

# SEASONAL AND LONG-TERM CHANGES IN BIRD NUMBERS AT LAKE WAINONO

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## ABSTRACT

Monthly bird counts were carried out at Lake Wainono, South Canterbury, from August 1968 to April 1978. Highest numbers of birds were at the lake from January to April because of a post-breeding increase in numbers of 18 common species. Six species reached peak numbers during the winter and only five during spring and early summer. Since 1968 White-faced Herons (*Ardea novaehollandiae*) have declined in numbers, whereas Paradise Shelducks (*Tadorna variegata*), Spur-winged Plovers (*Vanellus miles novaehollandiae*) and Black-backed Gulls (*Larus dominicanus*) have increased in numbers.

## INTRODUCTION

Lake Wainono is typical of New Zealand lagoons in the species that use it and the seasons they use it in. It not only provides valuable feeding grounds for coastal species but also acts as a pre- and post-breeding centre for inland-breeding species. The importance of the lake is increased by the absence of similar extensive wetland in the 250 km between Lake Ellesmere and Karitane Estuary. Lake Wainono is situated midway between these two localities and so occupies a vital link in the diminishing chain of lagoons and unaltered estuaries around the New Zealand coastline.

A regular series of observations over one or more years provides much more information about lagoons than do isolated counts. Regular surveys not only reveal the true value of such habitats and provide essential background information for future management but also help reveal seasonal trends in various species, their dispersals, and their movements to and from the breeding grounds. In this paper I present and discuss the seasonal variations in the abundance of 32 species at Lake Wainono based on monthly counts kept for ten years. Long-term changes in the numbers of some species during the study period are described also.

## THE LAKE

### *Physical characteristics*

Lake Wainono is situated on the South Canterbury coast 35 km south of Timaru at latitude 44° 42' S. The Maoris called it Ki-Wainono,

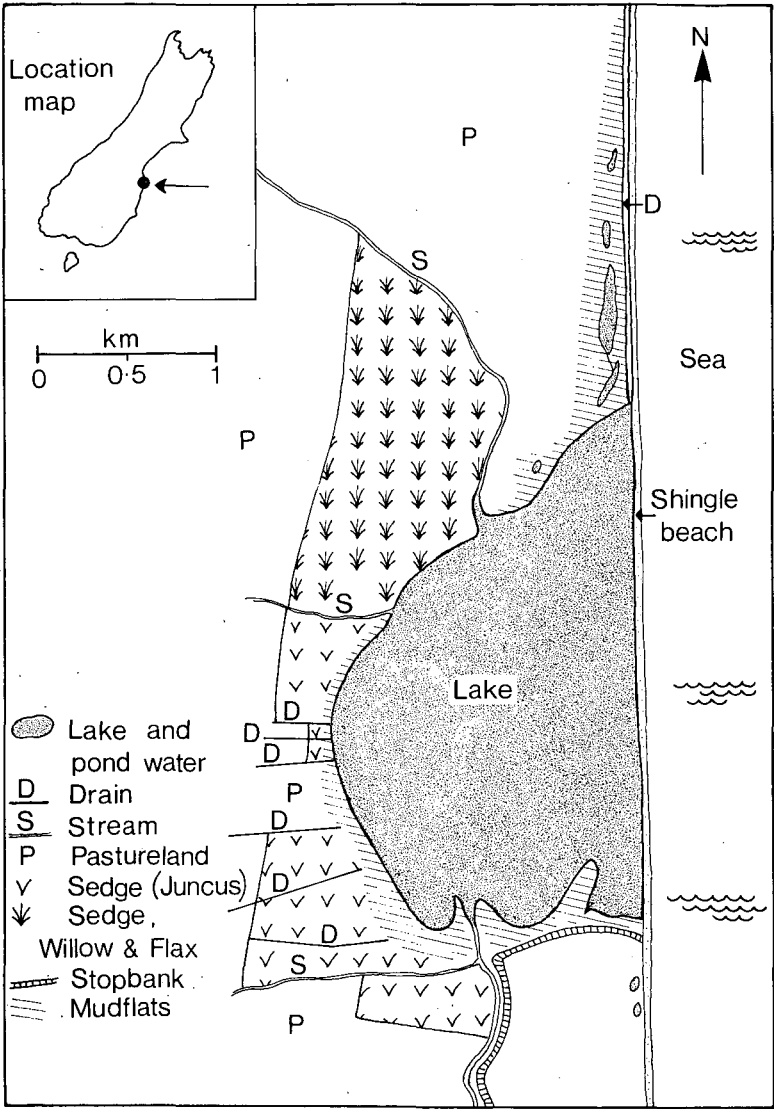


FIGURE 1 — Lake Wainono at normal water level.

"the lake of muddy waters" because the bed is a 20-40 cm thick layer of soft mud which is easily stirred up by winds. At its normal water level of 1.0 metre a.s.l., the lake covers 335 hectares and has a maximum length of 2.8 km (north to south) and a width of 1.7 km (Fig. 1). At very high water levels (1.5 metres a.s.l.), a narrow tongue of the lake extends northwards to give a total length of 5.0 km, covering 420 hectares. An artificial stop-bank at the south end of the lake prevents southward flooding. Separating the lake from the sea is a shingle beach about 50 m wide. Lake Wainono is very shallow, averaging less than one metre in depth and, except for the mouth of one of the streams, never exceeding 2 metres. The deep outlet stream flows southwards for 8 km to join the Waihao River where their combined waters enter the sea. When the sea is calm, the outlet often becomes a tidal channel and so the outlet stream and Lake Wainono fluctuate in level for several days to several weeks. In rough weather the outlet usually blocks, causing water from the Waihao River to back up into Lake Wainono. Because of these changes the salinity of the lake varies widely from about 5% to 25%, but is usually less than 10%. Seawater also seeps through the shingle-beach into the lake and vice versa.

During a drought in 1969 Lake Wainono became progressively shallower and from August until early December was less than 0.6 metre a.s.l. Mudflats were more than twice as extensive as when the lake was at its normal level. Except for two months in autumn 1973, these extremely low water levels were not repeated during the study period.

### Vegetation

Judging by the old hummocks around most of the lake's edge, the original swamp vegetation of the lake was probably dominated by the tall rush *Juncus fuscus*. *J. fuscus* occurs now only on the western side of the lake, merging to the north-west with thickets of willows (*Salix* spp.), flax (*Phormium tenax*) and the very tall grass *Festuca arundinacea*. The low-lying flats north of the lake support extensive areas of the small rush *Elaeocharis acuta* and, further back from these mudflats, several species of introduced grass grazed by cattle. The shingle beach is sporadically vegetated, the main shrubs being *Plagianthus divaricatus*, gorse (*Ulex europeus*) and lupins (*Lupinus arboreus*). Lining the lake's edge near these shrubs are the sedge *Scirpus caldwellii* and various grasses including *F. arundinacea*. The hummocky grassland to the south of the lake, which is grazed by cattle, has small patches of glasswort (*Salicornia australis*).

The main aquatic plants in the lake are *Myriophyllum* sp., *Lilaeopsis novaezealandiae*, *Ruppia megacarpa*, and *Ranunculus* sp. Several other species, including *Elodea* sp., grow in the freshwater drains and streams.

### *Aquatic invertebrates*

Because the substrate is very muddy and because the salinity, although normally low, fluctuates widely at irregular intervals, the invertebrate fauna is limited to only a few species. Only three groups, midges (*Chironomidae*), craneflies (*Tipulidae*) and amphipods (*Amphipoda*) are very common. At least two species of *Chironomus* and two species of tipulids occur as larvae in the mud. They emerge mainly in late spring and summer when large swarms of adults occur along the lakeshore. This means, however, that the larger larvae, on which many species of birds feed, decline at that time of year. The small amphipod *Paracorophium lucosi* is abundant in the water and soft mud throughout the year but tends to be replaced in the drains and pools by another amphipod, *Paracalliope fluviatilis*. Other less common inhabitants of the mud include oligochaetes, snails (*Potamopyrgus* spp.), and larvae of the caddis fly *Pycnocentria* sp. and the aquatic moth *Nymphula nitens*.

The transparent swimming mysid *Tenagomysis novaezealandiae* is often common along the sheltered eastern shore of the lake, while waterboatmen (*Sigara arguata* and *Diaprepocoris zealandiae*), which may not tolerate wide changes in salinity, are less common and of irregular occurrence. Larvae of the shorefly (*Ephydrella aquaria*) are usually common in the very salty ponds south of the lake, where swarms of adults occur in summer and autumn. At the edges of the lake, ponds and streams, the pond skater (*Microvelia macgregori*) often occurs in large numbers.

### *Fish*

Four species of fish occur in the lake throughout the year. They are long-finned eel (*Anguilla dieffenbachii*), short-finned eel (*A. australis*), brown trout (*Salmo trutta*) and flounder (*Rhombosolea* sp.). At certain times of the year the lake is visited by shoals of other species, particularly whitebait (*Galaxias* spp.), smelt (*Retropinna retropinna*) and yellow-eyed mullet (*Aldrichetta forsteri*). Lampreys (*Geotria australis*) occur in the outlet stream.

## METHODS

From August 1968 to April 1978 I carried out 96 bird counts at Lake Wainono, all but one of which were carried out in fine weather. Only three counts were made in May (the duck-shooting season) because of the danger of being shot. During each visit to the lake all species were counted except the ducks (*Anas* spp.) which were difficult to identify far out on the lake, Pukekos (*Porphyrio p. melanotus*) and crakes (*Porzana* spp.) which inhabited the densely vegetated lake margins, and all passerines apart from Welcome Swallows (*Hirundo neoxena*). In 1977, I made monthly estimates of the duck and pukeko populations in order to calculate the total bird population. Birds seen on the ocean beach or offshore were always excluded from the counts.

TABLE 1 — Number and average dates of counts and average monthly lake-level, October 1968 - April 1978.

	Summer		Autumn			Winter			Spring			D
	J	F	M	A	M	J	J	A	S	O	N	
No. of counts	9	9	8	7	3	7	6	8	6	7	12	14
No. of years in which counts were made	9	8	8	7	3	7	5	7	6	6	9	9
Average date of count	14	16	13	13	18	23	19	23	17	21	17	20
Average lake-level (metres above sea-level)	1.0	1.0	0.8	1.0	1.3	1.1	1.0	1.1	0.8	0.9	1.0	1.0

During each visit I walked over the entire lakeshore from the pools north of the lake clockwise around the lake. The grassland to the south and south-west of the lake was also visited because several species foraged there. Birds were counted, their habitats and the level of the lake (Table 1) were noted, and feeding and nesting were noted incidentally. Although each count took 5 hours the figures are considered to be fairly accurate, because regular dawn-to-dusk observations since 1976 have revealed that few species, other than swallows, move far around the lake unless disturbed. Whenever birds were disturbed, their numbers were rapidly checked by driving a vehicle to the appropriate parts of the lakeshore along one or more of the several access tracks.

To find the regular seasonal trends, the counts for each month are averaged for the ten-year period. Standard deviations are large for some species, due in some cases to long-term changes in a species' abundance during the study period, in others to fluctuations in local conditions such as lake level. When numbers are averaged for ten years, however, the seasonal trends still show.

The year-to-year data are presented as average counts for each year, but using only those months that show no significant seasonal variation. For example, numbers of Paradise Shelducks occurring in the months January, February, March and April are not significantly different ( $p > 0.1$ ) from one another, so for each year I have used the four counts from January to April only.

A list of all species recorded at Lake Wainono during the study period is given in Appendix 1.

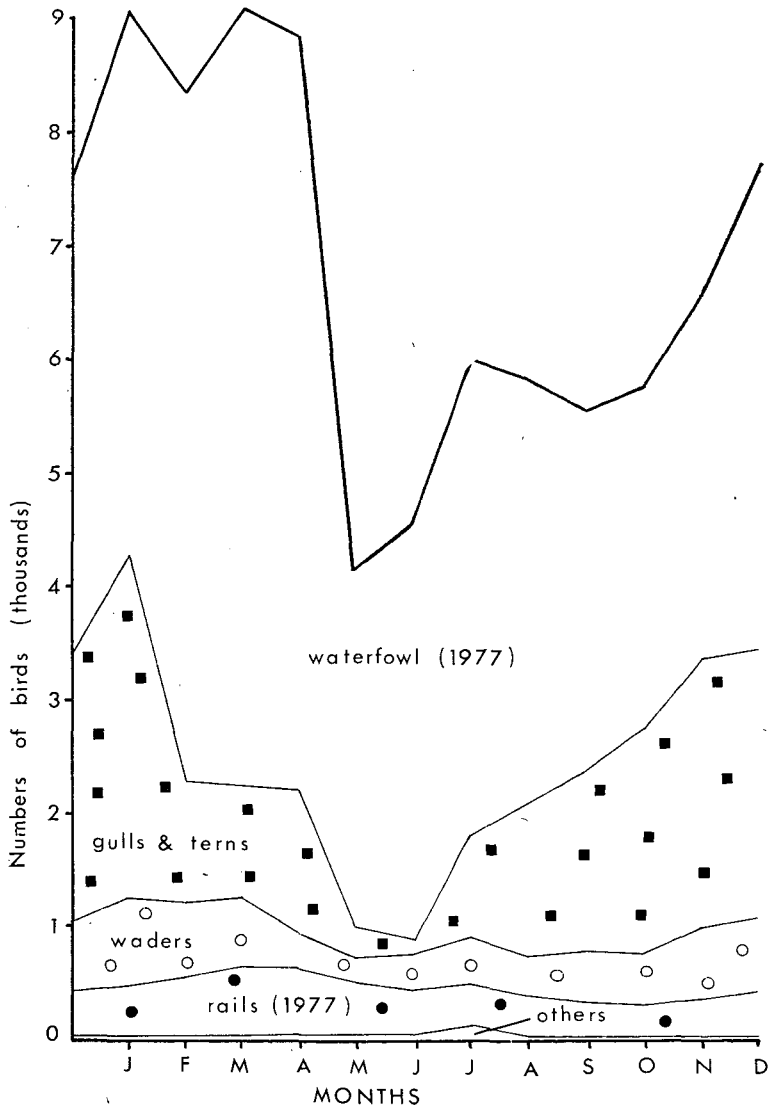


FIGURE 2 — Seasonal occurrence of total bird numbers at Lake Wainono. Passerines (except swallows) are excluded.

## RESULTS

An influx of birds to the lake resulted in a very large total population (up to 9100) in summer and autumn with waterfowl and gulls contributing 80-85% of the total (Fig. 2). In May the average numbers of birds plummeted to about 4000, due mainly to an exodus of waterfowl, and did not increase markedly again until November. The May exodus of waterfowl was accentuated by the start of the shooting season, which made many species visit safer areas such as the Washdyke Lagoon sanctuary 38 km to the north (Sagar 1976) or form large diurnal "rafts" out to sea. In all months, however, over half the bird population was waterfowl.

Despite wide fluctuations in total bird numbers, Lake Wainono was used extensively by most bird groups throughout the year. More than 100 each of waterfowl, rails, waders, and gulls and terns were always present. Different species, however, used the lake in different ways and most had their own patterns of seasonal abundance.

## COMMON SPECIES

BLACK SHAG *Phalacrocorax carbo*

Black Shags breed commonly inland in South Canterbury, the nearest colony to Lake Wainono being only 25 km to the north-west. They occurred at the lake throughout the year but were common only during winter (Fig. 3a). Four counts — two in June and two in July — produced more than 50 birds, the highest count being 155 in July 1976. Comparatively few birds were present during the spring, when the breeding grounds were occupied, and in May when they were probably scared away by shooters. I often saw Black Shags catching small unidentified fish, sometimes in the lake but usually in the outlet stream, which was usually less turbid than the main lake. Most sightings were of flying birds or of birds roosting in trees or on posts around the lake's edge. Many birds also fed at sea and returned to roost at the lake but the relative importance of sea and lake for feeding is not known.

LITTLE SHAG *Phalacrocorax melanoleucos*

The nearest known colony of Little Shags to Lake Wainono is nearly 80 km to the south at Moeraki. Therefore, the number present during the spring breeding season was significantly less than at other seasons, except for the May shooting season (Fig. 3b). The highest counts were 35 in August 1971 and 34 in December 1971. Unlike the Black Shag, Little Shags were seen to feed only in the lake and outlet stream and not at sea. Their dependence on lake foods was reflected in their scarcity during the 1969 drought, when very low lake levels combined with strong winds kept the lake permanently turbid. The average monthly count for 1969 was one, whereas in 1970 and 1971, when the lake was higher, the average monthly counts were five and 15.

### SPOTTED SHAG *Stictocarbo punctatus*

Spotted Shags were common offshore from late January to June each year and they regularly roosted on the shingle beach bordering the lake. They rarely used the lake itself up to 1977. The only birds found at the lake were two roosting together near the outlet stream in June 1971. However, during April and May 1977, up to 100 Spotted Shags fished and roosted at the lake, dropping by June to only ten. This unusual invasion of shags coincided with a period of very heavy seas and also with unusually large numbers of smelt on which they were feeding in the lake.

### WHITE-FACED HERON *Ardea novaehollandiae*

White-faced Herons occurred at Lake Wainono throughout the year and a few pairs nested in trees to the west of the lake. Numbers were greatest in late summer (Fig. 3c), followed by a marked autumn exodus to unknown wintering areas. The high July average possibly represented the return of these birds from their winter quarters before a dispersal to the breeding grounds. White-faced Herons fed in a variety of habitats in the Lake Wainono area and their numbers were not affected by the level of the lake. The drains entering the lake provided a fairly constant supply of aquatic vertebrate and invertebrate food, and terrestrial animals including skinks (*Leiopisma* sp.), grass-grubs (*Costelytra zealandica*) and earthworms (Lumbricidae) were also eaten.

Although White-faced Herons have increased in numbers throughout New Zealand (Carroll 1970) and are still increasing in inland South Canterbury, the Lake Wainono population has declined since the autumn of 1973 (Fig. 4a and b). The average numbers of herons at the lake from 1968 to 1973 was 21.0 compared with 7.3 from 1973 to 1978 ( $t = 5.49$ , 89 d.f.,  $p < 0.001$ ). The decline did not correlate with previous weather conditions (Meteorological Service data), lake level or water salinity. Surprisingly, an abundance of smelt (a common food of herons at the lake) during 1977 did not cause an influx of birds. This lack of response suggests there was a drop in the heron population of coastal South Canterbury and not just at Lake Wainono. Some evidence in support of this suggestion comes from observations I have made at other South Canterbury localities, such as Opihi River mouth, where the number of herons also declined. Current (1979) observations show that heron numbers are increasing again at Lake Wainono and it will be interesting to see if a cycle is starting to repeat.

### WHITE HERON *Egretta alba*

Before 1975, the White Heron was a rare late summer and autumn visitor to Lake Wainono, and only single birds were seen. Since November 1975, however, small numbers have occurred throughout the year with the highest count being seven in December 1977. Unlike White-faced Herons, which fed also in the pastures, White



Hérons fed only in water where they caught smelt and possibly other fish. They also visited ponds and streams several kilometres from the lake. Their numbers seemed unaffected by changes in lake level.

#### AUSTRALASIAN BITTERN *Botaurus stellaris*

A few resident Bitterns frequented the densely vegetated western margins of the lake and the banks of the outlet stream and other streams and ponds near the lake.

#### ROYAL SPOONBILL *Platalea leucorodia*

Royal Spoonbills visited Lake Wainono from November to April but were most often seen in December and January, the biggest flocks being 11 in December 1968 and 13 in December 1975. As this species is a late nester (H. A. Robertson, pers. comm.), the December flocks would have been entirely non-breeders. No juveniles were seen at the lake. As with White Herons, their numbers were unaffected by changes of water level. Both arrivals that I have seen (4 on 16/11/76 and 3 on 18/11/76) have been from the south and all three departures that I have seen (9 on 18/11/76, 1 on 24/12/76, and 2 on 22/2/77) have been to the north. Clearly, Lake Wainono functions only as a temporary feeding ground for birds bound for more northerly winter quarters.

#### BLACK SWAN *Cygnus atratus*

The Black Swan is one of the most conspicuous species on Lake Wainono but its numbers have fluctuated widely over the years. The maximum count was 2500 in February 1977, and the lowest was only 42 in November 1969, at the height of a drought. The usual pattern was for swan numbers to increase in late summer and autumn, but seasonal changes were obscured by changes in the breeding cycles of birds at Lake Wainono and by changes in the numbers of birds at the main Canterbury nesting grounds of Lake Ellesmere (Williams 1977).

There were two peaks in egg-laying at Lake Wainono, one in early spring and another in late summer or autumn. This contrasted with Lake Ellesmere where all eggs, including those of re-nesting birds, are laid in late winter or spring (Miers & Williams 1969). At Lake Wainono the spring peak was usually larger than the autumn peak and contributed to the build-up in swan numbers during the summer. In 1976, however, the autumn peak was the larger, which may have caused the unusual winter and spring increase in numbers of that year, although an influx of immature birds from Lake Ellesmere (Williams 1977) may also have occurred.

The swans fed mostly on the lake or in short-turfed pastures within a few hundred metres of the lake. Nesting occurred all around the lake shore but particularly amongst the *Juncus* on the western side.

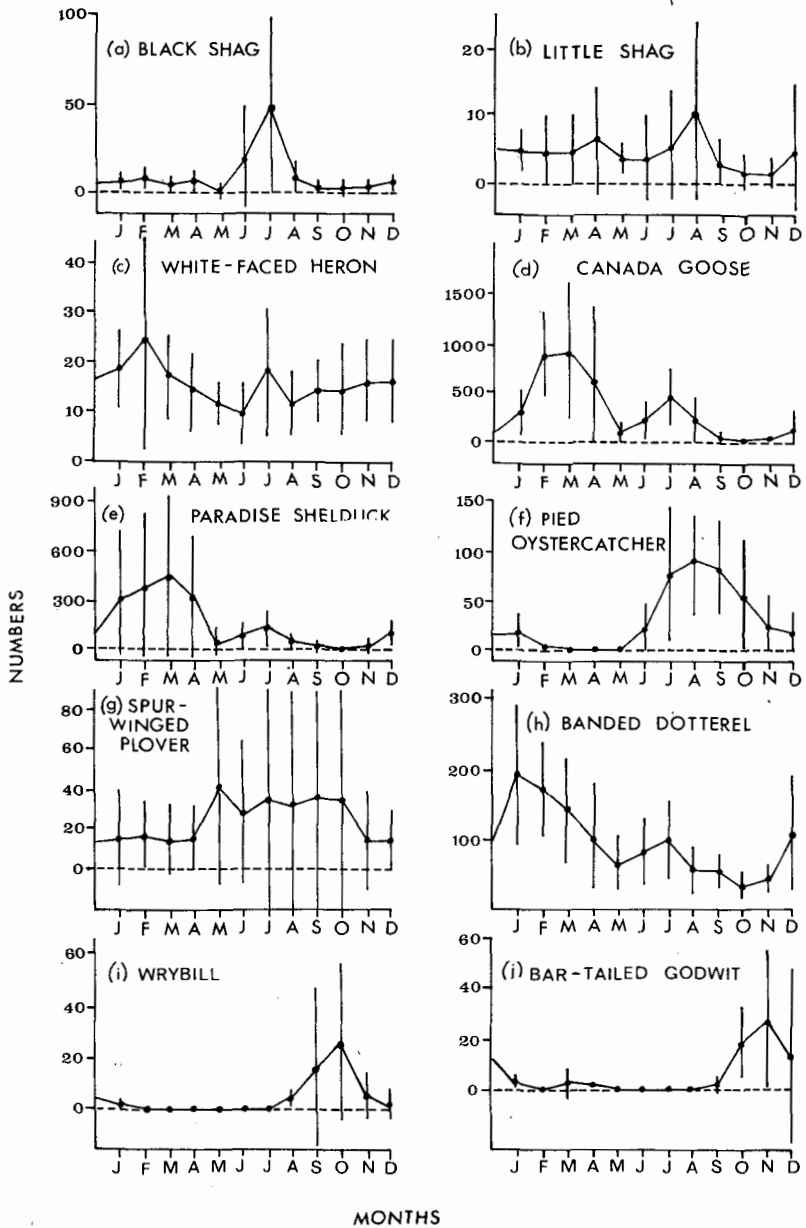


FIGURE 3 — Seasonal changes in bird numbers. The vertical lines are standard deviations of the means.

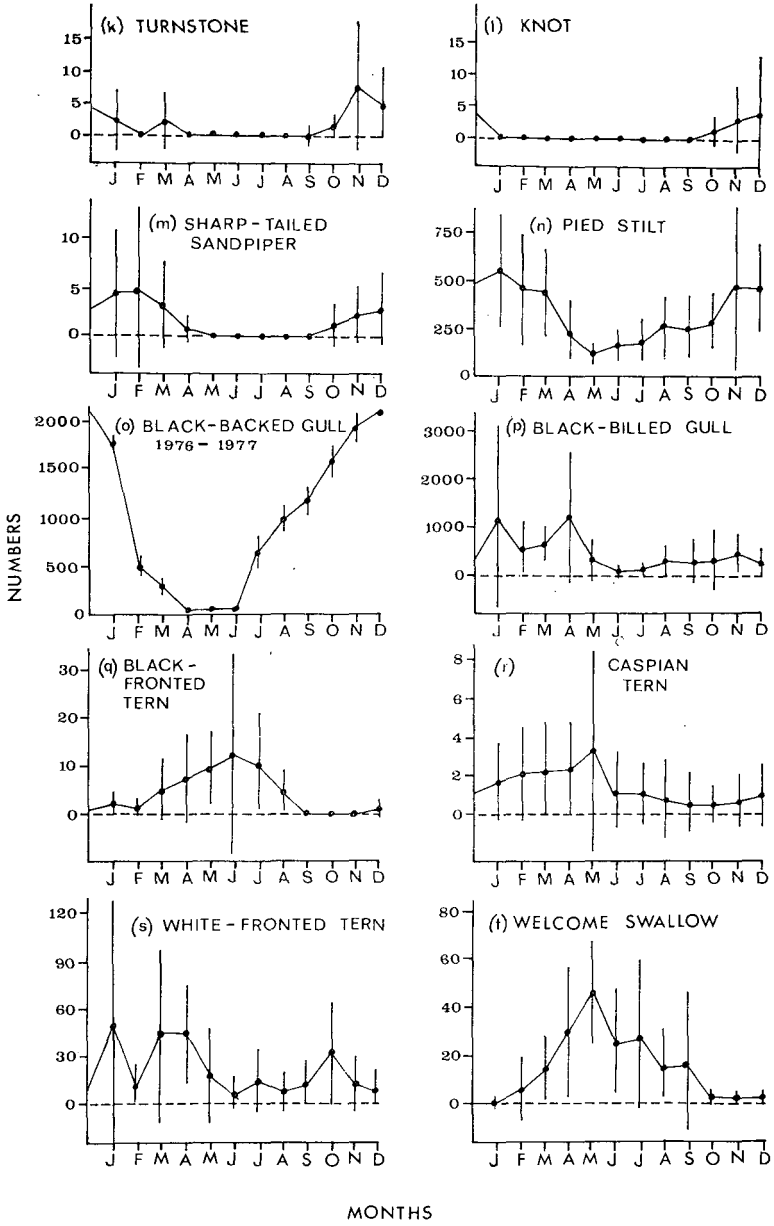


FIGURE 3 — Continued

### CANADA GOOSE *Branta canadensis*

Lake Wainono is an important coastal feeding and moulting site for Canada Geese, with numbers increasing during the summer to a peak from February to April (Fig. 3d). The maximum count was c. 2000 in March 1972. Few were found on the lake during the day-light hours of the May shooting season, but sometimes several hundreds were out at sea. Others probably visited the Washdyke Lagoon sanctuary where Sagar (1976) recorded peak numbers in April and May. Geese returned in large numbers to Lake Wainono following the shooting season, matching an exodus from Washdyke Lagoon, and were common until late August by when most had left for their inland breeding grounds. Fewer than 100 remained at the lake from September to November. I recorded nesting only once during the study period (in spring, 1977), but at least two pairs nested successfully the following year. Canada Geese fed mainly on pasture immediately north and south of the lake and occasionally flew to fields many kilometres from the lake to feed at night.

### PARADISE SHELDUCK *Tadorna variegata*

The Paradise Shelduck population at Lake Wainono followed a similar pattern to that of the Canada Goose with a post-breeding peak in numbers from January to April (Fig. 3e). Many of these birds moulted at the lake. Only a small percentage of Paradise Shelducks returned after the shooting season indicating dispersal to other localities, including perhaps the breeding grounds. By October almost all the birds remaining were breeding pairs which nested at haystacks, ponds and streams near the lake.

Since 1969 there has been a spectacular increase of Paradise Shelducks at the lake: the maximum count in 1969 was of 52 birds, but by 1978 it had increased to c. 1600 (Fig. 4c). Apart from 1969, when there was little water in the lake and surrounding pools, the quality of habitat for waterfowl has not visibly improved over the years. The increase in numbers, therefore, probably reflects a general increase of the Paradise Shelduck throughout South Canterbury, a reversal of the trend for the previous twenty years of excessive shooting (Williams 1971). During this study the Paradise Shelduck could not be shot at Lake Wainono. Since 1973, it has only gradually been returned to the game list in the Waitaki Valley, and in 1978 small numbers were shot at Lake Wainono (Waitaki Valley Acclimatisation Society Annual Report, 1978). This low hunting pressure has probably permitted the increase in population size. I have observed a similar increase inland in the Lake Tekapo region since 1968.

### DUCKS *Anas* spp.

Four *Anas* species were common at the lake throughout the study period. The Mallard (*A. platyrhynchos*) was the most common and the Grey Duck (*A. superciliosa*) the least common, while Grey

Teal (*A. gibberifrons*) and New Zealand Shoveler (*A. rhynchotis*) were in about equal numbers. Mixed flocks containing up to 400 of each of Grey Teal and Shoveler were regularly seen. All four species nested at the lake and reached peak numbers in summer and autumn. The maximum count of ducks (for 1977) was c. 4000 in March and April.

#### AUSTRALASIAN HARRIER *Circus approximans*

Harriers were too mobile to be counted accurately. Increased sightings in autumn and winter, however, probably represented a seasonal influx of birds to the lake. Harriers nested at several sites around the lake, particularly in long grass and on *Juncus*, and one was on the base of a disused Black Swan nest. I have seen Harriers successfully kill a Spotted Shag and a Mallard and attempt to prey on these species and other species of waterfowl.

#### MARSH CRAKE *Porzana pusilla*

I occasionally say Marsh Crakes in the rushes on the western side, in the flax and willow thickets beside two of the inlet streams, and along the outlet stream. About 1970, several pairs of Marsh Crakes and a single Spotless Crane (*P. tabuensis*) were located along the outlet stream within a few kilometres of the lake by a former Acclimatisation Society ranger, Mr Mervyn Keioller (pers. comm.).

#### PUKEKO *Porphyrio porphyrio*

The Lake Wainono area has the greatest concentration of Pukekos in South Canterbury and single flocks of up to 300 birds were seen during some visits. They breed mostly on the densely vegetated western side of the lake from where they disperse to feed, particularly in the damp fields to the south-west. The *Elaeocharis* flats north of the lake support a small breeding population. Few birds were seen foraging on the open mudflats, except where *Juncus* or other plants were growing nearby. In 1977 the Pukeko population was highest during autumn and early winter and lowest during spring.

#### SOUTH ISLAND PIED OYSTERCATCHER *Haematopus ostralegus*

Unlike the Washdyke Lagoon area, which had flocks of oystercatchers throughout the year (Sagar 1976), Lake Wainono was used by oystercatchers only in the winter and spring, with peak numbers from July to October (Fig. 3f). Almost all these birds were non-breeders because the flocks remained throughout the spring, whereas the few birds that nested around the lake were usually territorial by July and had laid eggs by August. They fed mostly in the damp pastureland to the south and south-west of the lake, where earthworms and grassgrubs were the main prey and were easily accessible. Few oystercatchers fed in the lake, probably because large prey such as bivalves and polychaetes were absent.

In late summer and autumn, when a post-breeding influx of

birds from inland South Canterbury might be expected, almost no oystercatchers were at the lake. Perhaps after October the food supply in the pastures was poor. In the pastures of mid-Canterbury, East & Pottinger (1975) found that the large third-instar larvae of grassgrubs were available for Starlings (*Sturnus vulgaris*) during winter and early spring but that the ensuing prepupal and pupal stages were smaller and not eaten by Starlings. Oystercatchers remaining at the Lake Wainono pastures after October would have to subsist mainly on earthworms, but earthworms also become less accessible as summer approaches, firstly because dropping soil moisture causes them to move to greater depths (Barnes 1968), and secondly because the ground hardens making it more difficult for oystercatchers to probe. In some irrigated pasture areas of South Canterbury, small flocks of oystercatchers may persist until February, suggesting that inaccessibility of earthworms is an important factor in the Lake Wainono exodus. The summer and autumn flocks at Washdyke Lagoon can be explained by their foraging mainly along the rocky seashore (P. M. Sagar, pers. comm.), a habitat not at Lake Wainono.

During the 1969 drought, fewer oystercatchers visited Lake Wainono than in any other year (Fig. 5). They were not seen feeding in the pastures, most feeding instead on midge larvae in the lake. A combination of three factors — hard soil, stunted growth of grassgrub larvae (East & Pottinger 1975) and deep burrowing of prey — probably contributed to the low numbers of oystercatchers in 1969, but the relative importance of each factor remains uncertain. Conversely, all the high counts (maximum of 162 in August 1968) coincided with wet pastures and the readily available food.

#### SPUR-WINGED PLOVER *Vanellus miles novaehollandiae*

The Spur-winged Plover was first reported in the Lake Wainono area in 1965 (Barlow 1972). During the study period it increased considerably at Lake Wainono (Fig 4d), reflecting its general increase and expanded range throughout South Canterbury. By the 1977 winter, flocks of over 100 were regularly seen with the highest count 153 in August 1977. Fewer birds were present in summer and autumn (Fig. 3g). The presence of large flocks during much of the breeding season (eggs laid mainly in July and August by the several pairs nesting at Lake Wainono) indicates that many of the birds present were non-breeders or perhaps late breeders.

Spur-winged Plovers preferred the damp fields around the lake, where earthworms and grassgrubs were taken on and just below the surface. Recently ploughed land was as popular with Spur-winged Plovers as with oystercatchers and Black-billed Gulls (*Larus bulleri*). During the 1969 drought no more than three birds were seen per visit and on four visits none was seen. Up to 23 birds were recorded the following year when the rainfall was normal. Like oystercatchers, Spur-winged Plovers occasionally visited the lakeshore to feed.

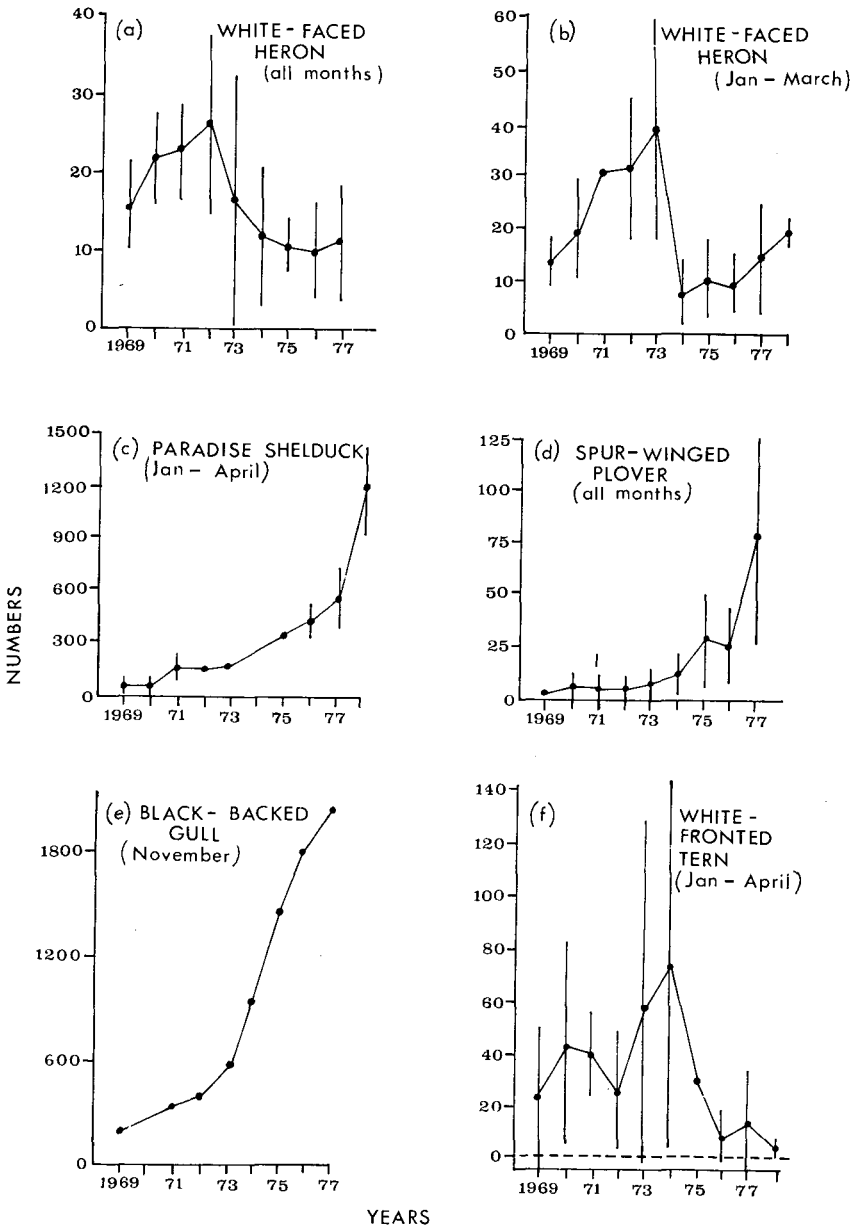


FIGURE 4 — Long-term changes in populations of five species. The vertical lines are standard deviations of the means.

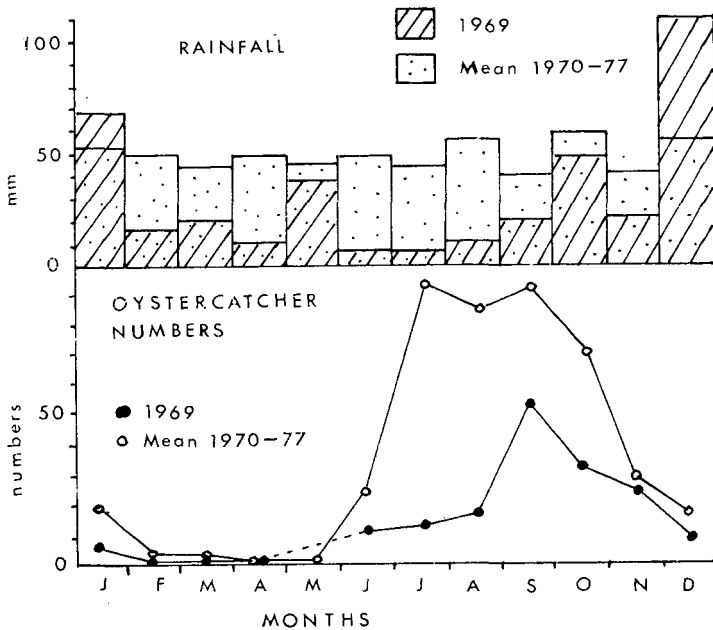


FIGURE 5 — Rainfall and oystercatcher numbers. Rainfall was recorded at Waimate Meteorological station, 8 km south-west of Lake Wainono.

#### BANDED DOTTEREL *Charadrius bicinctus*

Post-breeding flocks of Banded Dotterels began to form at Lake Wainono in mid-December with peak numbers occurring in January and February (Fig. 3h). The highest count was 380 in January 1977. Although large numbers of dotterels left the lake in autumn, up to 50% of the summer number remained for the winter. A further decline in August coincided with the return of birds to their breeding grounds in inland South Canterbury. Usually fewer than 60 birds were present from August to November, of which only 5-10 pairs nested along the inner margin of the shingle beach and mainly south of the lake. This scarcity of nesting birds was probably due to a shortage of their preferred nesting habitat — flat expanses of shingle with low plant cover (Bomford 1978). In August most dotterels at the lake were in adult plumage and by September all were in adult plumage. By mid-October the first juveniles were seen. During summer and autumn the non-breeding flocks foraged mainly in the short-turfed fields south of the lake, and few occurred at the lake's edge unless mudflats were exposed. During winter and spring most birds foraged beside the lake.



**WRYBILL** *Anarhynchus frontalis*

Wrybills visited Lake Wainono from August to January with peak numbers occurring in September and October (Fig. 3i). The highest counts were 81 in October 1969 and 73 in September 1970, when there were extensive mudflats suitable for their feeding. On the mudflats Wrybills fed on amphipods and adult and larval midges, while at the ponds south of the lake they also ate adult and larval shoreflies. All the Wrybills at Lake Wainono were in breeding plumage, but the late peak in numbers (September-October) suggests that not all would nest that year (R. Hay, pers. comm.). No juveniles or post-breeding flocks of adults were seen, despite an abundance of amphipods and other suitable food throughout the summer. This contrasts with Lake Ellesmere, which has a similar invertebrate fauna to Lake Wainono, where I have seen flocks of up to 30 adults and juveniles as late as 19 February. The absence of post-breeding Wrybills from Lake Wainono might be because South Canterbury birds can find mudflat food at the many inland tarns and lagoons near their usual riverbed habitat (Pierce 1979), and so they by-pass Lake Wainono on their northward migration. At one tarn near Lake Tekapo I have seen post-breeding flocks of up to 25 birds in January and February, with a few birds remaining until March or April.

**BAR-TAILED GODWIT** *Limosa lapponica***TURNSTONE** *Arenaria interpres***KNOT** *Calidris canutus*

These three Northern Hemisphere migrants visited Lake Wainono in spring and early summer, but almost all had left by mid-December (Fig. 3j, k, l). Only two Bar-tailed Godwits were recorded in February, the month when peak numbers occur in Otago Harbour (Otago Branch, OSNZ, pers. comm.). All three species disappeared from the lake in December perhaps because, with the emergence of the largest (fourth instar) midge larvae, the biomass of exploitable mudflat food was temporarily but greatly reduced by early summer. By mid-summer almost all these birds had moved to other presumably more profitable feeding grounds in New Zealand. In March a few northbound Bar-tailed Godwits and Turnstones — usually in partial breeding plumage — paused at the lake and fed on the next generation of midge larvae, which had by then increased in size. All the Bar-tailed Godwits and Turnstones seen in winter were in non-breeding plumage, and birds in partial or complete breeding plumage were not seen until late September. In October, up to 50% of all three species retained traces of breeding plumage.

**SHARP-TAILED SANDPIPER** *Calidris acuminata*

The Sharp-tailed Sandpiper was the only northern hemisphere wader to spend the whole summer at Lake Wainono. Peak numbers occurred in January and February (Fig. 3m) with the highest count

23 in February 1973. These sandpipers could exploit amphipod prey after the midges had emerged and so they found the lake suitable for feeding throughout the New Zealand summer. None was seen in winter.

#### PIED STILT *Himantopus himantopus leucocephalus*

Pied Stilts were the most common wader regularly at Lake Wainono and the highest count was 1392 in November 1970. Their numbers followed the pattern of other South Island breeding birds with a post-breeding increase during the summer and a decrease in autumn (Fig. 3n). From February to April small flocks were regularly heard flying north at night en route to the northern North Island where large numbers spend the winter (Sibson & McKenzie 1944, Veitch 1978). Many birds remained at Lake Wainono, however, and winter numbers were about one-third of the summer numbers. On the lake, the stilts usually ate amphipods, midge larvae and mysids, but they also ate larval and adult shoreflies at the nearby ponds and, in winter and spring, earthworms and grassgrubs in the fields. From August to December, a few stilts nested around the edges of the lake and at some of the ponds.

#### BLACK-BACKED GULL *Larus dominicanus*

Black-backed Gulls used Lake Wainono for nesting and roosting only, feeding almost entirely elsewhere. Peak numbers occurred during the height of the breeding season from October to January, and few birds were present by day in autumn and early winter (Fig. 3o). In all seasons, however, evening roosts contained many hundreds or thousands more birds than were present during the day. Some birds foraged in farmland west of the lake, but most flew north along the beach in the early morning and returned from the north in the late evening, suggesting that most of the large numbers of Black-backed Gulls at the coastal effluent discharge of the Pareora Freezing Works 25 km to the north, were Lake Wainono birds. From 1969 to 1977 the Lake Wainono breeding population increased ten-fold (Fig. 4e). In 1969 the colony occupied the peninsula at the south end of the lake but in subsequent years it spread over many hectares of adjacent pastureland. The local abundance of food possibly assisted the spectacular increase in gull numbers, although the freezing works had been operating for many years before 1969.

#### BLACK-BILLED GULL *Larus bulleri*

Post-breeding flocks of Black-billed Gulls occurred at Lake Wainono from January to April, the highest count being c. 5000 in January 1974. Few birds were present in winter (Fig. 3p). Up to 1000 were seen during spring when 150-200 pairs sometimes nested on the peninsula at the south end of the lake and particularly at the pools south of the lake. At the pools, nests were closely spaced on small islands and usually 50 or more fledglings were reared. These

nest sites were unusual because Black-billed Gulls normally nest inland on shingle riverbeds and the other few coastal nest sites I have seen in Canterbury have been at rivermouths. When the lake was low, flocks of Black-billed Gulls foraged for amphipods on the mudflats, but at higher lake levels they foraged further afield and returned only to roost. Like Black-backed Gulls, large evening roosts formed at the lake, particularly on the peninsula at the south end.

#### BLACK-FRONTED TERN *Sterna albostrata*

Lake Wainono was used by Black-fronted Terns mainly as a roosting area, with most feeding being carried out along the open sea coast where they were excluded from the counts. Despite the lake being unimportant for feeding, a seasonal pattern of Black-fronted Tern abundance was evident and it corresponded closely with the pattern I found during three years (1968-70) of sea-watching at St Andrews, 20 km north of Lake Wainono. Peak numbers occurred at the lake during the autumn and winter (Fig. 3q), but there were no records from September to November, the early part of the breeding season in inland South Canterbury and North Otago (Lalas 1979).

The highest count of terns was 60 in June 1974, on a day when the sea was particularly rough, perhaps disrupting normal feeding there. Only occasionally did I see birds catching small fish in the lake and unidentified aerial insects over the mudflats.

#### CASPIAN TERN *Hydroprogne caspia*

Although recorded in all months of the year, Caspian Terns were uncommon at Lake Wainono, the highest count being only nine in May 1977. Greatest numbers occurred from December to May, with fewer birds during the winter and spring (Fig. 3r). The scarcity of birds at Lake Wainono in winter contrasted with the Opihi River mouth, 60 km to the north, where at the same time of year, I have seen flocks of up to 32 birds. Both areas support large numbers of fish — the staple diet of Caspian Terns — but whereas the water is clear at the Opihi River mouth, Lake Wainono was often very turbid, preventing the terns from seeing their prey. No birds were seen at the lake during the 1969 drought when the water was turbid all year. In the spring of 1977, a pair of Caspian Terns raised a chick in the Black-backed Gull colony, this being the only nesting I have found at the lake. In December 1978 the colour-banded juvenile was seen at the Opihi River mouth.

#### WHITE-FRONTED TERN *Sterna striata*

White-fronted Terns occurred irregularly at Lake Wainono but were generally most common during summer and autumn (Fig. 3s) when juveniles as well as adults visited the lake. Like Black-fronted Terns, White-fronted Terns used the lake mainly for roosting by day and by night, the southern peninsula and the many posts in the lake being the favoured sites. Since 1975 the White-fronted Tern population

has declined (Fig. 4f) for unknown reasons, the pooled counts of 1976-78 being significantly less than the pooled counts of 1969-75 ( $t = 3.52$ , 84 d.f.,  $p < 0.001$ ). Unfortunately no regular counts were made at the two local breeding colonies at the mouths of the Waitaki and Opihi Rivers.

#### WELCOME SWALLOW *Hirundo tahitica neoxena*

Although the many ponds, streams and mudflats around Lake Wainono provide good feeding grounds for fly-catching birds throughout the year, Welcome Swallows were common during the non-breeding season only (Fig. 3t). Each year numbers began to increase in late February and flocks occurred during autumn and winter, but by mid-September most had dispersed for breeding. The Lake Wainono area is currently the most southerly breeding centre for Welcome Swallows in New Zealand but the breeding population is quite small (5-10 pairs) and cannot account for all of the winter influx. This and observations of southbound flocks in South Canterbury and Otago during late summer and autumn suggest that many swallows disperse southward from breeding grounds further north. A winter influx of swallows to Otago and Southland is also well in excess of the few known isolated pairs (Dr R. F. Smith, R. R. Sutton, pers. comm.).

#### OTHER PASSERINES

Several species of introduced passerines visited the edges of Lake Wainono to feed but they were not counted. When the lake was low, flocks of Yellowhammers (*Emberiza citrinella*), Skylarks (*Alauda arvensis*) and Starlings (*Sturnus vulgaris*) fed on invertebrates and/or seeds on the mudflats. House Sparrows (*Passer domesticus*) and Starlings regularly nested on the shooters' maimais in the lake. A complete list of all passerines seen at the lake is included in Appendix 1.

#### LOCALLY EXTINCT SPECIES

Five species that occurred commonly in the Lake Wainono area during the late nineteenth century (Studholme 1940), were not recorded from 1968 to 1978 and are presumed locally extinct. They are Dabchick (*Podiceps* sp.), Brown Teal (*Anas aucklandica*), Buff Weka (*Gallirallus australis hectori*), Australian Avocet (*Recurvirostra novaehollandiae*) and Fernbird (*Bowdleria punctata*).

#### SUMMARY OF SEASONAL TRENDS

Of the 32 species commonly recorded at Lake Wainono, at least 30 had seasonal variations in their numbers. There were three seasonal patterns with highest numbers occurring in either (i) winter, (ii) spring/early summer, or (iii) summer-early autumn. The remaining two species (Bittern and Marsh Crane) were seen too seldom for any seasonal change to be noted.

*Winter peak*

Six species of birds reached peak numbers at Lake Wainono during the winter. Two of these, the Black Shag and Black-fronted Tern, were non-breeding visitors from inland South Canterbury or Otago and appeared to use the lake mainly for roosting. Wintering flocks of Welcome Swallows and probably Pied Oystercatchers had a northern origin, while Harriers and Spur-winged Plovers were probably local breeders. The last four species nested in small numbers near the lake during spring.

*Spring/early summer peak*

Five species were most common at the lake during spring and early summer. Three of these (Bar-tailed Godwit, Turnstone and Knot) are migrants from the Northern Hemisphere and their stay at the lake was quite brief. They had usually left by December, probably because of a scarcity of suitable prey after December. Pre-breeding flocks of Wrybills paused at the lake, the greatest numbers occurring in September and October, over a month before the Northern Hemisphere waders. The Black-backed Gull was the only lake-breeding species that reached peak numbers in spring. Other species nesting regularly at the lake (Appendix) did not increase significantly until after the breeding season.

*Summer/early autumn*

Nineteen species reached their peak in summer and/or early autumn. Except for the Sharp-tailed Sandpiper, all were New Zealand breeders congregating temporarily at Lake Wainono after the breeding season. They were Little Shag, White-faced Heron, White Heron, Royal Spoonbill, all waterfowl (seven species), Pukeko, Banded Dotterel, Pied Stilt, Black-billed Gull, Caspian Tern and White-fronted Tern. Most of these species breed inland in large numbers and move to the coast afterwards.

The autumn migration from Lake Wainono was complete for only two (Royal Spoonbill and Sharp-tailed Sandpiper) of the 19 species, with up to 50% of the numbers of some species remaining during the winter. Food was still available to aquatic-feeding species during winter because temperatures were not low enough for the lake to freeze over. Nor did the ground in surrounding fields remain frozen for long enough each day to prevent probing birds such as oystercatchers obtaining sufficient food. The precise numbers of each over-wintering species probably depended on an interplay of several factors, such as normal dispersal habits, prey behaviour and abundance, daylength available for feeding, and seasonal changes in metabolic requirements.

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## APPENDIX 1 — Birds recorded at Lake Wainono, 1968-1978.

SPECIES	No. of records	Max. count	Months seen (1 = Jan. 2 = Feb. etc.)	HABITATS					
				B = breeding seen	Mudflats	Lake	Pond	Farmland	Thickets
Sooty Shearwater	1	2+	3		X				
Australian Pelican	2	3	2,4		X				
Australasian Gannet	6	2	3,4,5		X				
Black Shag	C	155	1-12		X				
Little Black Shag	2	3	1,2		X				
Little Shag	C	35	1-12		X				
Spotted Shag	4	100	4-6		X				
White-faced Heron	C	75	1-12	X	X	X		X <sup>B</sup>	
White Heron	C	7	1-12		X	X			
Little Egret	2	1	5,6		X				
Cattle Egret	4	2	4,5,8,10					X	
Australasian Bittern	C	2	1-12			X			X
Glossy Ibis	5	4	2,3,4,12	X	X	X			
White Ibis	1	1	12			X			
Royal Spoonbill	C	13	1-4,11,12		X				
Mute Swan	1	1	6		X				
Black Swan	C	2550	1-12	X	X <sup>B</sup>	X <sup>B</sup>	X		X <sup>B</sup>
Canada Goose	C	2000	1-12	X	X	X	X		X <sup>B</sup>
Paradise Shelduck	C	1600	1-12	X	X	X <sup>B</sup>	X <sup>B</sup>		
Grey Teal	C	-	1-12	X	X	X	X		X <sup>B</sup>
Grey Duck	C	-	1-12	X	X	X <sup>B</sup>	X		X <sup>B</sup>
Mallard	C	-	1-12	X	X	X <sup>B</sup>	X <sup>B</sup>		X <sup>B</sup>
NZ Shoveler	C	-	1-12	X	X	X	X		X
NZ Scaup	1	3	3		X				
Australasian Harrier	C	17	1-12	X	X	X	X <sup>B</sup>		X <sup>B</sup>
Nankeen Kestrel	1	1	12				X		
Marsh Crake	C	3	1-12						X
Spotless Crake	1	1	?						X <sup>-</sup>
Pukeko	C	700	1-12	X	X	X <sup>B</sup>	X <sup>B</sup>		X <sup>B</sup>
SI Pied Oystercatcher	C	162	1-12	X			X <sup>B</sup>		
Black Oystercatcher	2	1	2,8	X					
Spur-winged Plover	C	153	1-12	X		X	X <sup>B</sup>		
Least Golden Plover	14	3	1-3,11,12	X		X	X		
NZ Dotterel	2	1	2,10	X					
Banded Dotterel	C	380	1-12	X		X	X <sup>B</sup>		
Oriental Dotterel	1	1	1	X					
Black-fronted Dotterel*	1	1	4	X					
Wrybill	C	81	1,8-12	X		X			
Far-eastern Curlew	1	1	10	X					
Asiatic Whimbrel	1	1	1	X					
Little Whimbrel	1	1	11			X			
Bar-tailed Godwit	C	135	1-5,7-12	X		X	X		

## APPENDIX 1 — Continued

Asiatic Black-tailed Godwit	3	2	5,7,12		X	X	
Lesser Yellowlegs	2	1	2,3	X			
Greenshank	2	1	1,10	X	X		
Turnstone	C	25	1-7,9-12	X	X		
Knot	C	27	10-12	X	X		
Sharp-tailed Sandpiper	C	23	1-4,10-12	X	X		
Pectoral Sandpiper	11	4	1-4,12		X		
Curlew Sandpiper	7	5	1,3,6,9, 11,12	X	X		
Red-necked Stint	17	13	1-3,6,8, 10-12	X	X		
Pied Stilt	C	1392	1-12	X	X	X <sup>B</sup>	X <sup>B</sup>
Black Stilt	4	1	2,3,11,12	X	X	X	
Oriental Pratincole	1	1	3	X			
Southern Skua	1	1	11		X		
Arctic Skua	12	3	1-4,12		X		
Black-backed Gull	C	2150	1-12	X	X		X <sup>B</sup>
Red-billed Gull	2	1	11,12		X		
Black-billed Gull	C	5000	1-12	X	X	X <sup>B</sup>	X
Black-fronted Tern	C	60	1-8,12	X	X	X	
White-winged Black Tern	6	4	2,6,7,12	X	X	X	
Caspian Tern	C	9	1-12	X	X		X <sup>B</sup>
Little Tern	2	1	11,12	X	X		
White-fronted Tern	C	225	1-12	X	X	X	
Rock Pigeon	C	-	1-12				X
Shining Cuckoo	C	-	9-12				X
Long-tailed Cuckoo	2	1	10,11				X
Little Owl	C	2	1-12				X
Little Kingfisher	6	2	4,5,8		X	X	
Skylark	C	-	1-12				X <sup>B</sup>
Australian Tree Martin	1	1	6			X	
Welcome Swallow	C	90	1-12	X	X	X	X <sup>B</sup>
NZ Pipit	C	4	2-8,12	X			X
Hedgesparrow	C	-	1-12				X <sup>B</sup>
Grey Warbler	C	-	1-12				X <sup>B</sup>
Fantail	C	-	1-12				X <sup>B</sup>
Song Thrush	C	-	1-12			X <sup>B</sup>	X <sup>B</sup>
Blackbird	C	-	1-12			X <sup>B</sup>	X <sup>B</sup>
Silvereye	C	-	1-12			X	X
Bellbird	2	1	5,7				X
Yellowhammer	C	-	1-12	X		X <sup>B</sup>	X <sup>B</sup>
Chaffinch	C	-	1-12			X <sup>B</sup>	X <sup>B</sup>
Greenfinch	C	-	1-12			X <sup>B</sup>	X <sup>B</sup>
Goldfinch	C	-	1-12			X <sup>B</sup>	X <sup>B</sup>
Redpoll	C	-	1-12			X <sup>B</sup>	X <sup>B</sup>
House Sparrow	C	-	1-12		X <sup>B</sup>	X <sup>B</sup>	X <sup>B</sup>
Starling	C	-	1-12	X		X <sup>B</sup>	X <sup>B</sup>
Magpie	C	-	1-12			X <sup>B</sup>	X
Rook	1	1	12				X

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## SHORT NOTE

### SPINE-TAILED SWIFTS IN SOUTH OTAGO

At 11 a.m. NZDST on 16 February 1979, at Tautuku Lodge, South-east Otago, about 30 km south of Owaka on Highway 92, I noticed a Spine-tailed Swift (*Chaetura caudacuta*) and pointed it out to my companions Roger McElwain, Geoff Patterson, Paul Wright and Tony Harris. Closer observation revealed the presence of six birds, and over the next 15 minutes this increased in steps through 9 and 12 to 13. Five minutes later, at 11.20 a.m., a large flock appeared over the bush to the west, bringing the total number to at least 60.

The weather was overcast with light rain. The birds were flying fairly high over the bush (which in this area is podocarp-hardwood forest) with a rapid bat-like flight, interspersed with brief glides. They had long swept-back pointed wings and square tails. They were completely dark with under the tail a patch of white that was not easy to see. No white was noticed under the chin but could easily have been missed in the light conditions.

We last saw 25 of them flying over the Fleming River valley while we were looking for Fernbirds. We then left the area for the Tautuku Estuary.

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