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Changes in the observed bird abundance in a modified forest at Kowhai Bush, Kaikoura

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Abstract Kowhai Bush in the Kaikoura region represents an important wildlife reserve for some native forest bird species. It is home of 1 of the few populations of brown creepers (*Mohua novaeseelandiae*) and South Island robins (*Petroica australis*) in lowland forest in the Canterbury region. Here, I present results from 275 five-minute point counts that were conducted at Kowhai Bush from October until December from 1999 to 2001. I compare these data with those collected by Gill (1980) in the same months of 1976 at similar sites. These comparisons reveal that the observed abundance and composition of the species at Kowhai bush has changed between 1976 and 1999-2001. Overall, there was a decline in bird abundance between 1976 and 1999-2001 and there was a significant difference in bird abundance between the 2 habitats in which counts were undertaken at Kowhai Bush. At a species level, there were dramatic declines (>50%) in the observed abundances of brown creepers and South Island robins whilst blackbirds (*Turdus merula*), redpolls (*Carduelis flamea*), and European goldfinches (*C. carduelis*) had more modest, but still significant declines. These declines were offset somewhat by large increases (>50%) in the observed abundances of silvereyes (*Zosterops lateralis*), and song thrushes (*Turdus philomelos*) and significant increases in the observed abundances of bellbirds (*Anthornis melanura*) and chaffinches (*Fringilla coelebs*). I discuss a number of factors that might be responsible for these changes.

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Keywords Kowhai Bush; Kaikoura; bird abundance; 5-minute bird counts; point counts

INTRODUCTION

Kowhai Bush is a locally important reserve for wildlife in the Kaikoura region of Canterbury, New Zealand. It is dominated by manuka (*Leptospermum scoparium*) and kanuka (*Kunzea ericoides*) and is the site of 1 of the few lowland populations of South Island robins (*Petroica australis*) and rifleman (*Acanthisitta chloris*) in the Canterbury region of the South I (see appendix 1 for species in this study). The ease of access to Kowhai Bush has also made it an important site for avian research in New Zealand (Flack 1975; Gill 1980; Powlesland 1981, 1983; Moors 1983; Cunningham 1985; Sherley 1985; Briskie 2003; Barnett & Briskie 2007, 2010; Hale & Briskie 2007). Despite the importance of Kowhai Bush in a research and conservation context, there is little knowledge of long-term population trends of the avian species there. Indeed, this is the case for most manuka/kanuka forest throughout New Zealand.

New Zealand has an unenviable record of species decline and extinction since human settlement. In the past 2,000 years, 77 species of land-birds have gone extinct (Holdaway 1999). There are many causes for these declines, but in island ecosystems, introduced species are often a major cause of decline through competition,

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predation, parasitism, and disease (*e.g.*, Diamond 1984; Courchamp *et al.* 2003). For example, predation is a significant cause of decline for many forest bird species in New Zealand (*e.g.*, saddlebacks, *Philesturnus carunculatus*), despite large tracts of their habitat remaining. These large tracts of habitat are also home to other native and endemic forest birds (*e.g.*, robins) that, from a conservation perspective, are of less concern despite significant range contractions since human arrival. This is because it is thought that these species are no longer in decline and have reached a point of population equilibrium with their new environments (*e.g.*, King 1984). However, few data exist on the long-term population trends of New Zealand forest birds such as New Zealand robins, brown creepers, and rifleman as these species are not conservation priorities.

Most data on population trends are normally in response to a change in management strategy such as to use of 1080 to control possum (*Trichosurus vulpecula*) numbers (*e.g.*, Spurr & Anderson 2004) or trapping of rodents and mustelids (*e.g.*, Kelly *et al.* 2005). In 1 of the few long-term studies of bird abundance, Elliott *et al.* (2010) compared 2 data sets that were collected at Mount Misery in the Nelson Lakes National Park over a 30-year period. They found that many native and endemic forest bird species had declined over the course of the study. This suggests that many native species presently considered at little risk of extinction may be slowly declining. However, few other data are available on the long-term trends of abundance for many native New Zealand forest birds, and whether the declines observed by Elliott *et al.* (2010) are widespread is currently not clear.

Birds are often used as indicators of environmental quality because they are quick to survey, easy to quantify, and their abundance and species richness may correlate with environmental quality (*e.g.*, Dawson & Bull 1975; Bibby 1999; Bibby *et al.* 2000; Siegel *et al.* 2001). Gill (1980) conducted 459 bird counts at Kowhai Bush from 1976-1977 and showed that this area contained significant populations of South Island robins, brown creepers, and rifleman. Here, I compared the results of 275 five-minute bird counts for 18 species that were conducted at Kowhai Bush in the summers of 1999-2001 with a subsample of 66 five-minute counts taken in the same habitat and at the same time of the year in 1976 (Gill 1980). I compared the data both at species and community levels to assess if there have been any changes in the observed abundance between the early data set and the later data set. I also tested if there were any differences in bird abundance between a habitat of manuka/kanuka forest with a poorly developed understory and manuka/kanuka forest with a more developed understory.

METHODS

Study site

Data were collected during the springs of 1976, 1999, 2000, and 2001 at Kowhai Bush Reserve (173° 36′ E, 42° 23′ S) about 10 km from Kaikoura, New Zealand. Kowhai Bush is an ~240 ha strip of modified forest that stretches along the Kowhai River and is maintained as a flood barrier for the nearby rural areas. It is described in more detail by Gill (1980). The site consists of various flood-induced successional stages of native forest that has been modified by introduced mammals and human land use practices (*e.g.*, cattle browsing; Hunt & Gill 1979). I used a site that was adjacent to Schoolhouse Road. I took counts at 3 points in areas classified by Gill (1980) as habitat 1 and 3 points within habitat 2. Habitat 1 consisted of stunted manuka and kanuka (5-12 m high) with an undeveloped understorey. The ground cover consisted of mosses, grasses, ferns, lichens, and hook sedges. Habitat 2 had taller manuka and kanuka (7-13 m high) and a better-developed understorey dominated by introduced Montpellier broom (*Cytisus monspessulanus*). The ground cover consisted of grasses, ferns, and *Uncinia* (Gill 1980).

Field methods

Five-minute bird counts are not an absolute measure of abundance; they provide an index of bird abundance that is useful for making comparisons. The ease with which counts can be conducted has seen them become a standard ecological technique in New Zealand (Dawson & Bull 1975; Dawson *et al.* 1978; Gill 1980; Elliott *et al.* 2010). I conducted 275 five-minute bird counts (Habitat 1 = 146 counts, Habitat 2 = 129 counts; 1999 = 30 counts, 2000 = 122 counts, 2001 = 123 counts) starting at the Schoolhouse Road entrance to Kowhai Bush and progressing towards the river in a westerly direction. The stations were at least 200 m from one another and at least 100 m from the forest edge. Upon arrival at a station for a count, I waited at least 1 minute before starting in order to allow time for birds to habituate to my presence. I recorded the presence of every bird (see appendix 1) seen or heard for a period of 5 minutes and attempted to avoid counting the same individual bird twice. As five-minute counts only approximate bird abundance, I use the term observed abundance throughout the manuscript. I took a maximum of 1 count per day from each of the sites and counted the 18 species that were counted in Gill's (1980) study. I also recorded unidentified birds although these were omitted from analyses as the possibility that they had already been counted could not be excluded.

Statistics

I used generalised linear models throughout to test hypotheses. I used type III models with Poisson

Table 1. Mean numbers ± SE species per 5-minute bird counts among the different years. Letters in parentheses indicate the pair-wise commonalities in the counts between years from the generalised linear models. Test statistics were calculated using Wald's χ^2(*d.f.* = 3). *P*-value indicators: *< 0.05, ** < 0.01, *** < 0.001, — unable to compute statistic.

Species	Year				χ^2
	1976	1999	2000	2001	
Grey warbler	0.95 ± 0.11 (a)	0.63 ± 0.13 (a)	0.69 ± 0.06 (a)	0.89 ± 0.06 (a)	5.345
Brown creeper	2.13 ± 0.20 (a)	0.53 ± 0.10 (b)	0.22 ± 0.04 (b)	0.20 ± 0.38 (b)	23.246***
Silvereye	0.38 ± 0.14 (a)	1.93 ± 0.33 (b)	1.57 ± 0.15 (b)	1.33 ± 0.11 (b)	44.298***
Fantail	0.17 ± 0.06 (a,c)	0.50 ± 0.13 (a,b,c)	0.20 ± 0.05 (b)	0.02 ± 0.02 (a,c)	9.864*
South Island robin	0.22 ± 0.07 (a)	0.13 ± 0.06 (a,b)	0.04 ± 0.02 (b)	0.07 ± 0.03 (b)	11.607**
Bellbird	1.40 ± 0.13 (a)	2.17 ± 0.16 (b)	2.11 ± 0.08 (b)	1.30 ± 0.07 (a)	31.546***
Shining cuckoo	0.10 ± 0.04 (a)	0.07 ± 0.05 (a)	0.17 ± 0.04 (a)	0.19 ± 0.04 (a)	4.500
Rifleman	0.06 ± 0.04 (a)	0.06 ± 0.02 (a)	0.06 ± 0.02 (a)	0.08 ± 0.03 (a)	0.607
Tui	0 (a)	0 (a)	0.07 ± 0.024 (a)	0.02 ± 0.01 (a)	2.297
All native species	5.41 ± 0.32 (a)	5.97 ± 0.46 (a)	5.13 ± 0.18 (a)	4.11 ± 0.16 (b)	12.762**
Song thrush	0.30 ± 0. 70 (a)	0.87 ± 0.115 (b)	1.85 ± 0.08 (c)	2.00 ± 0.10 (c)	37.495***
Blackbird	1.02 ± 0.11 (a)	0.27 ± 0.10 (b)	0.66 ± 0.06 (c)	0.72 ± 0.06 (c)	15.972**
Skylark	0.11 ± 0.05	0	0	0	—
Redpoll	3.02 ± 0.38 (a)	1.27 ± 0.23 (a,b)	1.11 ± 0.08 (b)	0.97 ± 0.07 (b)	8.274*
Greenfinch	0.06 ± 0.05 (a)	0.03 ± 0.03 (a)	0.06 ± 0.02 (a)	0.05 ± 0.02 (a)	0.361
Goldfinch	0.89 ± 0.14 (a)	0.03 ± 0.03 (b)	0.47 ± 0.06 (c)	0.05 ± 0.02 (b)	42.222***
Chaffinch	1.21 ± 0.12 (a)	2.00 ± 0.20 (b)	1.71 ± 0.09 (b)	1.60 ± 0.10 (b)	10.016*
Yellowhammer	0.06 ± 0.03 (a)	0.03 ± 0.03 (a)	0.03 ± 0.02 (a)	0.02 ± 0.01 (a)	0.892
Dunnock	0.06 ± 0.04 (a)	0.07 ± 0.05 (a)	0.12 ± 0.03 (a)	0.09 ± 0.03 (a)	6.565
All introduced species	6.83 ± 0.52 (a)	4.57 ± 0.42 (b)	6.01 ± 0.16 (a)	5.50 ± 0.18 (a,b)	9.590*
All species combined	12.24 ± 0.47 (a)	10.53 ± 0.61 (b)	11.14 ± 0.23 (b)	9.61 ± 0.20 (c)	25.831***

distributions and log link functions. Year and habitat type were included as fixed factors as well as the 1st order interaction. Time-of-day, counter, station number, and Julian date were included as covariates in order to control for their effects on the dependent variable. All analyses were conducted using the LME4 package in R version 2.11.1 (R development Core Team 2010).

RESULTS

Overall effects between years and habitats

There was a significant difference in the total number of birds counted among years (Wald's χ^2 = 25.8, $P < 0.001$, *d.f.* = 3; Table 1, Fig. 1). Examination of the contrasts indicated that the main difference was between the data from 1976 and the later years although there was also a significant difference in the counts among 2001 and the previous 2 years (Table 1). There was also a significant effect of habitat on bird numbers (χ^2 = 15.3, $P < 0.001$, *d.f.* = 1; Table 2) with birds being more abundant in habitat 1 compared with habitat 2 (1976 data included). Overall, more birds were detected in habitat 1 (Table 2). This difference was primarily the result of greater observed abundances of introduced species in habitat 1 than in habitat 2 (Table 2). There was also a significant interaction between habitat and year (χ^2 = 12.6, $P = 0.006$, *d.f.* = 3). This interaction suggests that while the counts remained fairly constant in habitat 2 (around 10 birds per count) they tended to fluctuate among years in habitat 1 (between a maximum of ~14 to a low of ~10 birds).

Species level effects

There were many significant differences in individual species abundances among years (Table

Table 2. Mean numbers ± SE for species per 5-minute bird counts between the different habitats. Test statistics were calculated using Wald's χ^2 (*d.f.* = 1). *P*-value indicators: * < 0.05, ** < 0.01, *** < 0.001.

Species	Habitat		χ^2
	Type 1	Type 2	
Grey Warbler	0.73 ± 0.05	0.89 ± 0.06	2.532
Brown Creeper	0.62 ± 0.08	0.57 ± 0.09	2.342
Silvereye	1.72 ± 0.13	0.89 ± 0.08	44.711***
Fantail	0.14 ± 0.03	0.18 ± 0.04	0.471
South Island robin	0.02 ± 0.01	0.18 ± 0.04	14.284***
Bellbird	1.41 ± 0.07	1.99 ± 0.07	18.298***
Shining cuckoo	0.08 ± 0.02	0.24 ± 0.04	12.228***
Rifleman	0.10 ± 0.02	0.02 ± 0.01	7.405**
Tui	0.03 ± 0.01	0.04 ± 0.02	1.055
All native species	4.85 ± 0.17	4.93 ± 0.16	1.886
Song thrush	1.53 ± 0.08	1.53 ± 0.09	0.185
Blackbird	0.70 ± 0.05	0.73 ± 0.06	0.106
Skylark	0.04 ± 0.15	0	0.000
Redpoll	1.98 ± 0.15	0.82 ± 0.08	63.592***
Greenfinch	0.08 ± 0.02	0.02 ± 0.02	4.172*
Goldfinch	0.44 ± 0.06	0.26 ± 0.04	0.207
Chaffinch	1.79 ± 0.08	1.40 ± 0.08	7.501**
Yellowhammer	0.06 ± 0.02	0.01 ± 0.01	3.788
Dunnock	0.11 ± 0.03	0.07 ± 0.02	0.132
All introduced species	6.76 ± 0.19	4.84 ± 0.17	40.716***
All species combined	11.61 ± 0.23	9.77 ± 0.20	15.321***

1). There were dramatic declines (*i.e.*, >50%) in the observed abundances of brown creepers and South Island robins whilst blackbirds, redpolls, and European goldfinches had more modest, but still significant declines. These declines were offset somewhat by large increases (>50%) in observed abundance of silvereyes, and song thrushes and significant increases in the abundances of bellbirds and chaffinches. There were also differences among years that could not be explained from a temporal perspective. For example, fantails seemed to have highly variable observed abundances among years (Table 1). There were differences in abundance between habitats for 8 of the 18 species considered in this study (Table 2). Silvereye, rifleman, redpoll, greenfinch, and chaffinch were all significantly more abundant in habitat 1 whereas South Island robin, bellbird, and shining cuckoo were significantly more abundant in habitat 2.

DISCUSSION

There were many significant changes in the observed abundances of bird species at Kowhai Bush between the 1976 and the 1999-2001 observations. There were decreases in observed abundance for 5 species: blackbirds, brown creepers, European goldfinches, redpolls, and South Island robins. These decreases were offset somewhat by increases in the observed abundances of 4 species: bellbirds, chaffinches, silvereyes, and song thrushes. The reasons for these changes in the observed abundances of species are likely to be complex and interrelated, but I briefly outline some of the possible reasons.

Predation is often a major cause of population limitation and decline in birds (Newton 1998; Innes *et al.* 2010) and is probably the best explanation for the declines of brown creepers and robins at Kowhai bush. The declines of these 2 species are of concern because of doubts as to the long-term persistence of these species at Kowhai Bush. Powlesland (1983) noted that the adult robin population declined from 94 individuals to 16 individuals in the late 1970s. Therefore, it is possible that the robin population crashed in the late 1970's and has failed to recover due to predatory suppression of the population or other factors. Indeed, there is evidence that populations can change dramatically from year-to-year in the data collected from 1999 until 2001. For example, the observed abundance of bellbirds was >2 individuals per count in 1999 and 2000, yet fell to ~1.3 individuals per count in 2001. There was also a dramatic increase in the observed abundance of song thrushes from 1999 to 2000. Moors (1983) studied the causes of nest failure in birds at Kowhai Bush and found that predation by mustelids and rodents was responsible for 60-70% of nests failure for both native and introduced species. This rate of predation puts Kowhai Bush at similar levels of predation as some urban bird populations (van Heezik *et al*. 2008). Elliott *et al.* (2010) noted that the bird community structure at the Nelson Lakes National Park stayed fairly constant for long periods, and then would change dramatically over 1 or 2 years (as Powlesland [1983] noted). Elliott *et al.* (2010) also found that many native forest bird species have declined in relative abundance over a similar time scale as the scale of this study. Their data showed that there were declines in the abundance of grey warblers, bellbirds, New Zealand tomtits (*Petroica macrocephala*), tui (*Prosthemadera novaeseelandiae*), and rifleman. Of those species, 4 are found at Kowhai Bush, but all these species have shown little change in observed abundance there. However, the declines of brown creepers and South Island robins at Kowhai Bush are of concern because these populations may represent one of the few lowland forests where these species occur in the Canterbury region.

There were other changes in the observed abundances of birds at Kowhai Bush that reinforce the view that changes in bird abundance are the result of complex ecological and environmental processes. For example, the decline in blackbirds and increase in song thrush abundance are difficult to explain. This is because blackbirds tend to be more common in New Zealand forests than song thrushes (*e.g.,* Gill 1980; Spurr *et al.* 1992; Freeman 1999; Robertson *et al.* 2007; Elliott *et al.* 2010). The 1999-2001 data for blackbirds and song thrushes are likely to accurately reflect the relative abundance of both species as nest records suggest that song thrush nests are more numerous at Kowhai Bush during 1999-2001 than blackbird nests (J. Briskie, *pers. comm.*). Therefore, it might be the case that predation affects blackbirds and song thrushes equally, but the thrushes may have a larger local population surrounding Kowhai Bush than blackbirds and they can disperse into Kowhai Bush

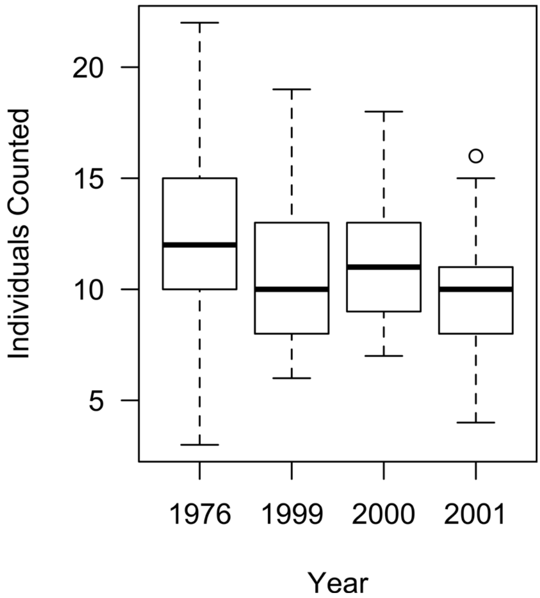

Fig. 1. Median number (thick line in box) of birds counted per 5-minute count in different years of the surveys. The box indicates the first and third quartiles whilst the bars indicate the 10th and 90th percentiles.

in higher numbers. Alternatively, predation may not be equal between the 2 species with blackbirds being more heavily affected by predators.

There were also declines in European goldfinch and redpoll abundances whilst chaffinches increased in abundance. Goldfinches and redpolls generally use the reserve during the breeding season, but populations decline during the non-breeding season (Gill 1980). Therefore, they are probably not obligate forest birds because they spend a large part of the year in areas other than Kowhai Bush. Chaffinches, conversely, are resident at Kowhai bush year round, but there probably is dispersal of birds from surrounding rural areas (Gill 1980). Therefore, the changes in observed abundance may be the result of changes in agricultural practices or other local scale effects, which have favoured chaffinches, but not redpolls or goldfinches. It is interesting to note that dairy grazing and irrigation have increased in the general area, but whether this has played a role in changing bird numbers within the forest reserve requires further study.

The nectivorous species increased in abundance between 1976 and the data collected between 1999 and 2001. This suggests there might be an increase in nectar and fruit sources at Kowhai Bush (although neither Gill nor myself collected data on this possibility). These food sources may have increased because of a decrease in browsing pressure by brushtail possums due to a ground-based poisoning program undertaken during 1999-2001 (*pers. obs.*). Possums can have severe browsing effects on New Zealand plants and may suppress flowering of some native plant species (and thus food supply to honeyeaters) (Sweetapple *et al.* 2002; Sweetapple 2008; Kelly *et al.* 2010) and they also eat eggs and nestlings (Brown *et al.* 1993). Therefore poisoning would have reduced possum numbers and so may have reduced their effects on bird reproduction and food availability (*e.g.*, Spurr & Anderson 2004). However, the results of possum poisoning might have had less impact on other mammalian predators (*e.g.*, rats and stoats) which might be responsible for predation of robins and brown creepers and so the lack of recovery of these species.

There was a decline in observed total bird abundance of birds between 1976 and later years. The result was not due to observer difference, as this factor was controlled in analyses. Although the average annual decline was <0.5% between 1976 and 1999, this change could be significant if it continues over the long term. The bird community and their observed abundances at Kowhai Bush seem fairly consistent with other modified forests throughout New Zealand (*e.g.*, Kikkawa 1966; Freeman 1999) although the abundance and diversity of native species is lower than areas with large unmodified forests (*e.g.*, Dawson *et al.* 1978; Moffatt & Minot 1994). For example, a study at Kennedy's Bush, which is a modified forest in Canterbury, revealed similar abundances for species like grey warblers, silvereyes, bellbirds, blackbirds, and dunnocks (Freeman 1999). However, there were higher observed abundances of fringillid species at Kowhai Bush, which might reflect differences in abundances in the surrounding rural areas or the sporadic distribution of these species.

Habitat 1 had higher observed bird abundances than habitat 2 at Kowhai Bush. This difference was likely the result of there being greater numbers of introduced birds in habitat 1 (Table 2). Overall, there were few differences in vegetation structure between the 2 habitats other than the canopy is higher and the understorey is better developed in habitat 2. However, the differences in relative abundances among bird species inhabiting the 2 different habitats are likely to be complex and include a combination of habitat preferences, differences in predator abundance, and proximity to forest edges.

In conclusion, the bird community at Kowhai Bush has changed between 1976 and counts that were conducted from 1999-2001. The differences in the nature of the changes among species suggest that there are multiple causes for changes in bird abundance (both within and among species). Large tracts of land in New Zealand are unmanaged forests which are deemed of little conservation value. Kowhai Bush may be fairly typical of these types of forests as it houses regionally important populations of South Island robins and brown creepers. Nevertheless, more information is needed on the status of a number of widespread forest bird species such as riflemen, South Island robins, and brown creepers. If further monitoring reveals that populations of native birds at Kowhai Bush continue to decline in the future, predator control may be required to preserve populations of South Island robins and brown creepers at this site in the future.

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Appendix 1. List of species counted in this study.

Species	Status	Diet
Grey warbler (*Gerygone igata*)	Endemic	I
Brown creeper (*Mohoua novaeseelandiae*)	Endemic	I
Silvereye (*Zosterops lateralis*)	Native	I, N, F
Fantail (*Rhipidura fuliginosa*)	Native	I
South Island robin (*Petroica australis*)	Endemic	I
Bellbird (*Anthornis melanura*)	Endemic	I, N, F
Tui (*Prosthemadera novaeseelandiae*)	Endemic	I, N, F
Shining cuckoo (*Chrysococcyx lucidus*)	Native	I
Rifleman (*Acanthisitta chloris*)	Endemic	I
Blackbird (*Turdus merula*)	Introduced	I, F
Song thrush (*T. philomelos*)	Introduced	I, F
Skylark (*Alauda arvensis*)	Introduced	I
Redpoll (*Carduelis flammea*)	Introduced	G, I
Greenfinch (*C. chloris*)	Introduced	G, I
Goldfinch (*C. carduelis*)	Introduced	G, I
Chaffinch (*Fringilla coelebs*)	Introduced	G, I
Yellowhammer (*Emberiza citrinella*)	Introduced	G, I
Dunnock (*Prunella modularis*)	Introduced	I

Diets: I = insectivorous, N = nectivorous, F = frugivorous, G = granivorous.