electric power development have probably increased the amount of habitat available for the feeding and breeding of the target species. However, some of this perceived benefit is probably offset by greater access to breeding colonies by mammalian predators and further encroachment of vegetation in the floodplain.

Increasing the residual flow by 10-20 m^3/s would probably isolate breeding colonies from predators, but only major floods would remove the encroaching vegetation.

INTRODUCTION

Until 1970 the flow of the Waiau River was uncontrolled, and some 450 m^3/s flowed from Lake Manapouri to the sea near Tuatapere. In 1970, hydro electric power development resulted in the construction of a rock weir which diverted most of the river's flow through the Manapouri Power Station, to discharge into Doubtful Sound. The Mararoa Weir came into operation in November 1976 and this diverted all but about 0.29 m^3/s of the flows of the Mararoa and Waiau Rivers.

The Waiau Working party recognised that hydro electric power development may have affected the distribution and abundance of aquatic bird populations on the river. However, a review of historical information about the birds of the Waiau River (Chisholm 1992)

concluded that there was little baseline information available for assessing the impacts of power development.

Consequently, the Waiau Working party set out to determine what bird populations are currently dependent upon the river and its associated riparian habitats. Pied Oystercatcher, Pied Stilt, Banded Dotterel, Black-fronted Dotterel, Black-billed Gull, Black-fronted Tern, and White-fronted Tern were identified as target species to survey; being the more specialised river species likely to occur in sufficient numbers.

The purpose of this study is to investigate the aquatic birds which occur on the Waiau River and to assess the likely effects of altered flow regime due to hydro electric power development. The study involved:

- surveying during the breeding and non-breeding seasons along three unconfined reaches of the Waiau River between the Mararoa Weir and the sea;
- assessing the habitat requirements of target species;
- assessing how the distribution and abundance of the target species may have been affected by hydro electric power development;
- determining flow requirements for the maintenance of habitats for aquatic birds.

SELECTION OF REACHES

Three reaches were selected between the Mararoa Weir and river mouth (Fig. 1). These were selected on the basis that they were relatively unconfined, so had wide floodplains, which previous studies have shown to support the greatest numbers of riverine bird species. The most upstream reach extended for 10.3 km from just below Whare Creek to about 3 km below where Redcliff Creek joins the Waiau River; this is referred to as the Redcliff reach. The second reach was divided into two sections, the first section extending 1.5 km downstream from where Wairaki Creek joins the Waiau, and the second extending 5.3 km upstream from the Clifden Bridge; this is referred to as the Wairaki and Clifden reach. The third reach comprised the lagoon (6.5 km long), plus 2.0 km of river immediately upstream; this is referred to as the Lagoon and lower river reach.

The Redcliff reach was surveyed on 23 November 1993 and 8 March 1994. This reach varies from a single channel immediately downstream of the Whare Creek confluence to three of four channels at the downstream end. Substrates are predominantly boulders upstream of the confluence with Redcliff Creek; downstream, small cobbles and gravel predominate. The flow becomes more freely migrating at the downstream end of the reach, with vegetation-free bars.

The Clifden and Wairaki reach was surveyed on 24 November 1993 and 9 March 1994. This reach varies from a single reach to three or four active channels adjacent to the Lill

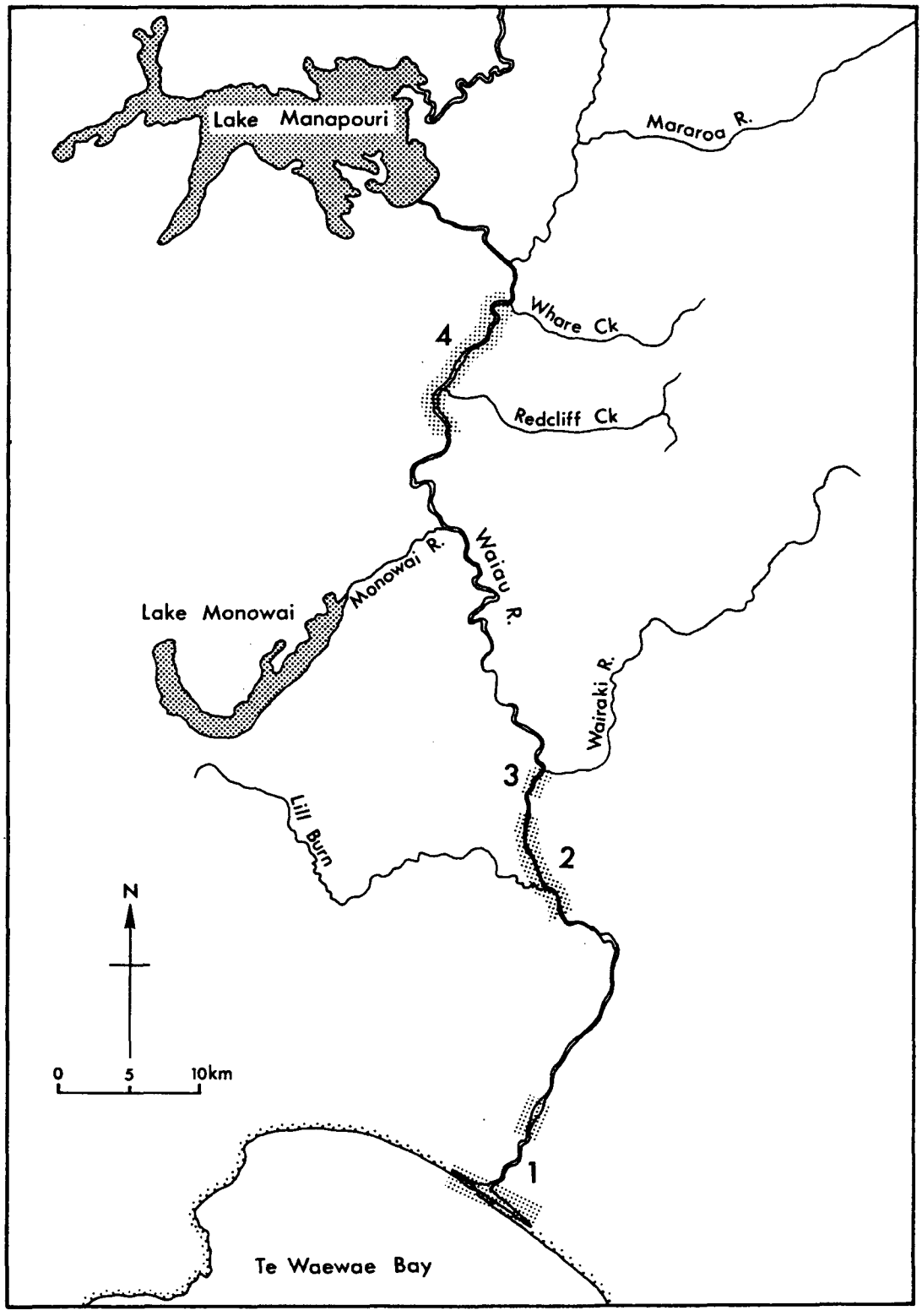


FIGURE 1. Location of reaches in the Waiau River surveyed for birds. 1. Lagoon and lower river reach; 2. Clifden section; 3. Wairaki section; 4. Redcliffreach.

Burn. Substrates vary from predominantly cobbles to gravels and sand. There are extensive alluvial flats, which indicate the lateral instability of the channels.

The Lagoon and lower river were surveyed on 22 November 1993 and 7 March 1994. Large cobbles predominate in the steep bar which separates the lagoon from the sea. Inland, the eastern and western ends of the lagoon are confined by steep terraces, however, shallow muddy backwaters occur elsewhere. The lower river comprises three or four channels which meander across broad, vegetation-covered alluvial flats.

METHODS

For each section of river, one or two observers walked downstream and counted aquatic birds as they passed them. Where the riverbed was broad, the observers were spaced 100-200 m apart. Channels were crossed so that mid-channel islands could be surveyed. Every effort was made to avoid counting birds more than once; for example, birds which moved downstream after being counted were subtracted from the total. Birds which flew high over the river were not counted, but birds in flight which were obviously searching for food from the river or floodplain were counted (this is especially relevant for terns). Because of their length, each reach was walked on successive days. However, as reaches were several kilometres apart it was assumed that there was negligible movement of birds from one reach to the next.

Bird totals in Table 1 should be considered as indices of the relative abundance of species rather than absolute counts. Although all species were counted with reasonable accuracy, some species are more cryptic than others. Banded Dotterels were the most difficult to count because they blended well with the riverbed habitat and did not call as much as other species when disturbed.

The habitat and behaviour of each bird counted were also recorded. Although habitat and behaviour were described only in general terms this information enables some comment to be made about which parts of the river each species uses, and what they use them for. A comprehensive study of habitat use by birds on the Waiau River was outside the scope of this investigation.

RESULTS

General distribution and abundance

A systematic list of the birds counted (Table 1) shows that the lagoon and lower river supported the greatest numbers and species during both the breeding and non-breeding seasons. Also, in both seasons there was a trend for fewer birds and species to occur with increasing distance upstream. During the breeding season 7795 birds/10 ha reach surveyed of 17 species were recorded in the lagoon and lower river, 5284 birds/10 ha of 12 species in the Clifden and Wairaki reach, and 776 birds/10 km of 13 species in the Redcliff reach. In the non-breeding season the corresponding figures were 1036 birds/10 km of 13 species,

165 of 8, and 126 of 7 respectively. Therefore more birds and species were present during the breeding season than in the non-breeding season.

TABLE 1. Numbers of aquatic birds counted on three reaches of the Waiau River, 22-24 November 1993 and 7-9 March 1994.

	Lagoon and lower river		Clifden and Wairaki		Redcliffs	
Distance covered (km)	8.5		6.8		10.3	
Species	22.11.93	07.03.94	24.11.93	09.03.94	23.11.93	08.03.94
Black Shag	7	9	1	21	9	2
Little Shag	9	3	-	1	3	1
Spotted Shag	330	650	-	-	-	-
White-faced Heron	5	1	2	-	2	1
Black Swan	-	6	-	-	-	-
Canada Goose	-	-	-	-	2	28
Paradise Shelduck	1	-	97	41	50	51
Mallard/Grey Duck	71	167	41	14	6	48
Grey Teal	2	4	-	-	3	-
Shoveler	4	4	4	-	-	-
Scaup	-	1	-	-	-	-
Pukeko	1	2	-	-	-	-
Pied Oystercatcher	8	-	21	-	3	-
Variable Oystercatcher	1	-	-	-	-	-
Pied Stilt	18	-	14	-	4	-
Banded Dotterel	-	-	29	-	-	-
Spur-winged Plover	147	-	21	24	2	1
Bar-tailed Godwit	12	-	-	-	-	-
Black-backed Gull	606	22	16	8	58	-
Red-billed Gull	-	8	-	-	-	-
Black-billed Gull 72%	4754	-	3319	-	658	-
Black-fronted Tern	-	-	34	1	5	-
Caspian Tern	-	-	-	2	-	-
White-fronted Tern	650	4	-	-	-	-
	6626	881	3599	112	805	132 = 12155

Spotted Shag, Black Swan, Scaup, Pukeko, Variable Oystercatcher, Bar-tailed Godwit, Red-billed Gull, and White-fronted Tern were recorded only in the lagoon and lower river. Banded Dotterel and Caspian Tern were found only in the Clifden-Wairaki reach section, and Canada Goose only from the Redcliff reach.

The following is a systematic list of the aquatic birds recorded during the two surveys of the Waiau River; information about their distribution and numbers on the river, habitat and food requirements, and for the targeted species breeding season is also included.

Black Shag *Phalacrocorax carbo*

Widespread, occurring in all reaches, but never abundant. Single birds flushed from slow-flowing stretches of river usually recorded. Largest group seen was nine birds feeding in a broad run of the Clifden reach in March.

Prefers terrestrial wetlands and coastal waters, particularly deep lakes and major rivers. Unaffected by fluctuations in turbidity (Fjeldsa 1985). Feeds predominantly on fish in most habitats, taking trout, eels and carp (Falla and Stokell 1945, Duncan 1968).

Little Shag *Phalacrocorax melanoleucos*

Occurred in all reaches of the Waiau, but only in small numbers.

Uses a wide variety of natural and artificial wetlands, and sheltered coastal waters. Feeds mostly on invertebrates, with smaller numbers of fish (Marchant and Higgins 1990).

Spotted Shag *Stictocarbo punctatus*

In both November and March a large roost of Spotted Shags was present on the inland side of the shingle bar near the mouth. Here the birds were protected from the prevailing southerly winds.

This shag is endemic (found only in New Zealand) and occurs in coastal waters. The total population was estimated at 60 000 - 150 000 breeding pairs (Robertson and Bell 1984). Almost nothing is known about its food, but it appears to feed mainly on planktonic crustaceans and possibly small fish (Oliver 1955).

White-faced Heron *Ardea novaehollandiae*

Occurred in all reaches of the Waiau, always alone. Usually flushed from quiet muddy backwaters.

This heron is widespread in New Zealand, occupying a wide variety of wetlands and pasture. Feeds on a wide variety of invertebrates and vertebrates.

Black Swan *Cygnus atratus*

A flock of six birds on the lagoon in March was the only record of this species.

Prefers waterbodies with abundant aquatic vegetation and nearby pastures. Food, almost entirely herbivorous, usually taking leaves and shoots of aquatic plants such as *Ruppia,*

Myriophyllum, Potamogeton, Egeria, Glyceria, Ranuculus and *Juncus* (Bucknell 1969, Adams 1971).

Canada Goose *Branta canadensis*

Found only in the Redcliff reach. Although only two birds were seen during the breeding season, there was an influx after breeding when flocks of 17 and 11 birds were seen loafing on a grass bank and in a riffle.

Occurs primarily in the high country during the breeding season, moving to coastal areas in autumn and winter. Grazes close to water in open grasslands, pasture and crops, or takes aquatic plants from water. Feeds primarily on terrestrial herbage, but also takes seeds and aquatic plants.

Paradise Shelduck *Tadorna variegata*

While only one shelduck was recorded on the lagoon and lower river in the breeding season, pairs were recorded about every 500 m of river in the Redcliff reach and a flock of 85 was loafing near Clifden. Fourteen pairs had downy young associated with them in the Redcliff reach and broods of 2 (2x), 3, 4 (2x), 5, 6 (2x), 7, 8 (2x), 11 (2x), and 13 were recorded. Broods of 2 and 5 were recorded downstream of the Wairaki Creek confluence, and a brood of 6 in the Clifden area. In the non-breeding season survey no shelducks were found on the lagoon and lower river. However, several pairs and a flock of 19, feeding and loafing in quiet water, were recorded in the Redcliff reach. Several pairs and flocks of 13 and 15 birds were recorded in the Clifden-Wairaki reach.

Paradise Shelducks are endemic to New Zealand; in the South Island they occur mainly in river valleys and tussock grassland of eastern foothills. Populations have fluctuated since European settlement, perhaps related directly to exploitation (Williams 1971). In 1984 there were an estimated 20 000 shelducks in Southland. They are mostly herbivorous, grazing on pasture and crops, stubble and seedheads; insects, earthworms and crustaceans are also taken when available.

Mallard/Grey Duck *Anas platyrhynchos/A. superciliosa*

The introduced Mallard and native Grey Duck interbreed and hybrids occur frequently, making species identification difficult. Because of this the two species were not separated during these counts.

These were commonest in the lagoon, where they loafed and fed in muddy backwaters. Upstream, they loafed on cobble/gravel bars along stretches of quiet water.

These ducks inhabit a wide range of aquatic habits such as small ponds, urban creeks, rivers, shallow margins of large lakes, and intertidal mudflats. Although they feed mainly on vegetation they also take much animal mater, such as insects and earthworms.

Grey Teal *Anas gracilis*

The few seen were in small groups.

Inhabits terrestrial wetlands, dams and sheltered estuarine waters. Prefers shallow freshwater lakes, ponds and swamps. Feeding occurs mainly in water less than 1 m deep or in flooded marginal vegetation, also out of water on exposed shores and mudflats. Food mainly seeds of aquatic plants and a wide range of aquatic invertebrates.

Shoveler *Anas rhynchotis*

Found in the lagoon and near Clifden, always in small groups and in vegetated backwaters.

Favours wetlands fringed with rush, also flooded pastures, sewage ponds, reservoirs and freshwater lakes. Its bill is adapted to filter feeding and it feeds mostly on animal matter obtained by dabbling in mud or at the surface of the water.

Scaup *Aythya novaeseelandiae*

One was seen on the lagoon in March.

This endemic duck prefers large open freshwater lakes, where it occurs over clear water, and shallow lakes of varying trophic status. It has benefitted from the construction of impoundments for water storage and hydro electricity generation. There is little information about its foods, but apparently aquatic plants and invertebrates are obtained by diving.

Pukeko *Porphyrio porphyrio*

The few seen were in muddy overgrown backwaters of the lower river.

This is essentially a bird of lowland swamps. In some areas it has expanded its range with the development of agriculture, while in others its habitat has been reduced by drainage or in-filling of swamps. They are mainly vegetarian, though small fish, birds and mammals are also taken (Tunnicliffe 1985)

Pied Oystercatcher *Haematopus ostralegus*

Found only in November, when it occurred mostly on the alluvial bars of the Clifden-Wairaki reach. Most of the 32 birds recorded in the November survey were in pairs, some of which appeared to be breeding. Many more birds were obviously breeding in paddocks adjacent to the Clifden-Wairaki and Lagoon-lower river reaches.

Recently, regular counts have recorded over 85 000 birds in New Zealand (Sagar 1989). All but a few pairs breed in the South Island where they nest mainly on pasture and gravel

riverbeds. Breeds August to December. On riverbeds most birds nest on higher level shingle islands without significant vegetation encroachment. Nests usually occur above the level of freshes. Feeds on invertebrates. Moves to the gravel riverbeds, coast and northwards after breeding, mainly to the major harbours of Auckland and Northland.

Variable Oystercatcher *Haematopus unicolor*

A single bird was recorded at the lagoon in November.

This endemic species occurs in coastal areas throughout New Zealand, where it feeds on shellfish, worms and crustaceans.

Pied Stilt *Himantopus himantopus*

Recorded in all three reaches, where it usually occupied muddy backwaters, some also observed on alluvial gravel bars in the Clifden section. None recorded in March.

Occurs throughout New Zealand in a wide variety of open terrestrial wetlands. Prefers mud and gravel substrates where it feeds on aquatic invertebrates (Pierce 1986). Breeds August to December in open areas close to partly migratory, generally open water moving to the coast and northwards after breeding. Over 20 000 have been recorded in recent regular nationwide counts (Sagar 1989).

Banded Dotterel *Charadrius bicinctus*

Found only on the alluvial gravel bars and channel margins of the Clifden section in November. Most of these birds were in pairs, some of which were breeding.

An endemic species which breeds from gravel coastal beaches to alpine streams throughout New Zealand. Breeds August to December on bare or partly vegetated gravel areas, particularly on high level stable terraces of braided rivers. After breeding, many move to Australia, but substantial flocks remain in coastal New Zealand. Recent regular counts have recorded about 20 000 birds (Higgins 1993), but an extensive study of banded birds indicates a population of 40 000 - 60 000 birds.

Spur-winged Plover *Vanellus miles*

In November, this species was most abundant on the lower river where flocks of 59 and 78 were counted feeding on grassy alluvial bars; a flock of 17 was feeding on a grassy bar in the Clifden section. Fewer were seen on the river in March, but many were on adjacent pasture.

This species colonised Southland from Australia in the 1930s and spread slowly throughout the South Island (Barlow 1972); colonisation of the North Island continues. Although technically a shorebird this species mostly breeds and feeds on pasture.

Bar-tailed Godwit *Limosa lapponica*

Two groups of six birds were seen feeding in sand/mud areas of the lagoon in November. None occurred elsewhere on the river.

This is a migratory species which breeds in Siberia east of Lena River and across the Bering Sea into northern Alaska (Turbott 1990). Over 100 000 birds have been recorded in New Zealand during November (Sagar 1989) where they frequent sand and mud areas of estuaries and harbours.

Southern Black-backed Gull *Larus dominicanus*

Most were recorded in the lagoon and lower river during November when breeding colonies of c. 150 and 250 birds were counted. At the lagoon nests were scattered along the inside of the bar, but on the lower river they were among the tall grass of islands. A group of 52 roosting birds was recorded in the Redclif section. Fewer birds were present in all sections during March.

This gull breeds throughout coastal areas and inland on riverbeds, stony paddocks and into the mountains (Kinsky 1963). It feeds on a wide variety of foods - from road-killed mammals to bivalves in sandy estuaries.

Red-billed Gull *Larus novaehollandiae*

Eight birds were seen on the lagoon in March.

Breeds on coast, also inland at Lake 'Rotorua. This is one of the commonest gulls of the coast, it rarely lives inland. During the breeding season its main food is planktonic crustaceans, although earthworms, kelp fly larvae and fish larvae are also eaten. It has a more varied diet outside the breeding season when it scavenges.

Black-billed Gull *Larus bulleri*

This was the commonest bird on all reaches in November, but none was recorded in March. Breeding colonies were present in all reaches in November, the largest being an estimated 3740 birds on the inside of the bar at the lagoon. All colonies were on gravel/cobble substrates devoid of vegetation. Two colonies at the lagoon were on the inside of the bar, one in the Redcliff reach was on cobble/gravel bar extending into the main channel, one in the Clifden section was on a gravel island, and one at the mouth of Wairaki Creek was on a bar and the margin of the shingle channel. With the exception of those at the lagoon, all

these colonies would be subject to periodic flooding in freshes. Although only the numbers of adults were estimated at the colonies, all also contained several hundred chicks. Few adults from these colonies fed on the river, most flew to adjacent paddocks.

An estimated 75 000 pairs of this endemic gull breed in Southland; they also breed in large colonies in Otago and Canterbury (Gurr 1985). In winter many birds migrate to the coast. They feed in open country and on lakes and rivers. Their diet includes insects, small freshwater fish, and they also eat refuse. On wet pasture and when following the plough they eat earthworms and grass grubs and other beetle larvae.

Black-fronted Tern *Sterna albostriata*

Found only on the upstream reaches, most birds being recorded in November. Two breeding colonies were found, both associated with Black-billed Gulls, one of seven pairs in the Clifden section and one of four pairs in the Wairaki section. Most of the off-duty birds were seen feeding over riffles and runs, with only three of 22 birds recorded flying inland to adjacent paddocks.

This is another endemic species, which is generally restricted to the South Island during spring and summer. In autumn and winter most Black-fronted Terns move from inland areas to the coast and there is a general movement northwards (Lalas 1979).

The population is estimated to be between 1000 and 5000 (Robertson and Bell 1984), consequently Black-fronted Terns are considered to be a threatened species (Bell 1986).

Breeding is almost entirely on braided riverbeds, usually on shingle islands.

Black-fronted Terns depend for most of their food on insects and fish taken from rivers, although they are opportunistic and will feed on insects and earthworms made available when paddocks are irrigated or worked. On rivers, most feeding occurs by taking prey from the water surface, particularly over riffles (Lalas 1977).

The aquatic insects drifting in the river come from the insect populations which live among the substrates on the bottom of the river. The density of drifting insects is directly related to the density of bottom-dwelling insects (Sagar and Glova 1992), so the amount of instream food-producing habitat (as described by Jowett 1992) is an important factor affecting Black-fronted Tern numbers.

Caspian Tern *Sterna caspia*

Two were seen feeding in the Clifden section during March. Both were banded and probably came from the colony at the Invercargill Estuary.

At most 3500 Caspian Terns live in New Zealand (Challies 1985) . The majority breed in colonies in the northern half of the North Island; the colony at the Invercargill Estuary marks the southern end of its range. They disperse at the end of the breeding season, usually

moving north. Feeds on fish, mainly yelloweyed mullet, piper, and small trout and flounders.

White-fronted Tern *Sterna striata*

Recorded only at the lagoon where an estimated 650 birds were breeding in November; only four birds remained in March. All the birds from the breeding colony fed along the coast, close inshore.

Until recently this was considered an endemic species, but small numbers now breed on some islands in Bass Strait. This coastal species eats fish - yelloweyed mullet, piper, anchovy, flounders, pilchard - and small crustaceans.

DISCUSSION

General bird fauna

The 24 species recorded during the two surveys show that the Waiau River supports a bird fauna typical of South Island rivers, with a species composition similar to that recorded from braided rivers in Canterbury (O'Donnell and Moore 1983). Colonial nesting species such as Black-billed Gulls, Black-fronted Terns and White-fronted Terns are notoriously fickle in where they nest and so numbers may change significantly from year to year, or even within a season if early nests are lost during a fresh. Therefore it is not desirable to compare bird numbers on several rivers.

Species which probably occur on the Waiau, but were not recorded during these two surveys, include the Australasian Bittern *Botaurus poiciloptilus* and Marsh Crake *Porzana pusilla* (especially in the wetlands and margins of the lower river), and White Heron *Egretta alba* and Royal Spoonbill *Platalea regia* at the lagoon. The bittern and crake probably breed and occur on the river throughout the year, while the heron and spoonbill would usually occur during autumn, winter and spring.

Fewest birds were recorded in the Redcliff reach and this is probably a result of the unsuitable substrates (predominantly boulders and large cobbles - Brierly undated). Consequently, most of the birds which occurred in this reach either fed from the water or in adjacent paddocks, rather than on the substrates of the floodplain. Also, with the exception of the Black-billed Gull colony on the cobbles/gravel of one of the higher alluvial bars, most of remaining birds would breed away from the river.

The most suitable substrates for breeding and feeding (small cobbles and gravel) occurred in the Clifden and Wairaki reach. This is indicated by the occurrence of species such as Banded Dotterel and Black-fronted Tern.

Substrates in the lower river were also usually suitable for breeding and feeding, but encroaching vegetation prevented most birds from using the area.

The lagoon is at the interface of marine and freshwater and so provides a greater variety of feeding habits than the river alone. Consequently the greatest numbers and diversity of birds were expected (and found) in this areas.

Target species

The Black-billed Gull was not only by far the most abundant of the target species, but also occurred in greater numbers than any other bird on the river. The estimated 4365 breeding pairs on the Waiau is a significant proportion of the Southland population of Black-billed Gulls. Given the pressures of human interference and predation by introduced mammals the estimated population of 75 000 pairs (Gurr 1985) is likely to have decreased or at best remained stable in recent years. Therefore the 4365 pairs breeding on the Waiau may represent a minimum of 5.8% of the Southland population.

Although only 39 Black-fronted Terns were counted during November this total must be considered in the context of an estimated national population of 1000 - 3000 birds. Consequently, the Waiau River supported 1.3-3.9% of the entire population of Black-fronted Terns, a significant proportion.

Numbers of other target species (Pied Oystercatcher, Pied Stilt, Banded Dotterel, White-fronted Tern) were relatively low when compared to national totals. The Black-fronted Dotterel was a designated target species, but none was found during these surveys. This species is expanding its range in east coast rivers of the South Island. Black-fronted Dotterals prefer to feed in shallow muddy backwaters which do not have much vegetation. they nest on cobble/gravel bars which are largely free of vegetation and flood debris. Such feeding and breeding habitats occur on the Waiau. Therefore as it occurs in catchments adjacent to the Waiau it is possible that it may yet colonise the river.

Effects of HEP development

No quantitative baseline information is available about the birds of the Waiau River before HEP development and this makes it difficult to assess the impacts of the altered flow regime. However, the reduction in mean flow probably has resulted in more habitat being available for breeding and feeding. In the Redcliff reach, where the exposed substrate is mostly unsuitable for breeding or feeding, the reduction in flows probably provided more suitable instream feeding conditions for broods of Paradise Shelducks and other waterfowl. The small substrates (cobbles/gravel/sand) of the Clifden-Wairaki reach will have provided more suitable feeding and breeding habitats for Banded Dotterels, Black-fronted Terns, Pied Stilts, Black-billed Gulls, and Pied Oystercatchers. However, some of these apparent benefits would be offset by the greater access to breeding colonies of such predators as mustelids and cats. Encroachment of vegetation in the lower river has offset any benefits of increased habitat availability because of lower flows.

The form of the lagoon does not appear too have been affected by the lower flows. Therefore the coastal birds in this area may not have been affected by reduction in flows.

Table 2 shows the breeding seasons of target bird species on the Waiau River. Breeding birds are most vulnerable to changes in flow. While there are not controls over changes in flow due to natural events, HEP development may produce freshes which adversely affect breeding success. Species such as Pied Oystercatcher, Banded Dotterel and White-fronted Tern usually nest on higher ground which is not affected by freshes. However, Pied Stilts, Black-billed Gulls and Black-fronted Terns usually nest in lower areas more prone to flooding during freshes. Therefore, HEP induced freshes during the breeding season of these species may adversely affect breeding success.

TABLE 2. Breeding seasons of target bird species on the Waiau River, 1993-1994.

	Breeding season											
	J	F	M	A	M	J	J	A	S	O	N	D
Pied Oystercatcher								———	———	———		
Pied Stilt									———	———	———	
Banded Dotterel								———	———	———	———	
Black-billed Gull	—								———	———	———	
Black-Fronted Tern								———	———	———	———	
White-fronted Tern	———									———	———	

My overall impression of the Waiau River during these surveys was that more feeding and breeding habitat for the target species had resulted from HEP development. However, increasing the residual flow 10-20 m^3/s would provide more instream feeding habitat (Jowett 1993) while also providing better isolation of breeding areas from predators.

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