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Bird species observed within a garden at Kaikōura, New Zealand, 2005–2016

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Abstract Over 11 years, the presence of bird species detected within a garden in Kaikōura, New Zealand, were recorded on a weekly basis. Of the 19 species, Eurasian blackbird (*Turdus merula merula*), house sparrow (*Passer domesticus domesticus*) and common starling (*Sturnus vulgaris vulgaris*) were most commonly detected followed by silvereye (*Zosterops lateralis*), the most commonly detected native bird. New Zealand falcon (*Falco novaeseelandiae*), Australian magpie (*Gymnorhina tibicen*) and California quail (*Callipepla californica brunnescens*) were each seen once. Others recorded were bellbird (*Anthornis melanura melanura*), chaffinch (*Fringilla coelebs*), common redpoll (*Carduelis flammea*), dunnock (*Prunella modularis*), European goldfinch (*Carduelis carduelis britannica*), European greenfinch (*Carduelis chloris*), grey warbler (*Gerygone igata*), red-billed gull (*Larus novaehollandiae scopulinus*), song thrush (*Turdus philomelos*), South Island fantail (*Rhipidura fuliginosa fuliginosa*), yellowhammer (*Emberiza citrinella*) and welcome swallow (*Hirundo neoxena neoxena*). Ten species exhibited significant seasonal variation; 4 showed significant increases and 2 decreases over the 11 years of the study. This study has shown that simple presence/absence observations of a species on a weekly basis can provide an index of numbers, and demonstrate seasonal movements and medium-term changes of bird species within an urban garden.

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Keywords Garden survey; Kaikōura; bird abundance; bird activity

INTRODUCTION

Bird studies have been reported for several gardens in the North Island of New Zealand. Seasonal, annual and diurnal changes in bird numbers were observed from a raised deck of his residence in the Western Hutt hills by Gibb (2000a, b). Guest & Guest (1987, 1993) noted the presence of birds seen in and from their gardens in Te Kuiti and Palmerston North, and Stidolph (1977) compared birds seen in a garden at Masterton in 1942-43 with those seen 29 years later (1971-72). On a larger scale, 30 Hamilton gardens were surveyed for bird species and abundance in August 1993, and these were related to the plant biomass (Day 1995). Other urban projects include studying birds present and their changes in the Auckland Domain (Gill 1989), Dunedin Botanic Gardens (Kikkawa 1959), and parts of Christchurch (Spurr *et al.* 2014). Since 2006, an annual national-scale New Zealand Garden Bird Survey (NZGBS) has taken place where participants spend one hour in mid-winter each year recording the largest number of each species seen at any one time (Spurr 2012); in addition to individual gardens, public parks, school grounds and other areas were

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Fig. 1. The study garden in Kaikōura. (Photo Andrew Spencer)

Fig. 2. The land use surrounding the study garden marked in the middle of the figure. The sea is 140 m to the northeast, and the scrubby bush hillslope begins 80 m to the southwest rising 60 m to the edge of the farmland plateau 170 m distant. (Photo: Google Earth 18 March 2017)

surveyed. The techniques used to assess birds present or counted in the above mentioned studies included: species presence on a daily (Stidolph 1977) or monthly (Guest & Guest 1987, 1993) basis; 5-minute bird counts along a transect (Dawson & Bull 1975; Gill 1989; Barnett 2011); and 10-minute bird counts at one site (Gibb 2000a, b).

In 2005, a trial survey was carried out in Marlborough based on the Garden BirdWatch (BTO 2016). Participants were asked to record the maximum number of a bird species actively using the resources in their garden each week; a similar amount of effort each week was preferred as continuity of record was considered to be more important than quantity (M. Bell *pers. comm.* 2005). In the 4 years leading up to that study, it was obvious that few birds were present in our garden at any time. Usually there were fewer than 5 of any species with the exception of house sparrows (*Passer domesticus*) which occurred in flocks of up to about 12 birds, and silvereyes (*Zosterops lateralis*) in flocks up to about 30 birds in winter. Not all species were present all year round, e.g., common redpoll (*Carduelis flammea*). Therefore, we decided to use a modification of this technique to gather the data for this study whereby only the species detected in a week are reported, not the number of birds.

Observations were made from summer 2005-06 through to spring 2016, with the aim of exploring seasonal and annual patterns of garden usage by species in a South Island setting.

METHODS

The study area was a garden situated on a 508 m^2 property (including 140 m^2 of buildings) in Kaikōura, New Zealand (42° 24′ 54″ E, 173° 41′ 26″ S) (Fig. 1). Although located 140 m from the sea and with a bush covered hillslope 80 m to the southwest rising 60 m to farmland 170 m from the house, the

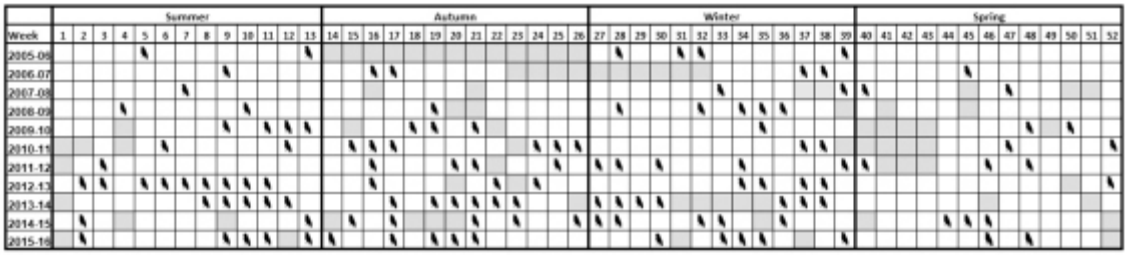

Fig. 3. Weeks during which bellbird were observed at the study site. Shaded weeks are missing data.

garden itself could be considered a suburban setting (Fig. 2). The boundary for recording observations was the fenceline and included any plants rooted in the garden that overhung the fenceline. Birds in trees outside the boundary that overhung the fence were not included unless they were on the garden side of the fence. The garden was dominated by 2 large Phoenix palms (*Phoenix* sp.) on the road boundary, native shrubs (including *Coprosma* spp., *Hoheria* sp., *Pittosporum* spp., *Hebe* spp.), introduced shrubs (including *Grevillea* sp., *Rosmarinus officinalis, Laurus nobilis, Bougainvillea* sp., *Callistemon* sp., *Pyracantha* sp.) and annuals with 2 small areas of lawn. Water was available at all times from a small pond and, sometimes, from a birdbath. Provision of food scraps was minimal, intermittent and mainly in winter.

In each week from summer 2005-06 through to spring 2016, species observed in the garden (i.e., on the ground, in plants, or perched on the fence) were recorded, as were welcome swallows (*Hirundo neoxena neoxena*) that hawked insects within the boundary of the garden. Other birds flying over the garden or seen from it such as shags (*Phalacrocorax* spp.), terns (*Sterna* spp.) and oystercatchers (*Haematopus* spp.) were excluded from the study as they could not be considered using the garden, unlike the welcome swallow. Although seen flying along the nearby hillslope, swamp harriers (*Circus approximans*) were not considered close enough to count as using the garden. Birds heard but not seen, e.g., grey warbler (*Gerygone igata*), were counted if we were sure they were within the property boundary.

During this study we were semi- or fully retired. As such, we were in the property most of the time, and able to detect birds as we were going about our daily routines, although we were absent at times. Weeks with 5 and 6 days of observations were treated as if they were full weeks as were weeks with 1-4 days of observations for species recorded as present. If a species was not recorded in a week with 1-4 days of observations it was treated as missing data if there was a reasonable probability of it being present, otherwise it was noted as not observed. For example, redpolls were never recorded in summer and spring, and so 1-4 day weeks without a redpoll recorded were treated as not observed, but in autumn and winter they were treated as missing data.

Recording began on the Monday of each week. The years began with summer starting on the closest Monday to 1 December. An approximation for months recorded was to combine the first 4 weeks of each season, the next 5, and the last 4 weeks.

Species nomenclature follows Checklist Committee (OSNZ) (2010). Statistical methods used (χ^2 tests to test for seasonal changes; F-tests to test the significance of simple linear regression analyses of changes over the years of the study; coefficient of determination to indicate how much variation in the linear regression analysis was accounted for by the time variable) are those given in Freese (1967).

RESULTS

A total of 19 species were observed using the study site during the 11 year period. Seasonal and annual patterns of individual species observations are detailed below.

Australian magpie *Gymnorhina tibicen*

One Australian magpie was seen perched on the roadside fence during the week of 10 November 2008.

Bellbird *Anthornis melanura melanura*

Bellbirds were detected during 26% of weeks and 70% of months (Table 1). Significant seasonal differences were apparent with a low of 13% in spring and a peak of over 32% in autumn and winter (Table 1, Fig. 3). There was a highly significant increase in observations over the years, the rate of increase being about 1.5 weeks/year; 86% of the variation in observations was explained by

Table 1. Bird species detected at Kaikōura between 2005-2016, their frequency of observations and seasonal variation. The critical values of the Chi² test to detect seasonal differences are: * = $\chi^2_{df=3,95\%} = 7.8$; ** = $\chi^2_{df=3,99\%} = 11.3$.

Species	Weeks Rank	Weeks Summer %	Weeks Autumn %	Weeks Winter %	Weeks Spring %	Seasonal χ^2	Weeks Annual %	Months Annual %
Australian magpie	17=	0	0	0	1		0	1
Bellbird	12	26	32	34	13	11.5**	26	70
California quail	17=	1	0	0	0		0	1
Chaffinch	6	28	33	68	56	24.8**	45	77
Common redpoll	15	0	12	13	0	36.6**	6	15
Common starling	3	76	96	98	98	5.1	92	99
Dunnock	5	43	71	84	72	18.6**	64	93
Eurasian blackbird	2	84	90	96	99	1.9	92	99
European goldfinch	8	47	33	43	46	3.3	43	78
European greenfinch	13	4	5	20	2	32.1**	8	20
Grey warbler	7	24	72	62	18	60.7**	44	85
House sparrow	1	99	98	100	100	0.1	99	100
New Zealand falcon	17=	0	0	1	0		0	1
Red-billed gull	11	47	6	26	38	39.8**	30	58
Silvereye	4	67	76	88	84	4.5	78	98
Song thrush	10	42	20	25	47	17.6**	34	73
South Island fantail	9	39	83	38	8	85.7**	41	71
Welcome swallow	14	1	16	6	2	30.5**	6	17
Yellowhammer	16	2	0	0	2	5.6	1	5

year (Table 2). The longest period with bellbirds not detected was 25 weeks in 2007-08; 2 weeks of this period were missing data (Fig. 3).

California quail *Callipepla californica brunnescens*
A single California quail was observed standing on a garden path on 15 December 2009.

Chaffinch *Fringilla coelebs*
Chaffinches were present in 45% of weeks and 77% of months, with highly significant seasonal differences (Table 1). Summer and autumn had the lowest numbers detected, in about 30% of the weeks compared to twice that in winter and spring. During the 11-year study period, no chaffinches were detected in the last 3 weeks of February and first week of March (Fig. 4). There was a significant downward trend in weekly detections over the years of about 1.5 weeks/year; only 37% of the variation was explained by year in the relationship indicating other factors, in total, were more important than time (Table 2). There were 2 periods over 30 weeks-long during which no chaffinches were detected (Fig. 4).

Common redpoll *Carduelis flammea*
Redpoll was one of the least frequently recorded species and observed in only 6% of weeks and 15% of months (Table 1). There was a highly significant seasonal difference with no redpolls recorded in summer or spring, and birds recorded only in about 12% of weeks in autumn and winter (Table 1, Fig. 5). There were periods of about 2 years without a redpoll being observed; there was no trend with years (Table 2).

Common starling *Sturnus vulgaris vulgaris*
This is 1 of 2 species known to have nested in the garden, and only in the Phoenix palms on the street frontage. Starlings ranked third of the 19 species and were detected in 92% of weeks and 99% of months (Table 1, Fig. 6). No significant seasonal

Table 2. The trend in the annual frequency of birds seen at the study site in Kaikōura, 2005-2016. Year is represented by 5 for 2005-06 through to 15 for 2015-16. CoD = coefficient of determination. Critical values of F: * = $F_{d.f.1,9;\ 0.05}$ = 5.1 and ** = $F_{d.f.1,9;\ 0.01}$ = 10.6.

Species	Trend over the years	F	CoD
Bellbird	% = -3.2 + 2.9 x year	54.0**	0.86
Chaffinch	% = 77.8 - 3.3 x year	5.3*	0.37
Common redpoll	% = 4.6 + 0.1 x year	0.1	0.01
Common starling	% =88.4 + 0.3 x year	0.2	0.02
Dunnock	% =78.1 – 1.5 x year	1.1	0.11
Eurasian blackbird	% = 91.0 + 0.1 x year	0.0	0.00
European goldfinch	% = 23.2 + 1.9 x year	1.3	0.13
European greenfinch	% = 4.0 + 0.4 x year	0.2	0.02
Grey warbler	% = 24.3 + 1.9 x year	4.5	0.33
House sparrow	% = 96.2 + 0.3 x year	4.3	0.32
Red-billed gull	% = 83.8 – 5.4 x year	20.5**	0.70
Silvereye	% = 39.4 + 3.8 x year	18.1**	0.67
Song thrush	% = 11.8 + 2.2 x year	8.1*	0.47
South Island fantail	% = 17.9 + 2.3 x year	5.1*	0.36
Welcome swallow	% = -10.0 +1.6 x year	5.0	0.36
Yellowhammer	% = 2.5 – 0.1 x year	1.4	0.13

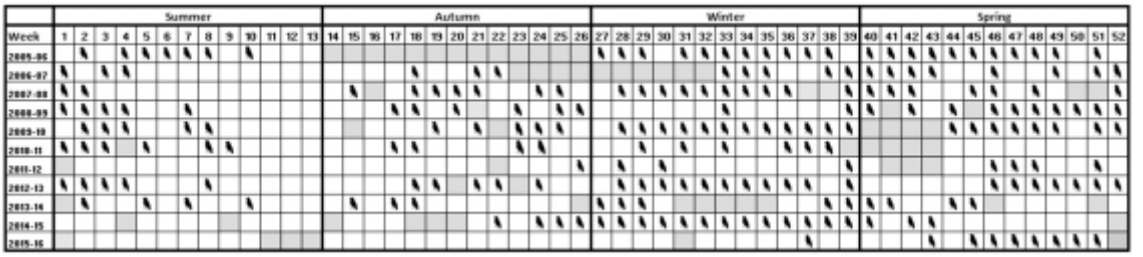

Fig. 4. Weeks during which chaffinch were observed at the study site. Shaded weeks are missing data.

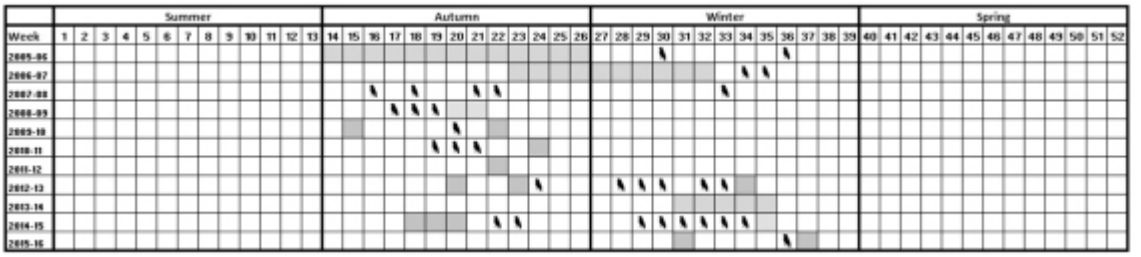

Fig. 5. Weeks during which common redpoll were observed at the study site. Shaded weeks are missing data.

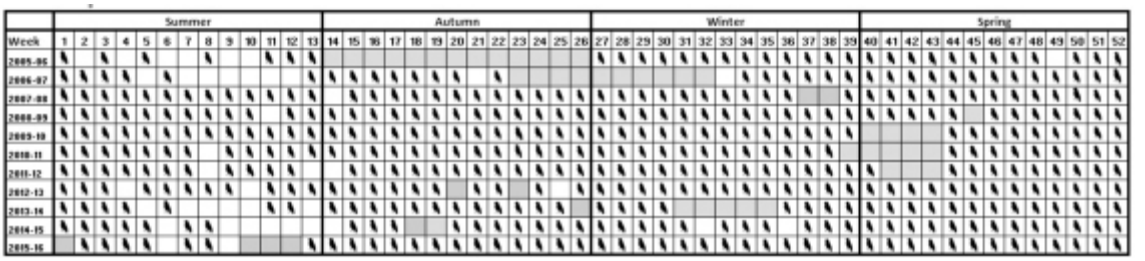

Fig. 6. Weeks during which common starling were observed at the study site. Shaded weeks are missing data.

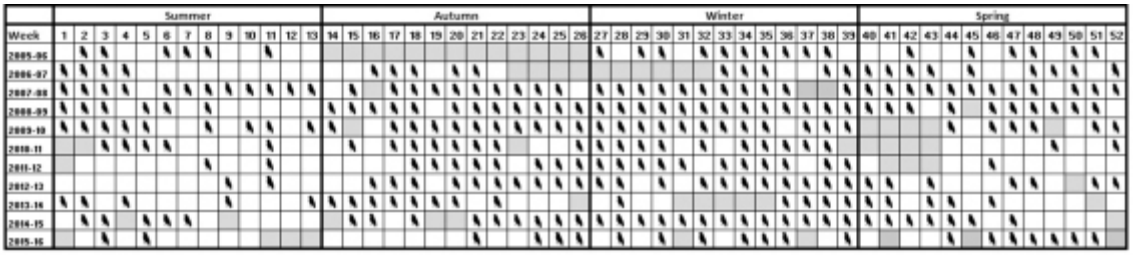

Fig. 7. Weeks during which dunnock were observed at the study site. Shaded weeks are missing data.

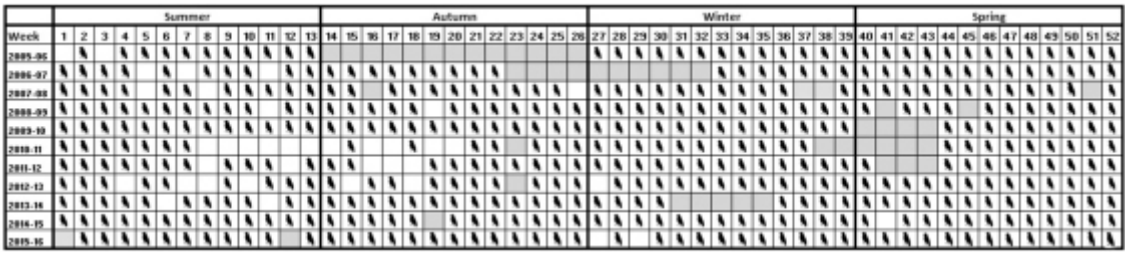

Fig. 8. Weeks during which Eurasian blackbird were observed at the study site. Shaded weeks are missing data.

differences were detected, although in summer birds were detected on fewer occasions, 76% of weeks compared to about 98% for the rest of the year (Table 1). There was no significant trend in observations with years (Table 2), and 6 weeks was the longest period with no starlings observed.

Dunnock *Prunella modularis*
One of the more common species, dunnocks were observed during 64% of the weeks and 93% of months (Table 1). There was a significant seasonal difference, with birds detected in only 43% of summer weeks rising to 84% in winter (Table 1, Fig. 7). Birds were not observed for periods up to 15 weeks, and there was no significant trend in observations over the years of the study (Table 2).

Eurasian blackbird *Turdus merula merula*
Blackbirds were very common, ranked second, and at least 1 bird was detected in 92% of the weeks and 99% of months (Table 1, Fig. 8). Slightly fewer birds were detected in summer, however there was no significant seasonal difference (Table 1). Likewise, there was no change in detection with years (Table 2). The longest period with no birds recorded was 7 weeks in summer 2010.

European goldfinch *Carduelis carduelis britannica*
Goldfinches were recorded in 43% of the weeks and 78% of months, and there was no significant season difference in numbers detected (Table 1). However, Fig. 9 shows that birds were detected less often at the change from summer to autumn and

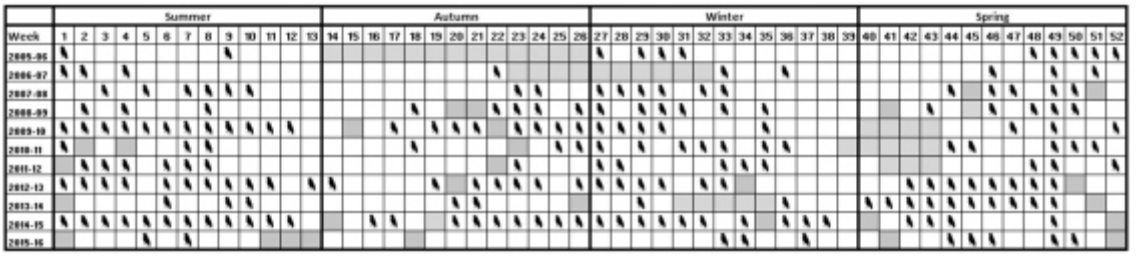

Fig. 9. Weeks during which European goldfinch were observed at the study site. Shaded weeks are missing data.

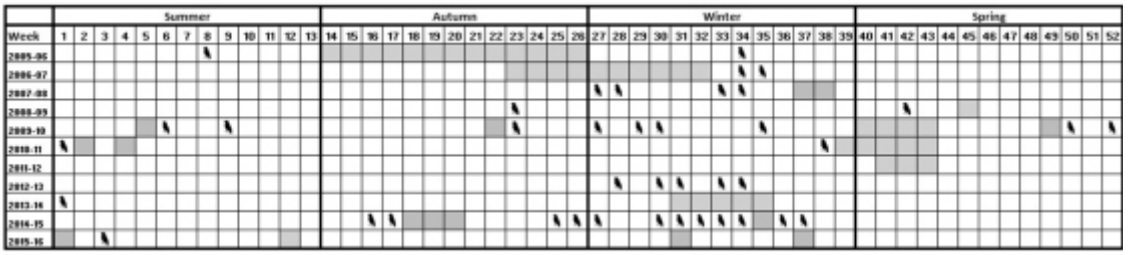

Fig. 10. Weeks during which European greenfinch were observed at the study site. Shaded weeks are missing data.

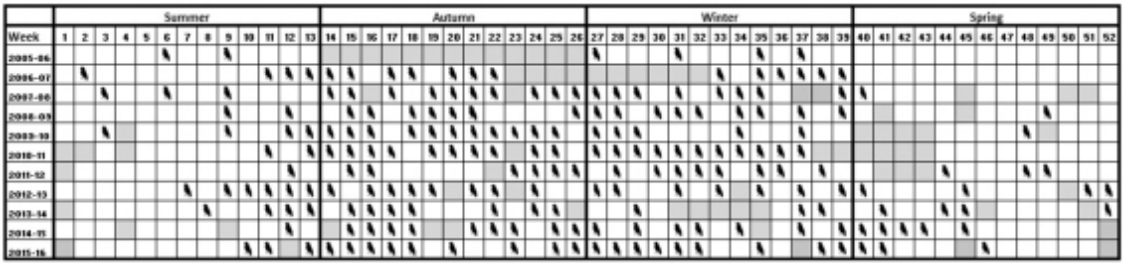

Fig. 11. Weeks during which grey warbler were observed at the study site. Shaded weeks are missing data.

at the change from winter to spring. There was no trend in the number of weeks birds were detected over the length of the study (Table 2). There were some extended periods when goldfinches were not detected, including a 17-week period in 2006-07 and a 25-week period in 2016.

European greenfinch ***Carduelis chloris***

This species was observed in only 8% of weeks and 20% of months (Table 1). There was a significant seasonal difference, with the majority of observations in winter and sporadic observations in other seasons (Table 1, Fig. 10). Birds were not observed for periods up to 93 weeks long. There was no detectable trend in the numbers of weekly observations over the years (Table 2).

Grey warbler ***Gerygone igata***

One of the more common species, grey warblers were detected in 44% of weeks and 85% of months (Table 1). There was a significant seasonal difference with most observations in autumn and winter (approximately 67% of weeks) compared to spring and summer (approximately 21% of weeks) (Table 1, Fig. 11). No significant trend in weekly observations with years was found (Table 2).

House sparrow ***Passer domesticus domesticus***

House sparrows nested in the garden and, like starlings, only in the Phoenix palms. The most common species observed, house sparrows were recorded in all but 4 of the weekly observations, and in every month over the 11 years (Table 1).

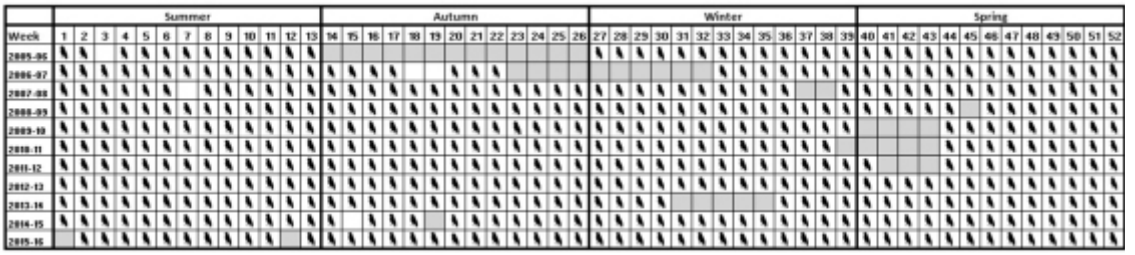

Fig. 12. Weeks during which house sparrow were observed at the study site. Shaded weeks are missing data.

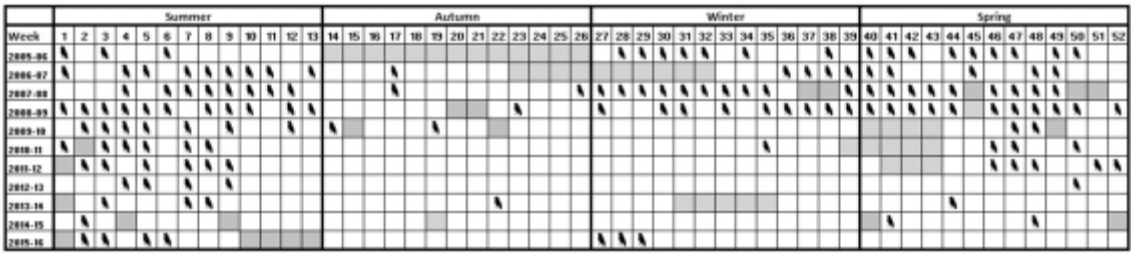

Fig. 13. Weeks during which red-billed gull were observed at the study site. Shaded weeks are missing data.

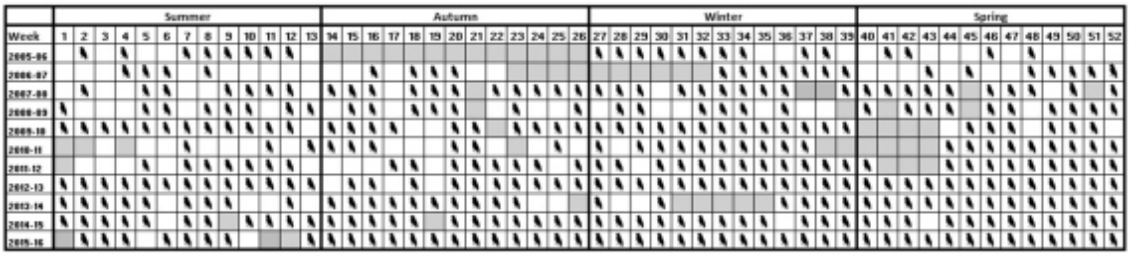

Fig. 14. Weeks during which silvereye were observed at the study site. Shaded weeks are missing data.

Consequently, there is no variation between seasons nor year trends (Table 2, Fig. 12).

New Zealand falcon *Falco novaeseelandiae*
One bird was seen briefly sitting on the roadside fence overlooking a birdbath on 29 June 2016.

Red-billed gull *Larus novaehollandiae scopulinus*
Red-billed gulls were observed in 30% of weeks and 58% of months (Table 1). There was a significant seasonal difference, with birds observed most in summer weeks (47%) and least in autumn (6%) (Table 1, Fig. 13). There was also a highly significant decline in the numbers of birds observed over the years, which explained 70% of the variation in the data (Table 2). Gulls were observed about 28 weeks/year fewer at the study end than the beginning (Table 2). Much of this decline occurred in winter and spring (Fig. 13).

Silvereye *Zosterops lateralis lateralis*
Silvereyes were the fourth most common, and most common native, species in the study, being observed in 78% of weeks and 98% of months (Table 1, Fig. 14). They were detected most in winter weeks (88%) and least in summer (67%), but the seasonal differences were not significant (Table 1). There was, however, a significant trend over the years (Table 2), with increased observations towards the end of the study when they were recorded nearly every week, about 20 weeks/year more than at the start of the study; 67% of the variation in the data was explained by the relationship with time (Table 2).

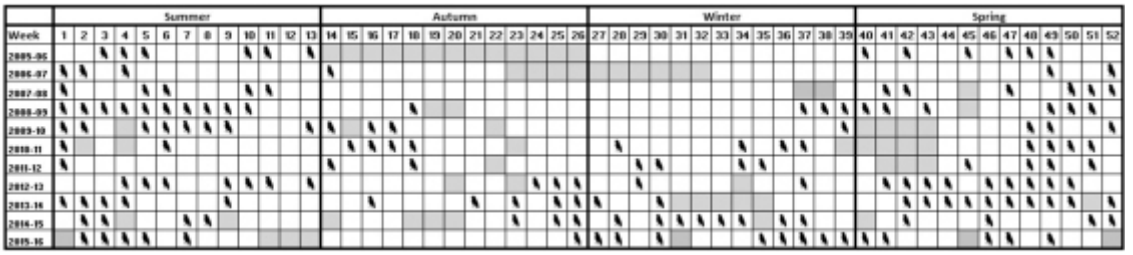

Fig. 15. Weeks during which song thrush were observed at the study site. Shaded weeks are missing data.

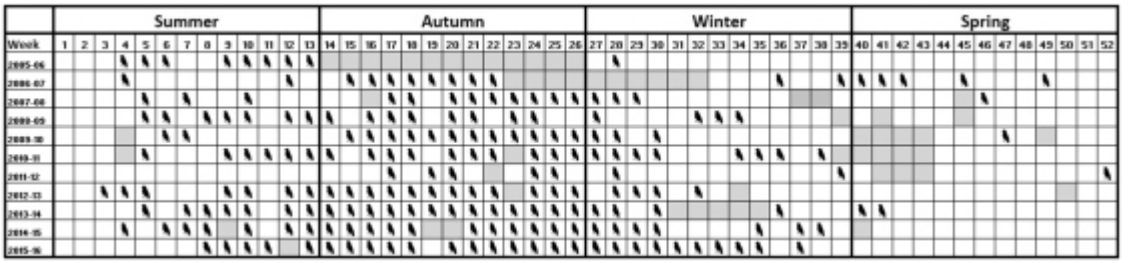

Fig. 16. Weeks during which South Island fantail were observed at the study site. Shaded weeks are missing data.

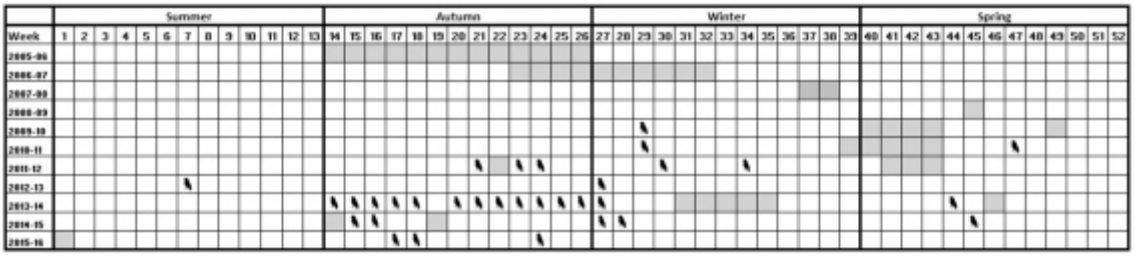

Fig. 17. Weeks during which welcome swallow were observed at the study site. Shaded weeks are missing data.

Song thrush ***Turdus philomelos***

Song thrush were observed in 34% of weeks and 73% of months (Table 1). There was a highly significant seasonal difference, with thrushes being observed about 22% of the autumn and winter weeks, and 45% of the spring and summer weeks (Table 1). In addition, there was a significant change over the years, with an increase of about 10 weeks/year over the length of the study as a consequence of more birds being observed in autumn and winter; 47% of the variation in the data was explained by the year factor (Table 2, Fig. 15).

South Island fantail ***Rhipidura fuliginosa fuliginosa***

Fantails were recorded in 41% of weeks and 71% of months (Table 1). There was a significant seasonal difference, with observations in 83% of weeks in autumn and in very few weeks in spring or early summer (Table 1, Fig. 16). A significant trend was detected in the numbers of observations with years, increasing about 1 week/year, though only a small proportion (36%) of the variation in the data was explained by year in the relationship (Table 2).

Welcome swallow ***Hirundo neoxena neoxena***

This species was first recorded in winter 2010, hawking over the property as part of a wider search for food; they were never seen perched. On average they were seen in 6% of weeks and 17% of months (Table 1). From 2010-2016, they were seen up to 5 weeks per year, except in autumn 2014 when they were seen in all but 1 week (Fig. 17). Although recorded in all seasons, swallows were

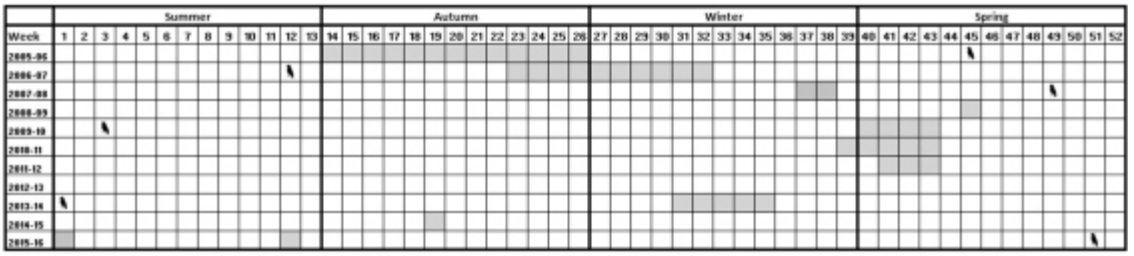

Fig. 18. Weeks during which yellowhammer were observed at the study site. Shaded weeks are missing data.

more commonly seen in autumn and early winter (Table 1, Fig. 17). With no swallows seen in the first 4.5 years, there was an increase in weeks birds were detected over the years, but it was not statistically significant (Table 2).

Yellowhammer *Emberiza citrinella*

Yellowhammers were only recorded in 6 weeks of the study, 3 during summer and 3 during spring. Because of the low numbers of sightings, there were no seasonal differences nor a trend with time (Tables 1 and 2, Fig. 18).

Native versus introduced species

There was no significant difference between native and introduced species detected here (excluding red-billed gull and species with less than 6 records) when comparing the number of species with greater autumn/winter observations to those with no trend and greater spring/summer observations ($\chi^2 = 1.66$ c.f. $\chi^2_{df=1,95\%} = 3.84$). Similarly, a comparison between the same species sets of increasing trends over time versus no change and decreasing trends also showed differences were not significant ($\chi^2 = 3.66$ c.f. $\chi^2_{df=1,95\%} = 3.84$).

DISCUSSION

This study has shown that there have been significant changes in the numbers of weeks a year in which some species were detected over the course of the study, and some species exhibited significant differences between seasons; these will be discussed below. Comparing the sets of native/self-introduced and introduced species, there were no significant differences in the number of species with increasing versus stable/decreasing annual detections over time nor peak detections in autumn/winter versus spring/summer peaks and no change.

There are a number of factors that affect comparisons of this study with others. The current garden survey was based on presence/absence of a species each week over 11 years and is, therefore, not directly comparable with studies that used other reporting methods. Notwithstanding, we can still get useful comparative data, especially from those studies with daily and monthly presence/absence data, monthly and weekly total counts, and even 5- and 10-minute bird count summaries.

The conspicuousness of birds with strong variations of song and colour throughout the year can influence the counts of birds (Dawson *et al.* 1978; Gill 1980; Freeman 1999; Gibb 2000a). However, in this study it was usually movements of birds that led to them being observed, rather than their song or colour attracting our attention. As a consequence, conspicuousness is not likely to have had a large influence on bird detection as we only needed 1 sighting of a bird in a week to score that species, and we were usually present for large proportions of a week. Grey warblers and bellbirds were 2 exceptions, as their song could be readily identified with the presence of a bird within the property boundary; others such as blackbird, song thrush and greenfinch were rarely heard singing in the property.

Gibb (2000a) considered that 12 years of data in his study could be too short to distinguish permanent from temporary changes. While that may be the case, linear regression analyses performed on his data confirmed the significance of the short-term changes he noted, and our trends over the years were for a similar length of time.

Three species (New Zealand falcon, Australian magpie and California quail) were only seen once during the current study. These visits were not entirely unexpected as all 3 had previously been observed on the farmland plateau to the southwest of the study site.

Bellbird

Bellbirds are found in many habitats including forests, scrublands, and urban parks and gardens (Higgins *et al.* 2001). This species was recorded present in this study more often (70% of months) than in a Te Kuiti garden (7% of months) (Guest & Guest 1987).

We observed significant seasonal differences, with fewer birds detected in spring/summer than

in autumn/winter. This could not be attributed to conspicuousness, as bird song in spring and summer would attract our attention to the birds' presence and, hence, higher detection rates. Local movements, perhaps looking for alternative food sources, could explain the seasonal changes (Higgins *et al.* 2001), with an influx to urban settings as here and in the Te Kuiti garden where bellbirds were rarely seen in summer, but were present in winter (Guest & Guest 1987). Studies in forests have noted birds present all year round, but fewer in the colder months presumably as birds move away (e.g., Dawson *et al*. 1978; Gill 1980; Freeman 1999). This is further demonstrated by the numbers of bellbirds breeding in forest remnants on the Port Hills near Christchurch; decreasing as they dispersed to, and increasing in number, in the city in autumn (Spurr *et al*. 2014). At Kowhai Bush Reserve, a kanuka (*Kunzea ericoides)* dominated forest 8 km from Kaikōura, lower counts of bellbirds were recorded in winter than summer (Gill 1980). These lower counts correspond to the period when there were more weeks with bellbirds detected at our garden. Bellbirds moving to the township in autumn from nearby native forest/scrub could, therefore, contribute to our increased sightings, and the return there in spring coincides with the onset of the breeding season and our decreasing observations.

There was a significant increase in the number of weekly observations of bellbirds over the years in our garden. The rate of increase was about 2 weeks per year, with no obvious reason for this, although the time factor accounted for a high proportion of the variation in the data. This may be part of an increasing national trend, as at the Kowhai Bush Reserve bellbird counts more than doubled between 1976 and 1999-2001 (Barnett 2011) albeit before this study, there were increases in bellbird numbers in the Port Hills and Christchurch City in the 2000s (Spurr *et al.* 2014) and there was a 28% increase reported by the NZGBS from 2007 to 2010 (Spurr 2012).

Chaffinch

Chaffinches can be found in almost any habitat including urban gardens (Higgins *et al.* 2006). We detected them in about 77% of months, which is considerably less than at Te Kuiti (95% of months) and Palmerston North (90% of months) (Guest & Guest 1987,1993).

Seasonal movements occur, with chaffinches moving from higher to lower altitudes in autumn and forest to open country and farmland in winter (Higgins *et al.* 2006; Angus 2013a). The highly significant seasonal differences observed here, with greater detections in winter, could indicate an influx from nearby farmland or forest. If so, this is consistent with fewer birds reported during autumn and winter than spring and summer in Kaingaroa Forest (Gibb 1961), Kennedy's Bush (Freeman 1999), Kowhai Bush (Gill 1980; Dean 1990), and the Auckland Domain (Gill 1989).

Although there was a significant downward trend of chaffinch detection with time, unknown factors accounted for the majority of the decrease. Other garden studies have reported larger decreases in observations over time; at Masterton the number of days chaffinches were seen had halved after 29 years (Stidolph 1977), and at Western Hutt the numbers/10-minute count dropped about 90% over 12 years (Gibb 2000a). In contrast, Barnett (2011) had an almost 50% increase in chaffinch counts when he compared his Kowhai Bush 1999-2001 counts with those of Gill (1980) taken in 1976.

Common redpoll

Redpolls are generally found in open country or forest margins, but can be found in parks and gardens (Higgins *et al.* 2006). In our garden, the redpoll was 1 of the least detected species.

Redpolls are not known to undertake regular migration, but there can be local movements, especially in winter (Higgins *et al.* 2006). The presence of birds only in autumn and winter during our study is contrary to other urban sites such as Palmerston North (Guest & Guest 1993), Dunedin (Kikkawa 1959) and Masterton (Stidolph 1977). Our observations are similar to those at the Western Hutt where small parties of redpolls arrived in March to August (Gibb 2000a) from, presumably, their breeding habitat. At nearby Kowhai Bush there were several winter months in which no redpolls were counted by Gill (1980), and Dean (1990) noted redpolls leaving in the non-breeding season to join flocks in nearby pasture. These latter movements are consistent with possible movements into Kaikōura and the increased bird presence we observed.

Because of the small number of redpolls observed in our garden, there was no trend over the years, unlike at Masterton when redpolls were not seen 29 years after initial observations (Stidolph 1977), and at Kowhai Bush where counts of redpolls fell by 60% over 25 years (Barnett 2011).

Common starling

Starlings can be seen in most habitats except deep in forests (Heather & Robertson 2005). Being regular visitors to our garden, they were recorded in 99% of months, which is comparable to the 100% observed at Te Kuiti, Palmerston North and Masterton (Stidolph 1977; Guest & Guest 1987, 1993); they were reported as "always common" in the Western Hutt hills (Gibb 2000a).

Dunnock
Dunnocks are found in many habitats including gardens (Higgins *et al.* 2006). In the current study, dunnock was 1 of the more common species being observed in nearly two-thirds of the study weeks, which is more than at Te Kuiti (Guest & Guest 1987).

The marked seasonal difference with birds detected in fewer weeks in summer than the other seasons was not quite as pronounced as at Te Kuiti, where they were seen rarely or not at all in summer months (Guest & Guest 1987). Gibb (2000a) also had higher 10-minute counts in winter and very low counts in summer in the Western Hutt hills. Dunnocks are not considered to be migratory in New Zealand (Heather & Robertson 2005) and their conspicuous song would make them more, not less, detectable in summer. The changes observed here must be local movements between the township and the adjacent farmland and nearby forest searching for food.

While there was no trend in the weekly observations over the time of this study, Stidolph (1977) observed a significant decline in numbers at Masterton, seeing dunnocks on only 173 days in 1971-2 compared to 276 days/year 29 years earlier. In the NZGBS, dunnocks decreased by 24% over the period 2007–2010 (Spurr 2012).

Eurasian blackbird
Blackbirds are commonly found in urban gardens and parklands as well as farmland, forests, and orchards (Higgins *et al.* 2006). They were one of the most frequently recorded birds in our garden. At least 1 was observed in all but 1 month of this study, close to the 100% observations reported for North Island gardens (Guest & Guest 1987, 1993; Stidolph 1977). While there were no detectable differences in seasonal presence here, other studies have shown changes in numbers counted throughout the year (e.g., Gill 1989; Freeman 1999; Gibb 2000a, b), even though blackbirds are not considered migratory (Higgins *et al.* 2006). There was no trend over the years in our presence/absence records, although in nearby Kowhai Bush Barnett (2011) counted about half the numbers of blackbirds that Gill (1980) recorded there 25 years earlier.

European goldfinch
Goldfinches can be found in most habitats including urban gardens (Higgins *et al.* 2006). In our garden, they were observed in 78% of months, less than 100% at Te Kuiti (Guest & Guest 1987) and 97% at Palmerton North (Guest & Guest 1993).

Goldfinches are not considered migratory, but local movements can occur (Higgins *et al.* 2006). That may be the reason we observed fewer birds at the change from summer to autumn and at the change from winter to summer. These changes, however, did not show up as a significant difference between seasons here. Other instances of local migration by goldfinches have shown as summer visitors to the Dunedin Botanic Gardens (Kikkawa 1959), Kennedy's Bush (Freeman 1999), Kowhai Bush (Gill 1980; Barnett 2011) and the Western Hutt hills (Gibb 2000a).

While a trend in weekly observations with time was not found here, a decrease of about 80% was reported to have occurred at Kowhai Bush from 1976 to 1999-2001 (Barnett 2011) which pre-dates this study, and Stidolph (1977) noted a decrease of 60% in the 29 years to 1971–72.

European greenfinch
Man-modified habitats seem to be preferred by greenfinches (Higgins *et al.* 2006), but this is another species recorded infrequently in our garden; a similar scenario noted for other garden (Stidolph 1977; Guest & Guest 1987, 1993; Gibb 2000a) and bush settings (Freeman 1999; Barnett 2011).

Greenfinches undertake local movements (Higgins *et al.* 2006) and this could explain the significant seasonal change. Birds at our study site were observed predominantly in winter and sporadically in other seasons, a similar pattern to that at the Auckland Domain (Gill 1989), and could reflect a move from nearby farmland searching for new food sources. These patterns are contrary to reports by Kikkawa (1959), Guest Guest (1987) and Freeman (1999) who observed birds mainly in summer.

There was no trend in the numbers of our weekly observations over the years, but Stidolph (1977) reported a drop in the number of days in which birds were seen in his garden in Masterton from 62 in 1942-43 to 10 29 years later. The NZGBS reported significant decreases for 3 years before rebounding in the fourth year (Spurr 2012).

Grey warbler
Grey warblers can be found in any habitat providing there are trees present (Higgins & Peter 2002). In the current study this species was recorded in 85% of months, which is less than at gardens in Te Kuiti and Palmerston North and forests at Kennedy's Bush and Kowhai Bush where grey warblers were seen every month (Gill 1980; Guest & Guest 1987, 1993; Freeman 1999).

Although grey warblers are considered to be sedentary (Higgins & Peter 2002) there was a strong seasonal effect in our garden, with birds observed in more weeks in autumn and winter than in spring and summer. The lower frequencies in spring and summer cannot be attributed to conspicuousness as the grey warbler's distinctive song would enhance

the probability of them being detected. Other studies have reported a similar trend with higher numbers in winter at Kowhai Bush (Gill 1980) and in August and September in the Auckland Domain (Gill 1989). Birds in the Hutt Valley disappeared in the breeding season (Bull 1959; Dell 1959; Gibb 2000a). The more frequent autumn/winter observations at our garden and at Kowhai Bush could indicate local movement from forest on the slopes of the Seaward Kaikōura range, 12 km from our garden, to lower altitude areas.

We found no significant trend with years, however Stidolph (1974, 1977) recorded an 85% decrease in the number of days grey warblers were seen at Masterton in 1971-72 compared to 29 years earlier, while Gibb (2000a) noted a drop of over 90% over 12 years in the Western Hutt hills. At nearby Kowhai Bush, Barnett (2011) did not detect any change in counts compared to those made by Gill (1980) 25 years earlier.

House sparrow

The house sparrow was the bird detected most often in our garden, 100% of months. The high frequency of sightings was not surprising as the species is found mainly in settled areas such as farmland and suburban/urban areas (Higgins *et al.* 2006) and had the highest count in the NZGBS (Spurr 2012). This species was also seen in gardens every month at Te Kuiti and Palmerston North (Guest & Guest 1987, 1993) and Masterton (Stidolph 1977), and was 'always abundant' in the Western Hutt hills (Gibb 2000a).

Red-billed gull

Although a bird of the sea-shore, red-billed gulls are commonly seen in the Kaikōura township scavenging food scraps. Visits to our garden were mainly by birds seen sitting on the house roof eating food brought in from elsewhere. The significant seasonal trend (most in summer and least in autumn) reflects birds moving away from Kaikōura in the non-breeding season. Banding records show many birds go from Kaikōura to, for example, Christchurch and Wellington in autumn and winter (L. Rowe *unpubl. data*; Heather & Robertson 2005*).* The significant downward trend with gulls present 28 weeks/year less at the end of the study period may be a consequence of the decline in numbers of breeding birds at the Kaikōura Peninsula from 2005 to 2013 before a recovery to 2015 (Fig. 1 in Mills *et al.* 2018).

Silvereye

Silvereyes occur in most habitats including urban/suburban parks and gardens (Higgins *et al.* 2006). In our garden, silvereyes were detected in 99% of months, almost as often as at Te Kuiti and Palmerston North where Guest & Guest (1987, 1993) recorded them every month, and at Masterton where Stidolph (1977) recorded them every day.

Silvereyes undertake local seasonal movements (Higgins *et al.* 2006), moving into town gardens for food in winter (Kikkawa 1962; Heather & Robertson 2005). In this study, there was no detectable seasonal change in weekly presence. However, during the winter season larger numbers were present, with flocks up to 30 birds instead of fewer than 5 birds during the summer, thus, indicating movement into the township (L. Rowe *unpubl. data*). This trend was similar to movements in the Hutt Valley, where more birds were counted in autumn/winter than in summer in the Western Hutt hills (Gibb 2000a, 2000b) and flocks move into urban areas in winter (Bull 1959). In Kennedy's Bush, there was a peak in numbers in autumn possibly from migrating flocks (Freeman 1999), and in Kowhai Bush there were fewer birds in winter (Gill 1980) implying movements out of the bush which could be towards the Kaikōura township.

There was a significant trend of increased sightings towards the end of our study, with birds present nearly every week, 20 weeks more in the last year than the first year. This increase follows an upward trend (a four-fold increase) in counts at Kowhai Bush from 1976 to 1999-2001 (Barnett 2011) and contrasts with the more than 50% decrease over a 12-year period at the Western Hutt hills (Gibb 2000a). At the national level, sightings of silvereyes decreased by 33% from 2007 to 2009 but then increased by 66% in 2010 (Spurr 2012), indicating high annual variability.

Song thrush

Another species that occupies most habitats (Higgins *et al.* 2006), song thrushes were detected in our garden less often than in gardens at Te Kuiti (every month) and Palmerston North (most months) (Guest & Guest 1987, 1993) and at the Western Hutt hills (on average each month) (Gibb 2000a).

While song thrushes are not migratory (Higgins *et al.* 2006), there were significant seasonal changes here as birds were recorded in twice as many months in summer than winter. This implies birds move into the town from rural or forest habitats to breed, the opposite to that in the Western Hutt hills (Gibb 2000a).

In addition to the seasonal differences, there was a significant increase in weekly observations with years; after 11 years birds were observed during an extra 10 weeks/year, a similar trend to the more than five-fold increase at Kowhai Bush over 25 years (Barnett 2011). This is contrary to reports

of declines of about 50% observed over 12 years at Western Hutt (Gibb 2000a) and Masterton (Stidolph 1977), and a 17% nationwide decline between 2007 and 2010 in the NZGBS (Spurr 2012).

South Island fantail

Fantails utilise a wide range of habitats including urbanized settlements (Higgins *et al.* 2006). In our garden, South Island fantails were observed less often (71% of months) than North Island fantail in Te Kuiti (every month) (Guest & Guest 1987) and at Palmerston North (most months) (Guest & Guest 1993).

While they do not migrate, there can be some local seasonal movements (Higgins *et al.* 2006). This could explain the highly significant seasonal differences, with more fantails recorded in autumn/early winter and very few in spring or early summer when they were probably at their preferred breeding areas. This is a similar pattern to that reported for the Hutt Valley, where fantails depart to scrub forest areas for the breeding season (Bull 1959; Dell 1959; Gibb 2000b). Kikkawa (1959) also reported that fantails moved from the Dunedin Botanic Gardens for 1-3 months of the breeding season. Fantails from our garden could move to bush areas including the nearby Kowhai Bush, but earlier counts of fantails there were inconsistent with no discernible pattern (Gill 1980).

The significant positive trend with years was different to other studies showing a slight decline at Masterton over 29 years (Stidolph 1977) and a significant decline of 37% in the Western Hutt counts over 12 years (Gibb 2000a).

Welcome swallow

Welcome swallows are often found in open areas, including settlements, and may be coastal or near wetlands (Higgins *et al.* 2006). One of the least common species recorded here, welcome swallows were seen hawking over the property as part of a wider search for food. They were not seen as often in our garden (17% of months) compared to Te Kuiti and Palmerston North (approximately 50-60%) (Guest & Guest 1987, 1993). Although they were recorded in all seasons, welcome swallows were more commonly seen in autumn and early winter which may be a seasonal movement associated with searching for food (Higgins *et al.* 2006). This is the opposite pattern to that at Palmerston North, where they were regularly seen in summer and sporadically in other months of the year (Guest & Guest 1993). Swallows were seen more often in the latter half of the study which may be a sign of an increasing local population.

Yellowhammer

As yellowhammers prefer open country (Heather & Robertson 2005) it was not surprising that they were recorded in our garden in only 6 weeks (3 in spring and 3 in summer). There can be local movements of yellowhammers (Angus 2013b), but seeing the birds here in summer/spring is opposite to the other garden studies. At Te Kuiti and Palmerston North they were mainly winter visitors (Guest & Guest 1987, 1993) and small flocks in the Hutt Valley urban area in winter headed off to scrub covered hills in summer (Bull 1959). The small numbers here meant no trend over time was detectable, unlike at Masterton where Stidolph (1977) reported yellowhammers had vanished over 29 years as open land nearby was converted into housing, and on a national basis there was a 47% increase in counts between 2007 and 2010 (Spurr 2012).

CONCLUSION

There were no obvious changes to our garden and the surrounding areas that would explain the observed changes; sheep and cattle grazing still occurs on the high terrace, there has been little change in the density of housing (only 2 houses were built nearby during the study) and associated gardens in the vicinity of the study site.

Nineteen species were observed here; 7 including the recently self-introduced welcome swallow can be considered "native", and 12 were introduced by humans. Four native species (bellbird, grey warbler, fantail and welcome swallow) with more than 3 sightings all exhibited seasonal variation with more records in the colder months; silvereye did not show significant variation, and red-billed gull observations were higher in the breeding seasons. Three (blackbirds, house sparrows and starlings) of the 12 introduced species were detected in >90% of weeks, and therefore, no seasonal trends could be detected in weekly presence. Of the 9 other introduced species, 6 species had more than 6 observations; chaffinch, redpoll, dunnock and greenfinch were observed more often in the colder months, song thrush were observed more in summer, and goldfinch did not appear to change. Most of these seasonal changes are likely to be local movements of birds from the adjacent farmland and nearby forests to the township chasing new food sources. There was no significant difference between sets of native and introduced species when comparing the number of species with greater winter observations to those with no trend and greater summer observations.

Observations of bellbirds, silvereyes, song thrushes and fantails increased over the 11 years of the study, whereas chaffinches and red-billed gulls decreased. For bellbirds, the trend was the same as

the NZGBS counts, that also noted trends we did not observe: increased counts of house sparrows and yellowhammers; decreased counts of dunnocks and song thrushes; and decreases over 3 years and a rebound in the fourth year for silvereyes and greenfinches (Spurr 2012). Comparisons of increasing trends with time against those with no increase and decreases were not significantly different for sets of native and introduced species.

While limited to a single garden in Kaikōura, observations of presence/absence on a weekly basis over 11 years can provide an index of bird numbers, and demonstrate seasonal movements and medium-term changes for bird species at that site. Comparisons with other garden studies highlighted the differences that do occur between sites and with time.

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