Effect of water levels on the seasonal use of Lake Wairarapa by waders

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ABSTRACT

The eastern shore of Lake Wairarapa is a nationally important site for waders. The monthly distributions of eleven species of wader and of White-faced Herons (*Ardea novaehollandiae*) are presented from monthly counts between November 1983 and October 1994. Numbers of Spur-winged Plovers (*Vanellus miles*) increased dramatically during this period.

Water levels in this shallow freshwater lake vary with regional rainfall, the management of floodgates at the outlet of the lake, and wind direction and strength. Numbers of Pied Stilt (*Himantopus himantopus*), Banded Dotterel (*Charadrius bicinctus*) and Black-fronted Dotterel (*C. melanops*), for which the lake is an important wintering site, declined once the water level rose over about 10.3 m above an imaginary reference point (datum), and also declined below about 9.95 m above datum. Our findings confirm the importance of managing lake levels and we discuss how these data were used in setting operating levels for a water right application to operate the floodgates at the outlet of the lake.

KEYWORDS: waders, water levels, lake management, conservation, Lake Wairarapa

INTRODUCTION

Lake Wairarapa (41°15'S, 175°15'E) is a large shallow freshwater lake at the southern end of the North Island. It has an area of 7800 ha and is generally less than 2.5 m deep (Fig. 1). The lake and its associated wetlands on the eastern side and nearby Lake Onoke together form the largest wetland complex in the southern North Island. These wetlands are considered of national importance for flora and fauna (Moore *et al.* 1984), and the National Water Conservation (Lake Wairarapa) Order 1989 specifically recognised the outstanding wildlife habitat on the eastern shoreline of Lake Wairarapa. The wetland system is also an integral part of the Wellington Regional Council's flood management scheme for the southern Wairarapa, with Lake Wairarapa acting as a reservoir to store excess flood waters. The water level in the lake can be varied by opening or closing floodgates at its outlet.

The wetlands have been significantly modified over the past 150 years. The lake-bed was lifted by a severe earthquake in 1855, and much of the wetland has been drained for agricultural development. In 1967, the Ruamahanga River was diverted to flow directly into Lake Onoke, and thus bypass Lake Wairarapa. Since 1974, the water levels in the lake have been largely controlled by the Wellington Regional Council which opens or closes six floodgates at the outlet of the lake. Nowadays, Lake Wairarapa is fed by the Tauherenikau River at the northeastern corner; several small streams draining the eastern side of the Rimutaka Range

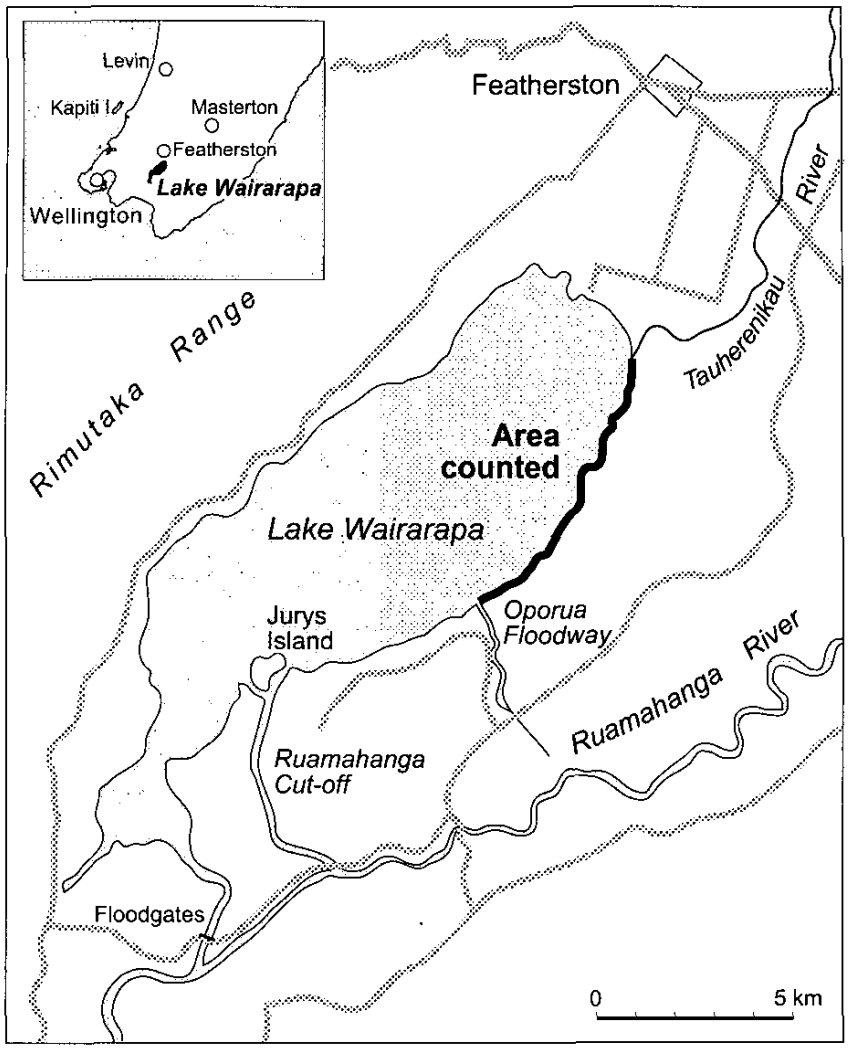

FIGURE 1 – Map of Lake Wairarapa showing the section of the eastern shore that was counted monthly, 1984-94.

enter the western side of the lake and, under flood conditions, it receives excess water from the Ruamahanga River via the Oporua Floodway in the middle of the eastern shore.

The western and eastern shores of the lake are physically and biologically very different. The western side is close to the foothills of the Rimutaka Range and the shoreline margin is narrow between farmland and open water. By contrast, the shore on the eastern side is very wide as the shore slopes gradually from open water through zones of different wetland vegetation types to farmland. Natural fluctuations in water level caused by rainfall and the effect of the prevailing north-westerly onshore wind have created zones of vegetation with varying degrees of tolerance to inundation. These periodically inundated and shallow water habitats on the eastern shore are the favoured haunts of wading birds (Moore *et al.* 1984), especially in the section between the Tauherenikau River and the Oporua Floodway.

Lake Wairarapa has been known as an interesting site for waders since the 1940s (Stidolph 1971); however, the habitat for waders has improved since the

major flood diversion works were implemented in the early 1970s. The reduced variation in water levels, and especially the shorter periods of flooding and drying, has encouraged a community of marsh turf plants to develop on the eastern shore and this presumably provides better habitat for invertebrates and hence waders. Before our study began, Moore *et al.* (1984) had recorded 21 species of wader at Lake Wairarapa and analysed the habitat use of ten of the species between November 1982 and October 1983. Their study showed that Lake Wairarapa was a nationally important site for several waders, and that the native marsh turf plants, saturated bare ground and very shallow water habitats found on the eastern shore were the preferred feeding habitats.

In this paper we analyse the monthly pattern of use of Lake Wairarapa by waders, and the long-term changes in numbers of some species, from a series of monthly counts over the 10-year period from 1984 to 1994. We investigate the effect that water levels have on the abundance of waders, taking into account the natural seasonal fluctuations in numbers of birds. A preliminary analysis of these data (5.5 years to April 1990) was used by the Department of Conservation in the process of preparing guidelines for the management of the lake (Robertson 1991) and also used by the Wellington Regional Council to set operational targets for lake levels as part of a water right application to manage the floodgates.

METHODS

Once every month, between November 1984 and October 1994, we counted the number of wading birds seen on the 8 km of lake shore and adjacent farmland between the Tauherenikau River delta and the Oporua Floodway. A few counts were done by other observers when we were busy counting waders elsewhere on the lakeshore during complete censuses of the lake.

Mean daily lake levels on the counting days were supplied by the Wellington Regional Council. The data are given as the height in metres above an imaginary "datum", rather than referring to the actual depth of the lake; recorded at the Burlings gauge on the western shore, they are only an approximation of the conditions on the eastern shore. 'Wind-set' from the prevailing north-westerly wind can increase daily mean water levels on the eastern shore by up to 0.5 m compared with the western side (Ian Gunn, Wellington Regional Council, unpubl. data); however, we generally avoided doing counts on very windy days. We were unable to do complete transects of the lakeshore when water levels were very high, because some stream-crossings would have been too dangerous. Instead, we visited the lake shore at various points to check the small areas of habitat that had not been inundated.

RESULTS

A total of 25 species of waders has now been recorded at Lake Wairarapa (Table 1); all have been found in the periodically inundated mosaic of marsh turf, short rushes and bare mud and sand on the eastern shore of the lake or nearby ponds. During our 120 monthly counts, we recorded 20 species of wader, includ-

TABLE 1 – Complete list of waders ever recorded at Lake Wairarapa. The columns show the maximum number recorded during our 120 counts in 1984-94, the number of times they were recorded during the 120 monthly counts on the eastern shore of Lake Wairarapa, and the number of years during which they were recorded.

Species	Scientific Name	Maximum	No. months	No. years
Pied Oystercatcher	*Haematopus ostralegus*	41	113	10
Variable Oystercatcher	*Haematopus unicolor*	31	84	10
Pied Stilt	*Himantopus himantopus*	1429	120	10
Black Stilt	*Himantopus novaezelandiae*	2	6	3
Banded Dotterel	*Charadrius bicinctus*	458	118	10
Black-fronted Dotterel	*Charadrius melanops*	117	94	10
Wrybill	*Anarhynchus frontalis*	5	10	7
Pacific Golden Plover	*Pluvialis fulva*	103	40	9
Spur-winged Plover	*Vanellus miles*	851	119	10
Turnstone	*Arenaria interpres*	5	8	6
Japanese Snipe	*Gallinago hardwickii*	3	2	1
Lesser Knot	*Calidris canutus*	55	24	9
Great Knot	*Calidris tenuirostris*	0	0	0
Curlew Sandpiper	*Calidris ferruginea*	1	10	5
Sharp-tailed Sandpiper	*Calidris acuminata*	19	47	10
Pectoral Sandpiper	*Calidris melanotos*	5	25	9
Red-necked Stint	*Calidris ruficollis*	2	4	4
Whimbrel	*Numenius phaeopus*	0	0	0
Little Whimbrel	*Numenius minutus*	0	0	0
Bar-tailed Godwit	*Limosa lapponica*	216	59	10
Black-tailed Godwit	*Limosa limosa*	0	0	0
Hudsonian Godwit	*Limosa haemastica*	1	2	2
Greenshank	*Tringa nebularia*	1	8	5
Marsh Sandpiper	*Tringa stagnatilis*	2	4	4
Lesser Yellowlegs	*Tringa flavipes*	0	0	0

TABLE 2 – The national importance of Lake Wairarapa to six wader species.

Species	Mean annual maximum[1]	Estimated national population[2]	National % at Lake Wairarapa
Pied Stilt	909	30,000	3.0
Banded Dotterel	385	50,000	0.8
Black-fronted Dotterel	82	1700	4.8
Golden Plover	55	900	6.1
Sharp-tailed Sandpiper	6.7	125	5.4
Pectoral Sandpiper	2.9	15	18.7

[1]often from counts covering the entire eastern shore
[2]data from Heather & Robertson (1996)

ing national rarities such as Black Stilt (*Himantopus novaezelandiae*), Japanese Snipe (*Gallinago hardwickii*), Hudsonian Godwit (*Limosa haemastica*), Greenshank (*Tringa nebularia*) and Marsh Sandpiper (*T. stagnatilis*).

During national wader censuses between 1984 and 1994, Lake Wairarapa was consistently placed in the top 15 sites nationally for waders, and second only to Lake Ellesmere as a freshwater wetland used by waders (Sagar *et al.* 1999). Lake Wairarapa proved to be an important national site for at least six waders: Pied Stilt, Banded Dotterel (*Charadrius bicinctus*), Black-fronted Dotterel (*C. melanops*), Pacific Golden Plover (*Pluvialis fulva*), Sharp-tailed Sandpiper (*Calidris acuminata*) and Pectoral Sandpiper (*Calidris melanotos*). For each of these species, the annual average maximum count at Lake Wairarapa was close to or greater than 1% of the estimated national population (Table 2).

The monthly pattern of occurrence of these six species plus the other five most common waders - Pied Oystercatcher (*Haematopus ostralegus*), Variable Oystercatcher (*H. unicolor*), Spur-winged Plover (*Vanellus miles*), Lesser Knot (*Calidris canutus*) and Bar-tailed Godwit (*Limosa lapponica*) - and White-faced Herons (*Ardea novaehollandiae*) are given in Table 3. The patterns were consistent between years and are generally similar to those reported for other New Zealand wetlands where waders have been counted monthly (Sagar 1976, Pierce 1980, Owen & Sell 1985). There were two exceptions: the numbers of Pied Oystercatchers remained remarkably constant throughout the year apart from a decline in November and December, and so perhaps the birds using Lake Wairarapa are mainly immature; and the numbers of Pied Stilts peaked in autumn rather than in summer as had been noted by Sagar (1976) and Pierce (1980) at coastal lagoons in Canterbury. Arctic migrants used the lake mainly from late spring to autumn, and the native waders generally used the lake mainly from late summer to winter. Spur-winged Plovers were exceptional, as their seasonal peak was in late spring and early summer, perhaps comprising mainly young-of-the-year and non-breeding adults. White-faced Heron numbers were variable throughout the year.

Numbers of each species of wader using the wetlands remained approximately constant through the 10-year period, except that Spur-winged Plover numbers increased greatly from a maximum of 211 birds in 1984/85 to a maximum of 851 birds in 1993/94 ($r=0.93$, $P<0.001$). The median monthly count of Spur-winged Plovers increased from 42 in the first year to 290 in the tenth year ($r=0.96$, $P<0.001$; Fig. 2), reflecting their increasing prevalence in the Wairarapa since they first bred in the region in 1976 (Sim 1976).

Lake Wairarapa is an important wintering site for three native wader species (Pied Stilt, Banded Dotterel and Black-fronted Dotterel), and so we analysed the effect of lake water level on their numbers. Because of the marked seasonal variation in numbers of each species, we plotted their relative abundance (numbers expressed as a percentage of the monthly mean for the 10 years) against lake level on the day of the count. In this analysis, we included data for months in which the 10-year mean for that species was >20, i.e., all months for Pied Stilts, eight months

TABLE 3 – Mean (and standard deviation) of monthly counts for White-faced Herons and 11 wader species at Lake Wairarapa (1984-94).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
White-faced Heron	5.9 (4.7)	19 (8)	13 (5)	8.1 (5.4)	5.6 (5.3)	11 (4)	12 (9)	8.4 (13.3)	7.3 (4.2)	12 (9)	13 (9)	16 (18)
Pied Oystercatcher	12 (9)	16 (9)	18 (11)	19 (13)	20 (11)	15 (8)	11 (6)	15 (4)	15 (8)	11 (9)	8.2 (5.6)	4.1 (4.4)
Variable Oystercatcher	2.5 (2.1)	3.2 (2.0)	7.9 (5.9)	7.0 (9.7)	8.2 (8.7)	5.6 (5.3)	4.8 (7.6)	3.6 (6.0)	2.7 (2.2)	2.7 (3.3)	2.7 (3.0)	1.2 (1.2)
Pied Stilt	499 (211)	485 (166)	479 (119)	607 (349)	740 (155)	547 (157)	567 (223)	419 (201)	209 (129)	261 (142)	330 (129)	414 (184)
Banded Dotterel	196 (92)	295 (70)	298 (123)	263 (69)	262 (132)	188 (83)	102 (70)	29 (27)	11 (17)	6.7 (4.4)	8.8 (6.6)	49 (47)
Black-fronted Dotterel	2.5 (2.7)	4.2 (6.5)	6.0 (10.8)	26 (21)	54 (40)	32 (27)	33 (21)	20 (21)	11 (8)	1.8 (4.4)	2.7 (3.4)	4.3 (5.3)
Pacific Golden Plover	21 (27)	19 (28)	7.2 (14.0)	0.2 (0.42)	0	0	0	0	3.0 (3.6)	29 (31)	24 (34)	30 (33)
Spur-winged Plover	120 (121)	111 (95)	21 (18)	106 (102)	93 (92)	58 (71)	189 (171)	260 (173)	253 (144)	323 (212)	216 (232)	265 (252)
Lesser Knot	6.8 (14.2)	0.1 (0.31)	0.8 (2.53)	0.1 (0.31)	0	0	0	0	0.1 (0.31)	2.5 (5.3)	14 (16)	3.4 (8.5)
Sharp-tailed Sandpiper	3.6 (4.3)	4.4 (5.6)	3.9 (4.8)	1.2 (2.5)	0	0	0	0	0.9 (1.10)	1.8 (1.9)	2.3 (2.6)	3.3 (3.8)
Pectoral Sandpiper	1.7 (2.0)	1.4 (1.8)	0.7 (1.06)	0.4 (0.70)	0	0	0	0	0	0.1 (0.31)	0.9 (1.37)	0.6 (1.07)
Bar-tailed Godwit	15 (15)	14 (17)	7.7 (12.4)	1.7 (2.5)	1.3 (2.5)	0.6 (1.35)	0.2 (0.63)	0.1 (0.31)	0.9 (1.91)	14 (14)	50 (62)	22 (21)

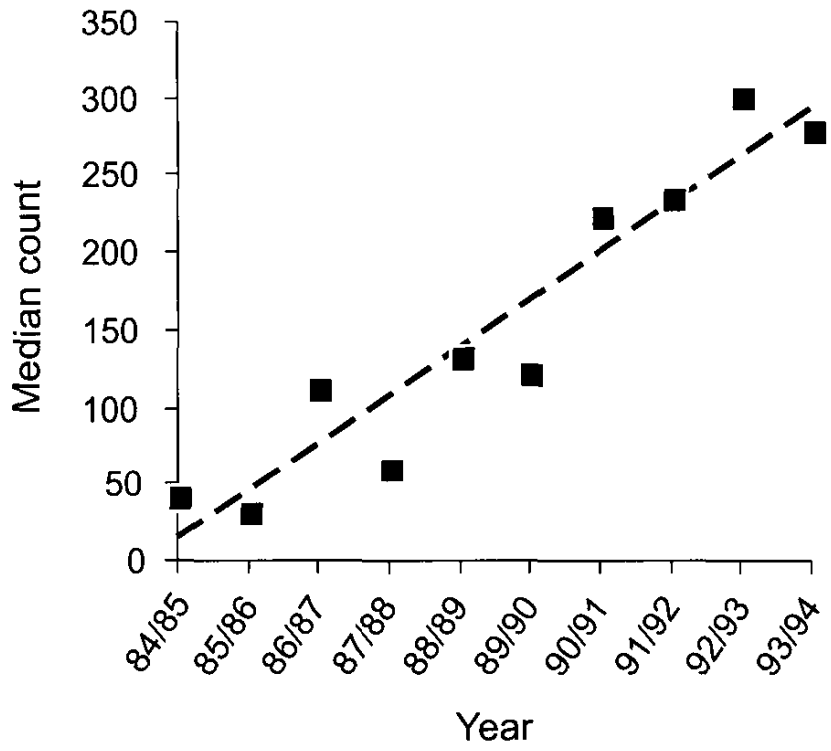

FIGURE 2 – Median monthly count of Spur-winged Plover on the eastern shore of Lake Wairarapa in 1984-94 (r=0.96, P<0.001).

for Banded Dotterel (January to July) and five months for Black-fronted Dotterels (April to August). For all three species, there was a highly significant negative correlation between their relative abundance and lake level (Table 4, Fig. 3). This was caused mainly by counts being almost invariably lower than average when the lake level exceeded about 10.3 m above datum. The significant correlations remained even when we excluded the exceptional (flood) lake level of 11.34 m above datum recorded in July 1985 (Table 4).

On further investigation of the graphs, it was apparent that at very low lake levels (less than 9.95 m above datum), the relative number of birds was again lower than expected. For Pied Stilt, there was a significant positive correlation (r=0.61, P<0.01) between relative numbers and lake level on days when the lake level was less than 10.0 m above datum, and for Banded Dotterel, the correlation was positive (r=0.25), but not significantly different from zero; however it was significantly different from the overall negative correlation (r= -0.43) for lake levels above 10.0 m above datum (z=2.13, P<0.05).

DISCUSSION

Lake Wairarapa is a nationally important site for a variety of wading birds, whose numbers are affected by changes in water level. When the lake rises over about 10.3 m above datum, the normal feeding habitat becomes submerged and hence inaccessible, and so the birds are displaced to adjacent farmland and further

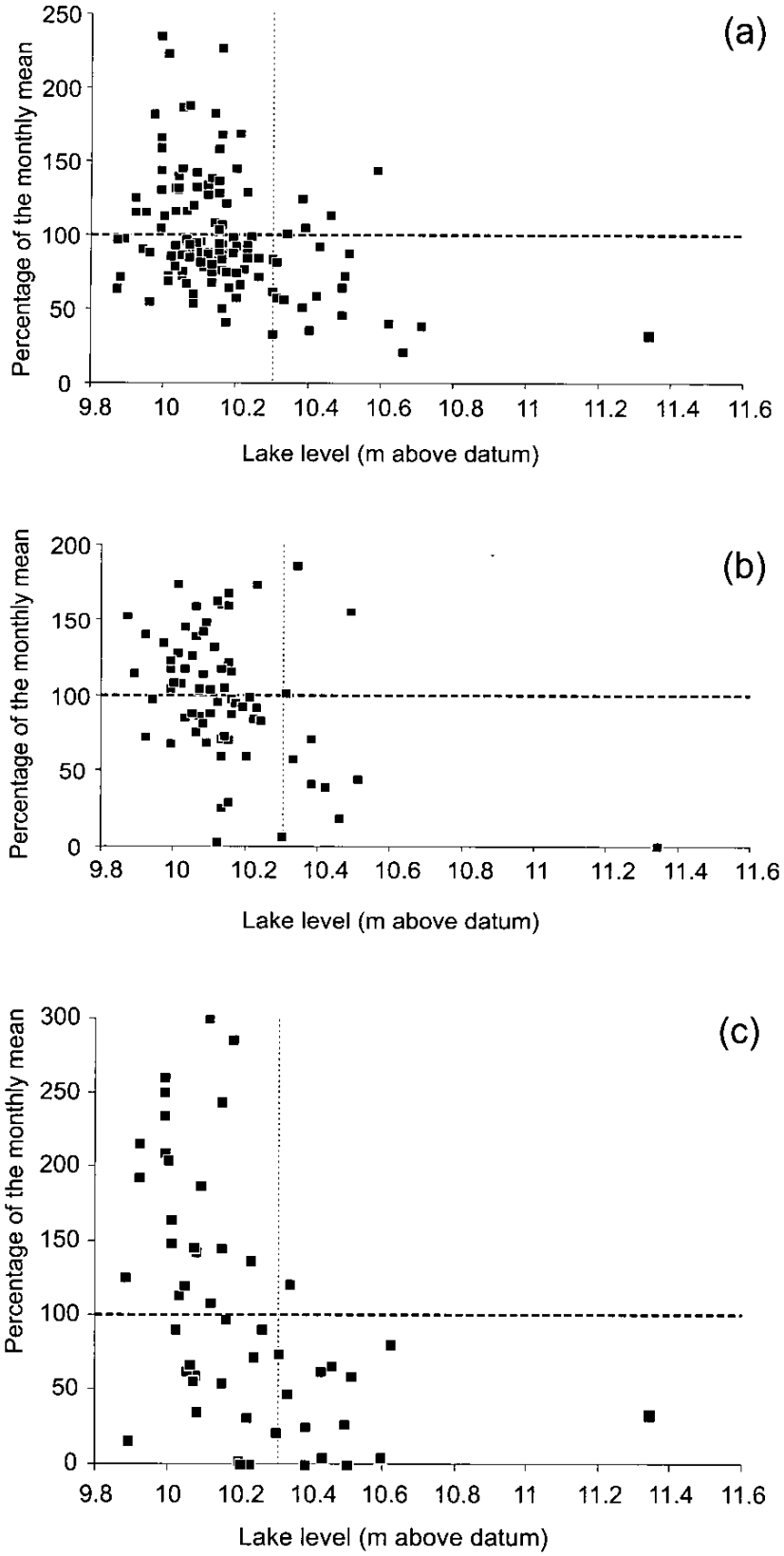

FIGURE 3 – Plot of the number of Pied Stilts (a), Banded Dotterels (b) and Black-fronted Dotterels (c), expresssed as a percentage of their monthly mean, against the water level in Lake Wairarapa ($r = -0.37$, $P<0.001$; $r = -0.42$, $P<0.001$; and $r = -0.49$, $P<0.001$ respectively).

TABLE 4 – Correlations between wader numbers (expressed as a percentage of the monthly mean) and lake level with and without the flood level of 11.34 m above datum recorded on 31 July 1985.

Species	Months used	r value (all)	r value (excl.11.34m)
Pied Stilt	All	-0.37***	-0.35***
Banded Dotterel	Jan to Jul	-0.42***	-0.32**
Black-fronted Dotterel	Apr to Aug	-0.49***	-0.55***

** $P<0.01$
*** $P<0.001$

afield. When the lake level drops, birds quickly return to the lake shore, indicating that this is their preferred feeding habitat. Under about 9.95 m above datum, the number of wading birds also declined, presumably because there were relatively few invertebrates along the new shoreline (mainly bare sandy substrates that were rarely exposed); also, as the upper part of the vegetated normal shoreline dried out, it may have become less suitable for invertebrate prey. These data indicate that the habitat is most suitable for wading birds when the lake level is within the range of 9.95 m to 10.3 m above datum.

The management of Lake Wairarapa has engendered considerable discussion over recent decades, especially when a plan was mooted to build polders into the lake and to convert about one quarter of the wetland into farmland (Moore *et al.* 1984). Eventually, this scheme was abandoned and a Water Conservation Order was granted by parliament in 1989 which recognised the outstanding wildlife values of the lake and its adjacent wetlands, and the role that natural fluctuations in water levels have had in creating and maintaining this outstanding wildlife habitat. The Water Conservation Order requires that water rights (such as for operating the floodgates) do not diminish significantly the outstanding wildlife habitat features of any part of the lake.

Most of the lake and its surrounding wetlands are managed by the Department of Conservation, while the Wellington Regional Council manages the operation of the floodgates. In the early 1990s, these organisations worked with the local users (farmers, iwi, duckshooters, fishers and other recreational or scientific groups, including the Ornithological Society of New Zealand) to develop management guidelines for the unified and balanced management of the Lake Wairarapa wetlands. The guidelines aimed to protect and enhance the wildlife and conservation values of the wetlands while providing for the needs of the various users (Robertson 1991). Central to discussions was the issue of the lake level management, and the preparation of a water right application for the operation of the floodgates that recognised the various competing interests.

The information on the seasonal use of Lake Wairarapa by birds, and especially the preliminary analysis (up to 1990) of the relationship between the numbers of important waders and lake levels, played a key part in developing the water

right for the operation of the floodgates that was approved in 1991. Of particular note was the agreement that the lake water level should be lowered as rapidly as possible if it exceeded 10.3 m above datum, to make the shore again available to waders and to lower the risk of flood damage to neighbouring farmers. The suggestion, based on preliminary data to 1990 (confirmed by the larger samples analysed here) was that numbers of waders declined at very low lake levels; this saw the imposition of minimum lake levels at various seasons that meant that the floodgates should be closed to prevent a further drop in water levels. The minimum levels were set at 10.15 m above datum in summer, 10.0 m above datum in autumn and spring, and 9.95 m above datum in winter. These various minima also aim to suppress weed (especially tall fescue) growth in summer, provide sufficient water depth for recreational yachting in summer, allow native marsh turf plants to flower and set seed in the autumn, and provide maximum water storage capacity of the lake in winter. The minima also recognise that natural evapotranspiration and soakage in summer would sometimes draw the lake down even with the floodgates closed; but it was very unlikely that a level as low as 9.95 m above datum would be attained for more than a few days in winter.

The proposed water management regime won support from all interested parties and a water right was granted to the Wellington Regional Council in 1991. With the new water regime in place for over seven years and a five-year gap in data collection, it would be timely to repeat the counts of waders to determine whether the new regime has had any significant impact on the birdlife in Lake Wairarapa.

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LITERATURE CITED

HEATHER, B.D.; ROBERTSON, H.A. 1996. The Field Guide to the Birds of New Zealand. Viking, Auckland.

MOORE, P.J.; OGLE, C.C.; MOYNIHAN, K.T. 1984. Habitat requirements of wetland birds in the Lake Wairarapa wetlands. *Occasional Publication No. 5. Wildlife Service*, Wellington.

OWEN, K.L.; SELL, M.G. 1985. The birds of Waimea Inlet. Notornis 32: 271-309.

PIERCE, R.J. 1980. Seasonal and long-term changes in bird numbers at Lake Wainono. Notornis 27: 21-44.

ROBERTSON, H.A. (Ed.) 1991. Lake Wairarapa Wetlands Management Guidelines. Lake Wairarapa Co-ordinating Committee, Department of Conservation, Wellington.

SAGAR, P.M. 1976. Birds of the Washdyke Lagoon area, South Canterbury. Notornis 23: 205-212.

SAGAR, P.M.; SHANKAR, U.; BROWN, S. 1999. Distribution and numbers of waders in New Zealand, 1983-1994. Notornis 46: 1-43.

SIM, D. 1976. Classified Summarised Notes. Notornis 23: 335.

STIDOLPH, R.H.D. 1971. The Birds Around Us. Hedley's Bookshop, Masterton.