Notornis, 2018, Vol. 65: 84–91
0029-4470 © The Ornithological Society of New Zealand Inc.

High densities of water-birds at two New Zealand fresh-water urban lakes

B.J. GILL*
Associate Emeritus, Auckland War Memorial Museum, Auckland, New Zealand

R.C. WEST
P.O. Box 133059, Eastridge, Auckland, New Zealand 1146

Abstract We compared summer counts of water-birds (November–January, 2012–2016; mainly Anatidae, Phalacrocoracidae, Rallidae, Laridae) at 2 small, shallow, urban lakes set in parkland surroundings: Western Springs Lake (Auckland) and Henley Lake (Masterton), New Zealand. We recorded 25 species of water-birds; 17 at Western Springs Lake and 22 at Henley Lake, with 14 species in common. The average total densities (and biomasses) were 61 birds/ha (113 kg/ha) at Western Springs Lake, significantly higher than the 40 birds/ha (95 kg/ha) at Henley Lake. Ducks (Tadorninae, Anatinae) made the biggest single contribution to numbers at both lakes (40–60% of total water-bird density). Swans and geese (Anserinae) were less common than ducks but because they were heavier birds they accounted for 60–70% of total biomass, and were therefore the main consumers of food and producers of droppings. Introduced water-birds made up 60–70% of the density at both lakes, and 80–90% of the biomass, with no significant differences between lakes. The presence of some native species (in significantly greater total density and biomass at Western Springs Lake), and breeding of the endemic New Zealand scaup at both sites, illustrate the potential conservation value of New Zealand's small urban lakes.

Gill, B.J.; West, R.C. 2018. High densities of water-birds at two New Zealand fresh-water urban lakes. *Notornis 65 (2):* 84–91.

Keywords Western Springs Lake; Henley Lake; aquatic birds; waterfowl; density; biomass

INTRODUCTION

The majority of New Zealanders live in urban areas and so their easiest way of connecting with nature is to visit urban parks and reserves. Urban lakes bring water-birds into close proximity with people in towns and cities. Urban lakes may serve as refuges for large numbers of water-birds (e.g. Evans & Warrington 1997, Traut & Hostetler 2004), especially if hunting is prohibited and if the lakes are sufficiently large with diverse lake-side micro-habitats that cater for the requirements of numerous species.

Counts of water-birds (mainly ducks, geese, swans, rails, gulls and shags) at Western Springs Lake, Auckland, yielded an average density of about 62 water-birds/ha (Gill & West 2016). For comparison, we could find no published densities for birds at other New Zealand fresh-water lakes. Therefore, in 2013–16 we made summer water-bird counts at Henley Lake, Masterton (450 km south of Auckland), another mid-sized lake with similar surrounding habitat to that at Western Springs Lake. By comparing these 2 lakes, lake-size and

Received 21 October 2017; accepted 3 January 2018
*Correspondence: *adiantum@outlook.co.nz*

habitat were equalised as a cause of any differences in water-bird diversity and abundance. There were minor differences in the species of water-birds living at the 2 lakes but we had no reason to expect the general kinds of water-birds or their total densities to differ.

We extended the comparison between the lakes by using densities and known average weights of water-birds to calculate biomasses. Numbers are one measure of importance, but the water-birds in the study varied in weight between about 300 g and 10.5 kg and we asked whether the most abundant species also contributed the most to biomass. These are the first bird biomass calculations that we know of for New Zealand lakes.

The aims of this study were: (1) to compare water-bird densities at Western Springs Lake with those at a second New Zealand lake; (2) to establish some base-line values for counts, densities and biomasses as biodiversity indicators for water-birds at New Zealand lakes; and (3) to begin to quantify the value of urban wetlands for water-birds given that they face extensive habitat loss elsewhere.

Fig. 1. General view of Western Springs Lake, Auckland, showing section of open lake-edge. Photo: B. Gill.

Fig. 2. General view of Henley Lake, Masterton, showing open lake-side habitat. Photo: B. Gill.

MATERIALS AND METHODS

Study-areas

Western Springs Lake (36°52′S, 174°44′E; Fig. 1) is about 4 km south-west of the Auckland city-centre (Gill & West 2016) and Henley Lake (40°57′S, 175°41′E; Fig. 2) is at the north-eastern edge of Masterton, a few hundred metres from the Ruamahanga River and close to the confluence of that river with the Waipoua River (Dennison *et al.* no date [c. 2000]; Anon 2013). Both lakes are small, shallow and oval-shaped. Western Springs Lake has an area of about 5 ha while Henley Lake covers about 11 ha. Both are surrounded by planted and maintained areas of specimen trees, shrubby borders, marsh and open mowed grass. A formed footpath encircles each lake-shore with small bridges over water-courses.

Counts

All counts were by BJG. Each consisted of a walk on the path around the lake (a route of about 1.5 km at Western Springs Lake and about 1.7 km at Henley Lake) tallying all water-birds seen on the lake surface, edges of islands visible from the shore, and open land adjacent to the lake. These counting areas were about 12 ha at Western Springs Lake and about 19 ha at Henley Lake. At both lakes, high visibility across the bulk of the counting area meant that any mass movements of birds were seen and double-counting avoided. Accurate counting was made easier at both lakes by the convenience of the lake-side paths and by the water-birds being habituated to the presence and movement of people. All counts were in the morning or afternoon (started between 0820 h and 1054 h, or between 1310 h and 1607 h). On average, counts lasted about 44 minutes at Western Springs Lake and about 40 minutes at Henley Lake. Counts began and ended at the park boundaries (Great North Road for Western Springs Lake and Te Ore Ore Road for Henley Lake). Other details of the counting protocols were as given by Gill & West (2016).

This study concerns summer counts (November–January). At Western Springs Lake, there were 2 counts per month in November, December and January of 2012–13 and 2013–14, making a total of 12 counts. Counting at Henley Lake was over 4 summers (2013–14 to 2016–17) and the counts were more clustered than at Western Springs Lake: 3 counts in November–December 2013, 1 in January 2014, 2 in December 2014, 2 in December 2015 and 4 in December 2016, making a total of 12 counts.

Commonest species

During the counts we recorded a total of 25 species of water-birds at the 2 lakes; 17 at Western Springs Lake and 22 at Henley Lake, with 14 of these species in common. However, 7 of the 25 species were excluded because never more than 6 birds were counted at any 1 time: black shag (*Phalacrocorax carbo*) at both lakes and Australasian shoveler (*Anas rhynchotis*), grey teal (*A. gracilis*), New Zealand dabchick (*Poliocephalus rufopectus*), white-faced heron (*Egretta novaehollandiae*), pied stilt (*Himantopus himantopus*) and black-fronted dotterel (*Elseyornis melanops*) at Henley Lake. Hence this report covers the 18 most abundant species of water-birds (listed in Table 1), a third of which were introduced (non-native). The counts for "mallards" were for New Zealand's introgressively hybridised population of mallard (*Anas platyrhynchos*) and grey duck (*A. superciliosa*). The small gulls were a pair of analogous species: red-billed gull (*Larus novaehollandiae*) at Western Springs Lake and black-billed gull (*L. bulleri*) at Henley Lake (see Stidolph 1978; Rebergen 2016). Pied shag (*Phalacrocorax varius*) and royal spoonbill (*Platalea regia*) were recorded during the counts only at Western Springs Lake and spur-winged plover (*Vanellus miles*) and mute swan (*Cygnus olor*) only at Henley Lake.

Densities and biomasses

We divided the number of birds counted by the counting area to obtain density (birds/ha) so that abundance at the 2 lakes could be compared. We obtained mean weights (Table 1) for the relevant species of water-birds by averaging the approximate weights for males and females given by Heather & Robertson (2015). We then converted individual species densities to biomasses (kg/ha).

Statistical analyses

Counts at Henley Lake were spread over 4 summers (compared with 2 summers at Western Springs Lake, with 1 summer in common) and mostly in December (at Western Springs Lake they were spread evenly in November, December and January). However, we have analysed only grand totals averaged over all summer counts at each lake, and consider that the Henley Lake counts still give a reasonable sampling of the summer bird numbers. RCW used "Minitab 14" (Minitab Inc., Pennsylvania State University) to produce descriptive statistics and compare mean summer densities and biomasses between the 2 lakes. Compared distributions were tested for normality and equal variance (Levene's Test), and, where appropriate, *t*-tests were performed to test for significant differences between locations. Only little black shags (*Phalacrocorax sulcirostris*) had a distribution (at Western Springs Lake) that failed the assumptions for a test.

RESULTS

The numbers of water-birds counted at the 2 lakes, and densities, are summarised in Table 1. Fig. 3 shows the relative abundance of water-birds at the 2 lakes expressed as the percentage of total density at each site of the 18 most abundant water-birds. The 4 commonest water-birds during the counts, based on density, were mallard, feral geese (*Anser anser*), black-backed gull (*Larus dominicanus*) and black swan (*Cygnus atratus*) at Western Springs Lake,

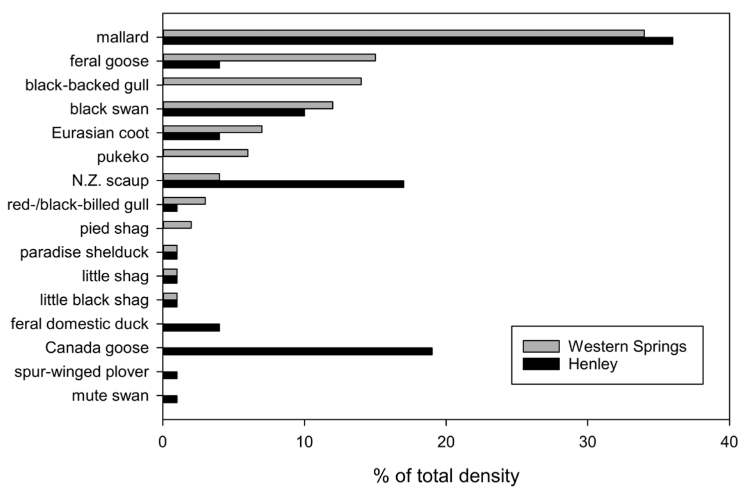

Fig. 3. Relative summer abundance of the 18 commonest water-birds at Western Springs and Henley Lakes expressed as % of their total density at each site. The birds are arranged in order of decreasing abundance at Western Springs Lake. The small gulls (one species at each lake) are plotted together. Royal spoonbill are not plotted because they were absent at Henley Lake and contributed <1% to density at Western Springs Lake (Table 1).

Table 1. Summary statistics for counts of the 18 commonest species of water-birds at Western Springs Lake, Auckland (n = 12 counts) and at Henley Lake, Masterton (n = 12 counts) in summer (November–January) 2012–2016. Introduced (non-native) species are marked with an asterisk. The data presented are mean numbers of birds per count (with minima and maxima), mean densities (birds/ha; with standard deviations), percentages of total density, and biomasses (kg/ha; calculated from the mean bird weights (kg) given in column 8). The last column shows results of t-tests comparing mean densities at the 2 lakes, with significance levels as follows: *** $P \leq 0.001$, ** $P \leq 0.01$, * $P \leq 0.05$, n.s. $P > 0.05$.

	Western Springs Lake								Henley Lake							
Species	Mean	Min	Max	Density	s.d.	% of total	Bird weight (kg)	Biomass	Mean	Min	Max	Density	s.d.	% of total	Biomass	Density t values (df)
Black swan*	89.1	61	114	7.4	1.3	12	5.50	40.9	77.4	35	109	4.1	1.2	10	22.4	6.65*** (22)
Black-backed gull	105.9	53	146	8.8	2.1	14	0.95	8.4	0.3	0	2	0.02	0.04	0	0.02	14.31*** (11)
Black-billed gull	0	0	0	0	0	0	0.28	0	7.9	0	24	0.4	0.4	1	0.1	-
Canada goose*	0.6	0	2	0.05	0.07	0	4.95	0.2	149.0	46	302	7.8	4.1	19	38.8	-6.55*** (11)
Eurasian coot	50.3	31	72	4.2	0.9	7	0.55	2.3	32.0	25	47	1.7	0.4	4	0.9	9.17*** (22)
Feral domestic duck*	1.5	0	3	0.1	0.07	0	1.50	0.2	30.3	14	57	1.6	0.7	4	2.4	-7.34*** (11)
Feral goose*	107.8	68	188	9.0	3.0	15	3.00	26.9	29.1	17	42	1.5	0.4	4	4.6	8.41*** (11)
Little black shag	9.8	1	26	0.8	0.8	1	0.80	0.7	4.1	0	15	0.2	0.3	1	0.2	-
Little shag	8.1	0	13	0.7	0.3	1	0.70	0.5	6.1	0	14	0.3	0.2	1	0.2	3.33** (22)
Mallard*	249.5	92	464	20.8	10.0	34	1.20	25.0	277.5	177	378	14.6	3.1	36	17.5	2.05ns (13)
Mute swan*	0	0	0	0	0	0	10.50	0	5.4	2	14	0.3	0.2	1	2.9	-
NZ scaup	25.8	9	46	2.2	0.9	4	0.65	1.4	134.4	55	226	7.1	3.6	17	4.6	-4.59*** (12)
Paradise shelduck	6.3	1	13	0.5	0.4	1	1.55	0.8	4.6	1	12	0.2	0.2	1	0.4	2.52* (15)
Pied shag	11.5	4	18	1.0	0.4	2	1.95	1.9	0	0	0	0	0	0	0	-
Pukeko	42.6	30	61	3.6	0.9	6	0.95	3.4	0.1	0	1	0.004	0.02	0	0.005	14.27*** (11)
Red-billed gull	18.5	0	91	1.5	2.7	3	0.28	0.4	0	0	0	0	0	0	0	-
Royal spoonbill	1.8	0	14	0.2	0.3	0	1.70	0.3	0	0	0	0	0	0	0	-
Spur-winged plover	0	0	0	0	0	0	0.36	0	5.7	0	27	0.3	0.4	1	0.1	-
All 18 water-birds	728.9	510	1,079	60.7	15.1	100		113.3	763.8	461	1,036	40.2	8.7	100	95.1	4.08*** (17)

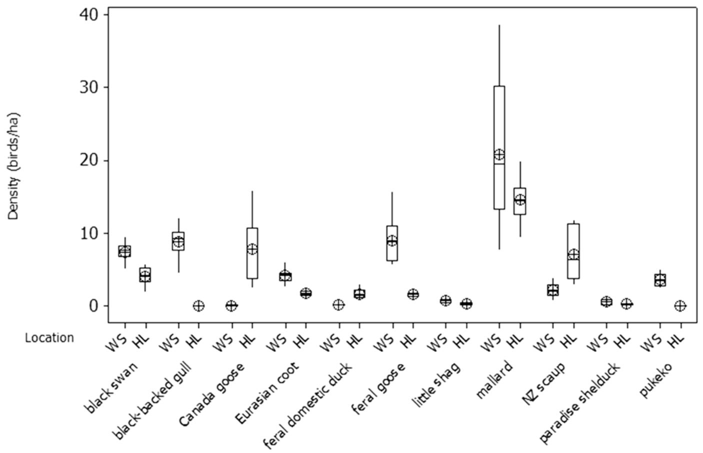

Fig. 4. Boxplots comparing summer densities of the 11 most abundant species of water-birds common to both Western Springs (WS) and Henley Lakes (HL). Each boxplot shows the mean (circle), median (central horizontal line), quartiles (upper and lower limits of box) and range excluding outliers (vertical line).

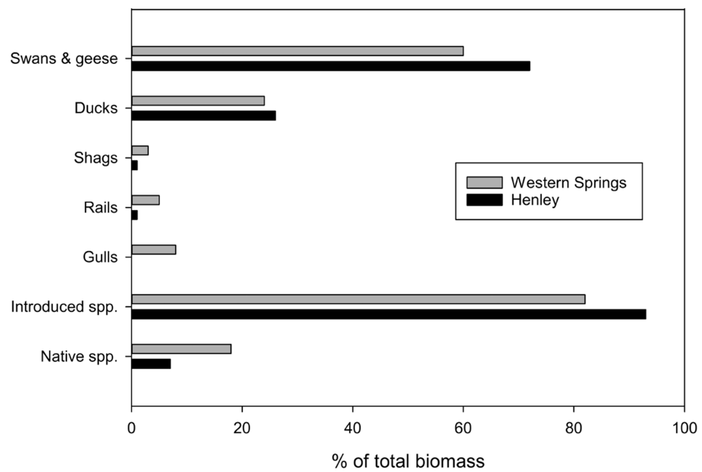

Fig. 5. Relative summer abundance of the 18 commonest water-birds at Western Springs and Henley Lakes expressed as % of their total biomass at each site and grouped into 5 higher taxonomic units and into introduced versus native species.

accounting for 76% of total density (calculated from Table 1). At Henley Lake the 4 most common species were mallard, Canada geese (*Branta canadensis*), New Zealand scaup (*Aythya novaeseelandiae*) and black swan, together comprising 84% of total density.

Of the commonest species common to both locations, those with a significantly higher density at Western Springs Lake (Table 1; Fig. 4) were black swan, black-backed gull, Eurasian coot (*Fulica atra*), feral geese, little shag (*Phalacrocorax melanoleucos*), paradise shelduck (*Tadorna variegata*) and pukeko (*Porphyrio melanotus*). Conversely, Canada geese, feral domestic duck and New Zealand scaup had significantly higher densities at Henley Lake. For mallards there was no significant difference in mean densities between locations.

The combined mean density of water-birds at Western Springs Lake during the summer counts was 61 birds/ha (Table 1), significantly higher than at Henley Lake (40 birds/ha). The water-birds at the lakes varied in size from small gulls (c. 0.3 kg) to mute swan (c. 10.5 kg). The mean water-bird densities convert to total biomasses (Table 1) of 113.3 kg/ha (Western Springs Lake) and 95.1 kg/ha (Henley Lake) with a significant difference ($t_{22} = 2.09$, $P \leq 0.05$).

Considering higher taxonomic groupings (Table 2, Fig. 5), mean biomass was not significantly different between the 2 lakes for "swans and geese" or ducks, but it was significantly higher at Western Springs for shags, rails and gulls. Whereas ducks (subfamilies Tadorninae, Anatinae) dominated in numbers at both lakes (39% of water-bird density

Table 2. Mean summer densities (birds/ha) and biomasses (kg/ha) of the 18 commonest species of water-birds at Western Springs Lake and Henley Lake grouped into 5 higher taxonomic units (the royal spoonbill and spur-winged plover belong to other taxonomic groups) and grouped into introduced and native species. The last 2 columns show results of *t*-tests comparing the means at the 2 lakes (significance levels as for Table 1; ns = not significant).

	Western Springs		Henley		*t* values (df)	
	Density	Biomass	Density	Biomass	Density	Biomass
Swans & geese	16.4	68.0	13.7	68.8	1.92 ns (22)	-0.14 ns (22)
Ducks	23.6	27.3	23.5	24.9	0.02 ns (15)	0.62 ns (13)
Shags	2.4	3.0	0.5	0.4	6.12*** (22)	8.37*** (12)
Rails	7.7	5.7	1.7	0.9	14.8*** (12)	15.5*** (11)
Gulls	10.4	8.8	0.4	0.1	9.21*** (11)	13.2*** (11)
Introduced spp.	37.4	93.2	29.9	88.6	1.93 ns (22)	0.56 ns (22)
Native spp.	23.3	20.1	10.3	6.5	7.87*** (22)	11.6*** (22)

at Western Springs Lake and 58% at Henley Lake; calculated from Table 1), swans and geese (subfamily Anserinae)—heavy birds at 3.0–10.5 kg each—eclipsed ducks in biomass (60–70% of total, Fig. 5). Ducks, being smaller birds (0.7–1.6 kg), contributed only a quarter of the biomass at both lakes (Fig. 5). Therefore, swans, geese and ducks (family Anatidae) contributed nearly all the biomass of water-birds at both lakes (84% at Western Springs Lake; 98% at Henley Lake).

All the swans and geese, and the commonest duck (mallard), were introduced species. Introduced water-birds contributed 62% to density (calculated from Table 1) and 82% to biomass (Fig. 5) at Western Springs Lake and 74% and 93% (respectively) at Henley Lake. The densities and biomasses aggregated for the introduced water-birds did not differ significantly between the lakes (Table 2), whereas native water-birds were at significantly higher densities and biomasses at Western Springs Lake than at Henley Lake.

DISCUSSION

Summer counts showed similarities in the water-birds at Western Springs and Henley Lakes, the most striking being in the relative abundance (Fig. 3) and density (Fig. 4) of mallards (commonest water-bird at both lakes), the aggregated biomasses for swans/geese and ducks (Fig. 5), and the aggregated densities and biomasses for introduced water-birds (Table 2). However, there were also differences between the lakes in their water-bird faunas, for example, the greater numbers of gulls at Western Springs Lake and of New Zealand scaup at Henley Lake (Fig. 3), and the greater density and biomass of native water-birds generally at Western Springs Lake (Fig. 5). At Western Springs Lake feral geese made up 15% of water-bird density and no more than 2 Canada geese were scored at any count (Table 1), whereas at Henley Lake the situation was reversed, with Canada geese making the second-greatest contribution to water-bird density (19%) and feral geese being a minor component (4%). Canada geese are increasing in numbers and range in the North Island (Gill *et al*. 2010) and can be expected to increase at Western Springs Lake.

The water-birds at the 2 lakes were dominated by introduced species (mallard, feral goose, Canada goose and black swan) that benefited from association with humans. The geese and black swans, for example, grazed the large areas of mown grass beside the lakes. Native black-backed gull were a major species at Western Springs Lake but they used it as an open space for "loafing" (Gill & West 2016). All 5 of these species took the food that people offered at the lakes. The only other species contributing more than 10% to density (Fig. 3) was the New Zealand scaup at Henley Lake—a lake-dependent endemic. Neither lake supported significant numbers of grey teal or Australasian shoveler, native ducks that are less tolerant of human disturbance (Innes *et al.* 1999).

At both Western Springs and Henley Lakes, the public regularly fed bread to compliant birds. Both lakes had small wooded islands that offered retreats for roosting and nesting birds where they were relatively safe from disturbance by people and dogs. Predator control was low-level at both lakes during the study. Instead, a factor contributing to the higher water-bird densities at Western Springs Lake was possibly its better water-quality. Western

Springs Lake has underground springs with an inflow-rate of up to 9 million litres per day; half that in summer (Anon no date [c. 2000]). Henley Lake is artificial, created from gravel pits and first filled in 1988–89 (Anon 2013). It has restricted water flows and experiences chronic, and at times severe, algal blooms (Farmer 2016).

The novel biomass estimates in this study revealed a paradox. Ducks made the biggest single contribution to water-bird density at both lakes (39% at Western Springs Lake and 58% at Henley Lake), but by virtue of their greater size swans and geese dominated the biomass (60–70% of total). This establishes swans and geese as the main consumers of food at these urban lakes and producers of droppings. Since the dominant duck and all swans and geese were introduced species, the contribution of native water-birds to the biomass at both lakes was small.

The highest densities we found for previous studies of water-birds in New Zealand were 28 and 27 birds/ha (Gill & West 2016) calculated from numbers and areas given for 2 South Island estuarine localities reported by Crossland (2013) and Pierce (1980). In a review of Australian water-bird counts in wild, non-urban habitats (Halse *et al.* 2005) the highest density reported was 34 birds/ha at Lake Eyre (South Australia). In a study of 46 non-urban lakes in Florida (USA), the highest total water-bird density (including raptors and passerines) was 803 birds/km^2, or 8.0 birds/ha (Hoyer & Canfield 1994). At 11 non-urban lakes in southern Sweden, Nilsson & Nilsson (1978) reported a maximum total water-bird density (species using open water, including raptors) of 71.6 birds/km^2, or 0.7 birds/ha. We have now quantified water-birds at Henley Lake at about 40 birds/ha. We conclude that water-bird densities are high at Henley Lake and very high at Western Springs Lake.

At Florida lakes, Hoyer & Canfield (1994) recorded maximum densities of 1.8 birds/ha for mallards, much lower than we recorded for the same species at Western Springs Lake (20.8 birds/ha) and Henley Lake (14.6 birds/ha). However, the 2 other possible species comparisons gave closer densities between the 2 countries. For ring-necked duck (*Aythya collaris*) Hoyer & Canfield (1994) recorded 2.2 birds/ha whereas for New Zealand scaup (same genus) we counted 2.2 birds/ha (Western Springs) and 7.1 birds/ha (Henley). For American coot (*Fulica americana*) Hoyer & Canfield (1994) estimated up to 2.9 birds/ha, and for Eurasian coot (same genus) we counted 4.2 birds/ha (Western Springs) and 1.7 birds/ha (Henley).

The highest water-bird biomass calculated by Hoyer & Canfield (1994) was 465 kg/km^2 which is 4.7 kg/ha. Our biomass estimates of 95 kg/ha (Henley Lake) and 113 kg/ha (Western Springs Lake) seem to demonstrate the extent to which water-bird densities may be inflated in small managed urban lakes, where the water-birds habituate to the presence of people and most species benefit from supplementary feeding. Introduced rather than native water-birds dominated at our 2 study lakes, but both supported the endemic New Zealand scaup (2–7 birds/ha) with breeding noted at both lakes during the study. Our data begin to quantify the extent to which small urban lakes—tranquil retreats in the midst of much unsuitable habitat—can encourage diverse kinds, and high numbers, of water-birds at a time when they face extensive loss of wild habitat.

ACKNOWLEDGEMENTS

For helpful discussion of particular aspects of this study we thank Rosanne Heyes (Masterton District Council), Jason Froggatt, Leigh Bull and Murray Williams.

LITERATURE CITED

Anon (no date [c. 2000]). *A guide to Western Springs*. Auckland, Auckland City.

Anon 2013. *Henley Lake Park reserve management plan*. Masterton, Masterton District Council.

Crossland, A.C. 2013. Wetland bird monitoring at the Avon-Heathcote Estuary and Bromley Oxidation Ponds, Christchurch: August 2009 to July 2010. *Notornis 60*: 151–157.

Dennison, T.; Scadden, C; Watt, B. (no date [c. 2000]). *Where to find Wairarapa birds* [titles differ on cover and p. 1]. Masterton, Ornithological Society of New Zealand.

Evans, D.M.; Warrington, S. 1997. The effects of recreational disturbance on wintering waterbirds on a mature gravel pit lake near London. *International Journal of Environmental Studies 53*: 167–182.

Farmer, D. 2016. Vow to fix gem of a lake [Henley Lake, Masterton]. *Wairarapa Times-Age, 28 Mar. 2016*: 1.

Gill, B.J.; Bell, B.D.; Chambers, G.K.; Medway, D.G.; Palma, R.L.; Scofield, R.P.; Tennyson, A.J.D.; Worthy, T.H. 2010. *Checklist of the birds of New Zealand, Norfolk and Macquarie Islands, and the Ross Dependency, Antarctica*. Fourth Edition. Wellington, Te Papa Press.

Gill, B.J.; West, R.C. 2016. Counts of waterbirds at Western Springs Lake, Auckland, New Zealand. *Notornis 63*: 142–151.

Halse, S.A.; Pearson, G.B.; Hassell, C.; Collins, P.; Scanlon, M.D.; Minton, C.D.T. 2005. Mandora Marsh, north-western Australia, an arid-zone wetland maintaining continental populations of waterbirds. *Emu 105*: 115–125.

Heather, B.D.; Robertson, H.A. 2015. *The field guide to the birds of New Zealand*. Second Edition. Auckland, Penguin Random House.

Hoyer, M.V.; Canfield, D.E. 1994. Bird abundance and species richness on Florida lakes: influence of trophic status, lake morphology, and aquatic macrophytes. *Hydrobiologia 279/280*: 107–119.

Innes, J.; Whaley, K.; Owen, K. 1999. Abundance and distribution of waterbirds of the Rotorua lakes, 1985–1996. *Conservation Advisory Science Notes 236*: 1–45.

Nilsson, S.G.; Nilsson, I.N. 1978. Breeding bird community densities and species richness in lakes. *Oikos 31*: 214–221.

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

Rebergen, A. 2016. Changes in the number of black-billed gulls (*Larus bulleri*) nesting on the Ruamahanga River, Wairarapa, between 1998 and 2012. *Notornis 63*: 50–53.

Stidolph, R.H.D. 1978. Black-billed gull in northern Wairarapa. *Notornis 25*: 158.

Traut, A.H.; Hostetler, M.E. 2004. Urban lakes and waterbirds: effects of shoreline development on avian distribution. *Landscape & Urban Planning 69*: 69–85.