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Food preferences of the bellbird (*Anthornis melanura*) in native forest remnants on the Port Hills, Banks Peninsula, New Zealand

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Abstract Food preferences of the bellbird (*Anthornis melanura*), an endemic honeyeater, were determined by comparing the proportional use of plant species for nectar, fruit, and invertebrate feeding with the proportional availability (foliar cover) of plant species in forest remnants on the Port Hills, near the city of Christchurch, New Zealand. Of 529 feeding observations throughout the year, 56% were on invertebrates, 29% on nectar, and 15% on fruit. Invertebrate feeding predominated in all months except August to November, when nectar feeding predominated. *Kunzea ericoides*, *Fuchsia excorticata*, and *Hoheria angustifolia* were used more than expected from their foliar cover for invertebrate feeding, while *F. excorticata*, *Sophora microphylla*, *Pseudopanax arboreus*, and *Phormium tenax* were used more than expected for nectar feeding, and *Coprosma robusta* and *Myrsine australis* more than expected for fruit feeding. Little nectar was available in winter, which may explain why some bellbirds moved from the hills to the city at the end of the breeding season. However, more research is needed on the influence of temperature on these movements and on the resources used by bellbirds in the city.

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INTRODUCTION

The bellbird (*Anthornis melanura*) is an endemic New Zealand honeyeater (Meliphagidae) that feeds on nectar, honeydew, fruit, and invertebrates. Previous studies have shown that the importance of different foods varies seasonally, with nectar and honeydew most important in late winter, spring, and early summer, fleshy fruit most important in late summer and autumn, and invertebrates most important in winter, although invertebrates may be eaten all year round (Gravatt 1971; Craig *et al*. 1981; Angehr 1986; O'Donnell & Dilks 1994; Williams & Karl 1996; Murphy 1998; Baker 1999; Murphy & Kelly 2001, 2003). Nectar and honeydew also may be eaten all year round, when available (Gravatt 1971; Gaze & Clout 1983; Angehr 1986; O'Donnell & Dilks 1994; Murphy & Kelly 2001, 2003). Fruit is generally swallowed whole (maximum diameter *c.* 10 mm, most <6 mm) (Clout & Hay 1989; Burrows 1994a; Williams & Karl 1996; Kelly *et al.* 2010). Some larger fruits may be pecked.

Previous studies of bellbird foraging have reported nectar being taken from at least 139 plant species (62 indigenous, 77 adventive), fruit from at least 97 plant species (77 indigenous, 20 adventive),

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invertebrates from at least 50 plant species (all indigenous), and honeydew from at least 6 plant species (all indigenous) (Appendix 1). Bellbirds probably obtain food from other plant species not reported or reported but not known to us. The most frequently reported species used by bellbirds for nectar feeding include kohekohe (*Dysoxylum spectabile*), fuchsia (*Fuchsia excorticata*), rewarewa (*Knightia excelsa*), pohutukawa (*Metrosideros excelsa*), lowland flax (*Phormium tenax*), small-leaved kowhai (*Sophora microphylla*), and puriri (*Vitex lucens*). For fruit feeding, the most frequently reported species include wineberry (*Aristotelia serrata*), shining karamu (*Coprosma lucida*), glossy karamu (*C. robusta*), kahikatea (*Dacrycarpus dacrydioides*), fuchsia, mahoe (*Melicytus ramiflorus*), and red matipo (*Myrsine australis*) (Appendix 1). It is unclear whether feeding from these species is reported frequently because they are the species most frequently occurring in the locations where the observations were made or because they are preferred by bellbirds (*i.e.*, used more than expected from their availability). Some studies have measured the proportion of each plant species present that bellbirds have been seen feeding on at one location (*e.g.*, Gravatt 1971; Angehr 1986; Rasch & Craig 1988; O'Donnell & Dilks 1994; Williams & Karl 1996; Murphy & Kelly 2001; Anderson 2003). However, even from these studies it is unclear whether plant species comprising a high proportion of bellbird feeding observations are preferred to other species or simply are more abundant (or more available to bellbirds) than other species at that location. That is, these studies did not distinguish between frequency of use and frequency of use in relation to the availability of plant species.

Only 3 previous studies have related the proportional use of plant species for feeding (or all activities including feeding) to the proportional availability of plant species in the study areas (Warburton *et al*. 1992; Ridley 1998; Murphy & Kelly 2003), although 3 other studies related proportional use to proportional availability of nectar at different times of the day and in different positions within a single tree (Craig & Douglas 1984a, 1986; Rasch & Craig 1988). The multi-species studies showed that some plant species were used more than would have been expected from their proportional availability, and therefore could be regarded as preferred by bellbirds for feeding. For example, in podocarp-hardwood forest at North Okarito, bellbirds used rimu (*Dacrydium cupressinum*) for invertebrate and fruit feeding and southern rata (*Metrosideros umbellata*) for nectar feeding more than expected from their availability (Warburton *et al*. 1992). In a modified podocarp-hardwood forest remnant in South Canterbury, studied only in autumn and winter, bellbirds used red matipo, kahikatea, and kohuhu (*Pittosporum tenuifolium*) more than expected for fruit feeding, although only red matipo was used statistically more than expected (Ridley 1998; Ridley *et al*. 1999). In forest comprising predominantly mountain beech (*Nothofagus solandri* var. *cliffortioides*) at Craigieburn, where nectar and fruit resources were scarce, honeydew from beech trees and nectar and fruit from mistletoes (*Alepis flavida* and *Peraxilla tetrapetala*) were eaten more than expected from their availability (Murphy & Kelly 2003).

The objective of our study was to determine whether bellbirds preferentially used certain plant species as sources of food in forest remnants on the Port Hills, Banks Peninsula, on the outskirts of Christchurch city. Bellbirds breed in these forest remnants during spring and summer and some remain there throughout the year, but others visit the city temporarily in late autumn, winter, and early spring (Spurr *et al*. 2010), presumably in search of food and/or in response to changing temperatures. If in search of food, this could imply that food is limiting on the Port Hills over winter. Bellbirds on the Port Hills are known to eat nectar and fruit from a range of both indigenous and adventive plant species (Burrows 1994a, 1994b), but it was not known whether any of these species were preferred to others, and if their availability might be limiting the bellbird population.

METHODS

Study areas

The study was undertaken in 4 west-facing reserves of remnant mixed hardwood-podocarp forest on the Port Hills, Christchurch, at altitudes ranging from 270–470 m a.s.l.: Kennedy's Bush (135 ha) (43° 63′ S, 172° 62′ E), Cass Peak Reserve (4.4 ha) (43° 64′ S, 172° 62′ E), Omahu Bush (103 ha) (43° 66′ S, 172° 62′ E), and Ahuriri Reserve (7 ha) (43° 67′ S, 172° 62′ E). Observations were made along 14 transect lines, each 200 m long: 7 in Kennedy's Bush, 5 in Omahu Bush, and 1 each in Ahuriri and Cass Peak Reserves. Data from the 4 areas were combined.

Plant species availability

Plant species availability to bellbirds in the study areas was determined from measurements of foliar cover on reconnaissance plots (Allen 1992). Three *c.* 20-m square plots were spaced at *c.* 50-m intervals along each 200-m transect line, giving 21 plots in Kennedy's Bush, 15 plots in Omahu Bush, and 3 plots each in Ahuriri and Cass Peak reserves (total 42 plots). Percent foliar cover of each plant species was estimated in 6 cover classes (<1%, 1–5%, 6–25%, 26–50%, 51–75%, 76–100%), by tier (0–0.3 m, 0.3–2 m, 2–5 m, 5–12 m, >12 m), at each plot. The average canopy height ranged from 6.5 to 16 m. The cover-

class midpoints for all plots and all tiers above 0.3 m were summed to give a single foliar cover value for each species. The percentage contribution of each species to the total of all species foliar cover values was used to represent plant species availability to birds. It was assumed that foliar cover was a reasonable measure of availability, and all plant species above 0.3 m were equally available to bellbirds (see Discussion). Plant species names were based on the New Zealand Plant Names Database (http://nzflora.landcareresearch.co.nz).

Plant phenology

Seasonal plant food availability to bellbirds was assessed by recording the presence of flowers and ripe fruit on 40 plant species at least monthly in 2004. Most of the monitored species had both flowers that produced nectar and fruit that was fleshy. However, some had nectar-producing flowers but dry fruit, and some had fleshy fruit but wind-pollinated flowers that did not produce nectar. The assessments were partially repeated in 2007 and 2010. Specimen plants (1–6, mostly 4 of each species) were selected within 25 m of transect lines. Subjective estimates of flower and fruit availability were made on a 0–3 scale as follows: 0, no flowers or fruit; 1, sparse flowers or fruit (<25% of possible maximum); 2, moderate flowers or fruit (25–75% of possible maximum); 3, abundant flowers or fruit (75–100% of possible maximum). Additional casual observations were made of flowering and fruiting of other plant specimens within the study areas.

Bellbird feeding

Observations of bellbird feeding were made at least twice monthly in 2004, 2007, and 2010 during the course of other work. Observers (the authors) walked along the transect lines at a slow pace (~ 0.5 km/h) and whenever bellbirds were encountered we recorded, if possible, the plant species and food type (nectar, fruit, or invertebrate) that they were feeding on, within a strip of 25 m on either side of the transect lines. We did not record bellbird gender. It was assumed that bellbird feeding was equally observable on all plant species and all food types. This was probably not true for tall emergents but these were rare in our study areas.

Use in relation to availability

Preferential use of plant species was determined by comparing the observed frequencies of use (for feeding) with expected frequencies obtained from plant species foliar cover values. Differences between the observed and expected frequencies were tested using a chi-square goodness-of-fit test, and if a significant difference was found, Bonferroni-adjusted confidence intervals ($P < 0.05$) were used to determine which plant species had observed frequencies significantly different from their expected (Byers *et al*. 1984). All plant species were considered potentially available to bellbirds for invertebrate feeding, but wind-pollinated species (*e.g.*, *Coprosma* species) were excluded from analyses for nectar feeding (because they do not produce nectar) and dry-fruited species (including *Pittosporum* species) were excluded from analyses for fruit feeding (because usually bellbirds eat only fleshy fruit).

RESULTS

Plant species availability

Thirty-eight plant species (plus 7 species of ground fern and 1 sedge) were recorded on the reconnaissance plots (Table 1). Species comprising >10% of the plant cover were mahoe, horopito (*Pseudowintera colorata*), and round-leaved coprosma (*Coprosma rotundifolia*), and in addition those comprising >5% were lemonwood (*Pittosporum eugenoides*), kanuka (*Kunzea ericoides*), pate (*Schefflera digitata*), red matipo, supplejack (*Ripogonum scandens*), fuchsia, and five-finger (*Pseudopanax arboreus*). Some other plant species used or potentially used for feeding by bellbirds were present in the study areas but not recorded in the reconnaissance plots (Table 1).

Plant phenology

Flowers were recorded on 33 species (Fig. 1). These include 3 species (shining karamu, glossy karamu, and round-leaved coprosma) that are wind-pollinated and do not produce nectar, but do produce fleshy fruit (see below). In 2004, the earliest flowering species were five-finger and gorse (*Ulex europaeus*), which started flowering in May, followed by fuchsia in Jun, kowhai in Jul, and horopito in Aug. The sequence of flowering was similar (plus or minus about a month) in 2007 and 2010.

Ripe fruit was recorded on 29 plant species (Fig. 2). These include 2 species (lemonwood and kohuhu) that produce dry fruit, but the seeds are coated with mucilage that seems to be attractive to birds (Burrows 1994a), and both species have flowers that produce nectar. As with flowering, five-finger was also amongst the earliest species with ripe fruit, which started appearing in Jan 2004 (and Nov 2007). Other early-fruiting species included wineberry, round-leaved coprosma, and fuchsia. Some species such as five-finger, fuchsia, and red matipo had flowers and ripe fruit on the same or different plants at the same time. Other species, such as *Coprosma propinqua* (mingimingi), had no flowers or fruit at all in 2004 (and were not monitored in 2007 or 2010). The number of species flowering at any one time ranged from 5 species

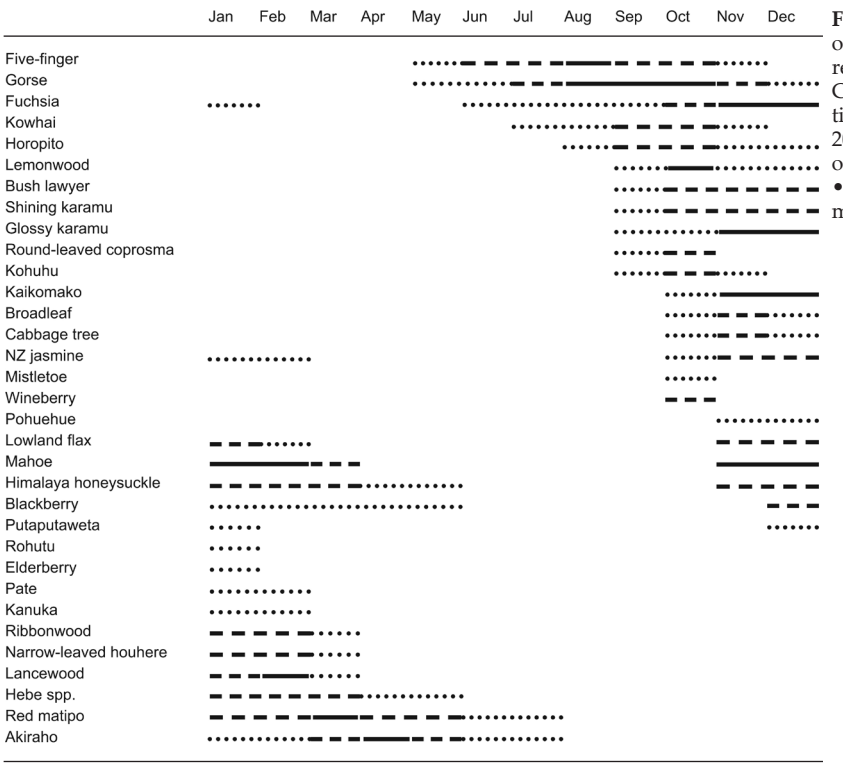

Fig. 1. Seasonal occurrence of flowers on plants in forest remnants on the Port Hills, Christchurch, in 2004. Flowering times were similar in 2007 and 2010. Symbols indicate intensity of flowering of each species: •••••••• sparse, — — — moderate, ——— abundant.

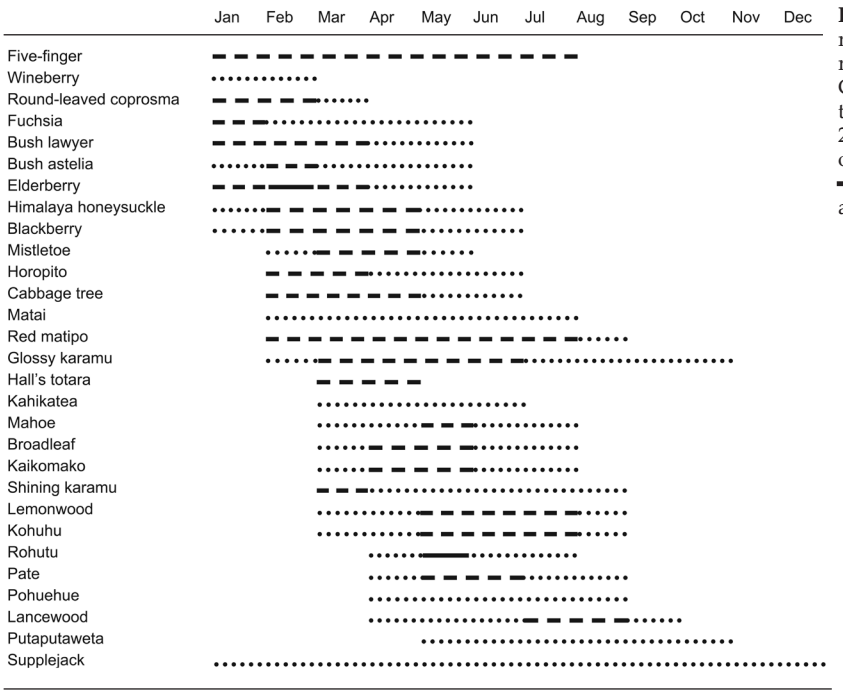

Fig. 2. Seasonal occurrence of ripe fruit on plants in forest remnants on the Port Hills, Christchurch, in 2004. Fruiting times were similar in 2007 and 2010. Symbols indicate intensity of fruiting: •••••••• sparse — — — moderate, ——— abundant.

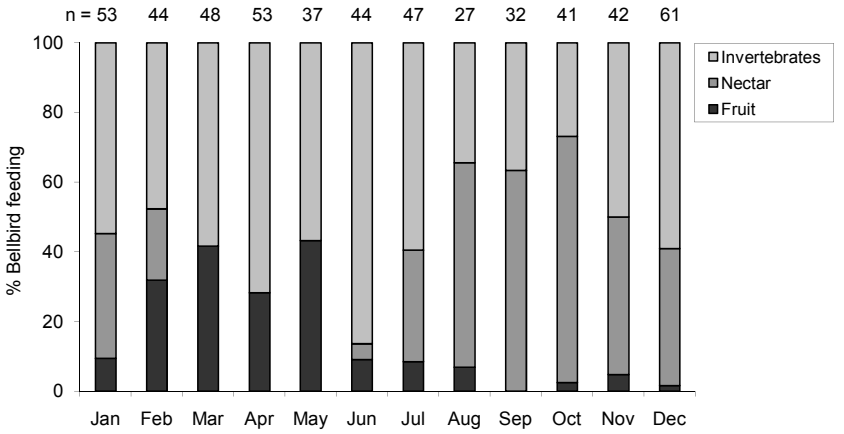

Fig. 3. Seasonal feeding on invertebrates, nectar, and fruit by bellbirds, Port Hills, Christchurch.

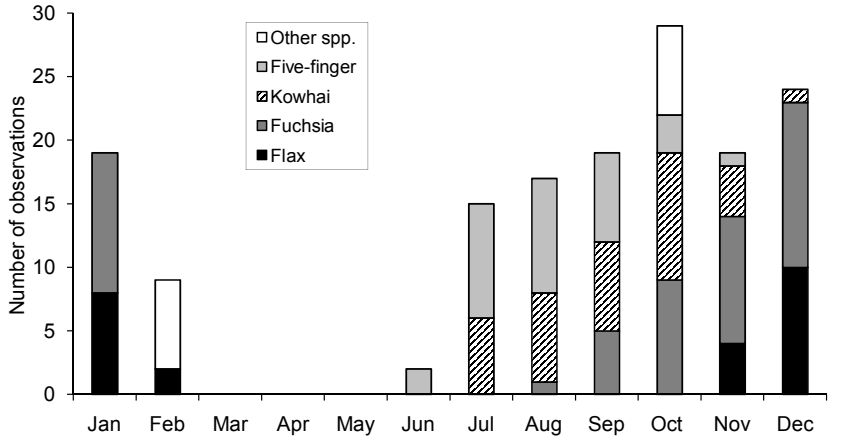

Fig. 4. Plant species used for nectar feeding by bellbirds, Port Hills, Christchurch.

in Jun to 18 species in Nov (Fig. 1). The number of species with ripe fruit at any one time ranged from 1 species in Nov to 26 species in Apr (Fig. 2).

Bellbird feeding

In total, 529 observations were made of bellbirds feeding: 56% on invertebrates, 29% on nectar, and 15% on fruit. Feeding on invertebrates occurred throughout the year, though was most frequent in autumn and early winter (Mar–Jul), reaching a peak of 86% in Jun (Fig. 3). Nectar feeding occurred mostly in late winter, spring, and early summer (Aug–Jan), reaching a peak of 71% in Oct. Fruit feeding was observed mostly in late summer, autumn, and early winter (Feb–May), reaching a peak of 43% in May. Invertebrate feeding predominated in all months except Aug to Nov, when nectar feeding predominated. Nectar feeding was not observed in Mar, Apr, or May, and fruit feeding was not observed in Sep and little observed from Aug to Dec. From Jun to Aug, bellbirds switched from feeding on still-present fruit of red matipo, glossy karamu, lancewood (*Pseudopanax crassifolius*) and other species to nectar of early-flowering five-finger, kowhai, and fuchsia.

Bellbirds were observed feeding on 32 plant species in total (Table 1). All 3 food types (invertebrates, nectar, and fruit) were obtained from some plant species, but only 1 or 2 food types from other plant species. Invertebrate feeding was observed on 20 plant species, by far the most on kanuka, followed by fuchsia, lemonwood, and narrow-leaved houhere (*Hoheria angustifolia*) (Table 1). Nectar feeding was observed on 10 plant species, mostly on fuchsia, kowhai, five-finger, and flax (Table 1). The 1st nectar feeding of the season, in Jun (early winter), was on five-finger, followed by kowhai, fuchsia, and flax as the seasons progressed (Fig. 4). Fruit feeding was observed on 16 plant species, with most on red matipo, glossy karamu, round-leaved coprosma, and horopito (Table 1). Fruit feeding started in Dec on fuchsia, followed by the various *Coprosma* species, red matipo, horopito, and mahoe as the seasons progressed (Fig. 5). The fruit feeding observed in Oct and Nov was on pate that was fruiting late.

Table 1. Plant species composition in reconnaissance plots (excluding 7 species of ground fern and 1 sedge)[1], and plant species used by bellbirds for feeding on invertebrates, nectar, fruit, and all 3 combined, Port Hills, Banks Peninsula. Flower types (E, entomophilous; O, ornithophilous; W, wind pollinated) from Webb *et al*. (1999), Newstrom & Robertson (2005), Kelly *et al*. (2010), and *pers. obs.* Fruit types (D, dry fruit; F, fleshy fruit) from Burrows (1994a, 1994b) and *pers. obs.*

Plant species		Flower type	Fruit type	Foliar cover (%)	Bellbird feeding observations			
Scientific name	Common name				% Invertebrates	% Nectar	% Fruit	% All foods
Melicytus ramiflorus	Mahoe (whitey wood)	E	F	11.84	4.1		7.1	3.4
Pseudowintera colorata	Horopito (pepper tree)	E	F	11.48	2.4	0.7	9.5	3.0
Coprosma rotundifolia	Round-leaved coprosma	W	F	11.23	1.7		9.5	2.5
Pittosporum eugenoides	Tarata (lemonwood)	E	D[2]	7.81	9.9	2.6		6.2
Kunzea ericoides	Kanuka	E	D	6.84	52.1			28.7
Schefflera digitata	Pate	E	F	6.35			7.1	1.1
Myrsine australis	Red matipo	E	F	5.86	1.4		23.8	4.5
Ripogonum scandens	Supplejack	E	F	5.62				0
Fuchsia excorticata	Fuchsia	O	F	5.37	12.0	32.0	6.0	16.8
Pseudopanax arboreus	Five-finger	E[3]	F	5.13	3.1	20.3	1.2	7.8
Pseudopanax crassifolius	Lancewood	E	F	2.81	0.7	3.3	4.8	2.1
Dicksonia squarrosa	Wheki tree fern	W	D	2.69				0
Astelia fragrans	Bush astelia	E	F	2.08			1.2	0.2
Griselinia littoralis	Broadleaf	E	F	1.47			3.6	0.6
Podocarpus hallii	Hall's totara	W	F	1.34	1.0			0.6
Urtica ferox	Stinging nettle	W	D	1.34				0
Sophora microphylla	Small-leaved kowhai	O	D	1.10	1.4	22.9		7.4
Cordyline australis	Cabbage tree	E	F	0.98	0.3			0.2
Plagianthus regius	Ribbonwood	E	D	0.98	0.3			0.2
Cyathea dealbata	Silver tree fern (ponga)	W	D	0.98				0
Coprosma propinqua	Mingimingi	W	F	0.98	0.3			0.2
Ulex europaeus	Gorse	E	D	0.73				0
Pennantia corymbosa	Kaikomako	E	F	0.61			1.2	0.2
Phormium tenax	Lowland flax	O	D	0.61		15.7		4.5
Carpodetus serratus	Putaputaweta (marble leaf)	E	F	0.49				0
Cyathea smithii	Soft tree fern	W	D	0.49				0
Aristotelia serrata	Wineberry	E	F	0.37				0
Prumnopitys taxifolia	Matai	W	F	0.37	0.3			0.2
Prumnopitys ferruginea	Miro	W	F	0.37				0
Veronica spp.	Hebe	E	D	0.37				0
Coprosma lucida	Shining karamu	W	F	0.24			2.4	0.4
Coprosma robusta	Glossy karamu	W	F	0.24			19.1	3.0
Rubus cissoides	Bush lawyer	E	F	0.24			1.2	0.2
Coprosma linariifolia	Yellow-wood	W	F	0.12				0
Pittosporum tenuifolium	Kohuhu (black matipo)	E	D[2]	0.12	1.0	0.7		0.8
Hoheria angustifolia	Narrow-leaved houhere	E	D	0.12	6.2			3.4
Solanum aviculare	Poroporo	E	F	0.12				0
Rubus fruticosis	Blackberry	E	F	0.12				0
Parsonsia heterophylla[4]	New Zealand jasmine	E	D	0		1.3		0.4

Table 1. Continued.

Dacrycarpus dacrydioides[4]	Kahikatea	W	F	0	0.3			0.2
Olearia paniculata[4]	Akiraho (golden akeake)	E	D	0	0.3			0.2
Leycesteria formosa[4]	Himalaya honeysuckle	E	F	0		0.7		0.2
Myrsine divaricata[4]	Weeping matipo	E	F	0			1.2	0.2
Lophomyrtus obcordata[4]	Rohutu (NZ myrtle)	E	F	0			1.2	0.2
Unknown[4]	Moss on log on ground	W	D	0	1.0			0.6
Total observations					292	153	84	529

1. Species recorded in the reconnaissance plots but excluded from the table are *Asplenium polyodon* (sickle spleenwort), *Blechnum fluviatile* (ray water fern), *Microsorum pustulatum* (hound's tongue fern), *Polystichum neozelandicum* (common shield fern), *P. vestitum* (prickly shield fern), *Pteridium esculentum* (bracken fern), *Schizaea dichotoma* (fan fern), and *Carex* spp. (sedge).
2. Dry fruit but seeds coated with mucilage (Burrows 1994a).
3. Entomophilous flowers clustered in compact inflorescences with robust perches for birds (Kelly *et al.* 2010).
4. These species were not recorded in the reconnaissance plots. Other species not recorded in the reconnaissance plots but present in the study areas and potentially used for feeding by bellbirds included *Ileostylus micranthus* (mistletoe), *Muehlenbeckia australis* (pohuehue), and *Sambucus nigra* (elderberry).

Use in relation to availability

Bellbird use of plant species for feeding (all months combined) was significantly different from what was expected if it had been distributed in proportion to plant species foliar cover (χ^2_{12} = 1910.3 for invertebrate feeding, χ^2_{12} = 1451.2 for nectar feeding, χ^2_{12} = 614.0 for fruit feeding, $P < 0.001$ for all analyses). For invertebrate feeding, kanuka, fuchsia, and narrow-leaved houhere were used more than expected from their availability, five-finger, kowhai, and lemonwood as expected (*i.e.*, in proportion to their availability), and lancewood, red matipo, pate, round-leaved coprosma, horopito, mahoe, and other species less than expected, on the basis of Bonferroni-adjusted confidence intervals (Fig. 6a). For nectar feeding, five-finger, flax, fuchsia, and kowhai were used more than expected, lancewood and New Zealand jasmine (*Parsonsia heterophylla*) as expected, and kanuka, red matipo, pate, lemonwood, horopito, mahoe, and other species less than expected (Fig. 6b). For fruit feeding, red matipo and glossy and shining karamu (predominantly glossy karamu) were used more than expected, kaikomako (*Pennantia corymbosa*), broadleaf (*Griselinia littoralis*), lancewood, fuchsia, pate, round-leaved coprosma, horopito, and mahoe as expected, and five-finger and supplejack less than expected from their availability (Fig. 6c). Other species were used as expected.

DISCUSSION

In this study we investigated the availability of plant species to bellbirds, the timing of the availability of nectar and fruit on these plant species (phenology), and the use (and use in relation to availability) of these plant species by bellbirds for feeding on nectar, fruit, and invertebrates in forest remnants on the Port Hills near Christchurch.

Plant species availability

We recorded only 38 plant species in our 4 study areas, fewer than Burrows (1994a, 1994c) did just in Ahuriri Reserve. However, our species list was from a limited plot-based method whereas his was from a thorough search of the area. The species we recorded were those we were likely to see bellbirds feeding on (*i.e.*, those within 25 m of our transect lines). Our results showed that the 7 species with most foliar cover were used by bellbirds mainly for invertebrate or fruit feeding. Plant species used by bellbirds for nectar feeding were more limited in availability.

Plant phenology

Our results on the seasonal sequence of flowering and fruiting largely agreed with results obtained previously from Kennedy's Bush (Godley 1979), Ahuriri Reserve (Burrows 1994c), Hinewai Reserve (Campbell 2006), and other forest remnants on Banks Peninsula (Burrows 1994b). They also largely agreed with results from studies in beech-podocarp-hardwood forests in South Westland (O'Donnell & Dilks 1994) and Nelson (Williams & Karl 1996). The main feature of the phenology records was that different species started flowering and fruiting at different times, spreading the availability of nectar and fruit over a longer period than if the reproductive stages of different species were synchronised. Thus, some nectar or fruit was available over much of the year. However, little nectar was available from Apr to Jul and little fruit from Sep to Dec (plus or minus about a month in different years).

Bellbird feeding

Our list of plant species used for feeding by bellbirds was obtained from only a small number of observations (529 *cf.* 4270 made by O'Donnell & Dilks 1994) and is incomplete. For example, Burrows (1994a, 1994b) saw bellbirds feeding on fruit of an additional 12 plant species in a wider range of Banks Peninsula forest remnants than in our study (although he did not see bellbirds feeding on the fruit of red matipo).

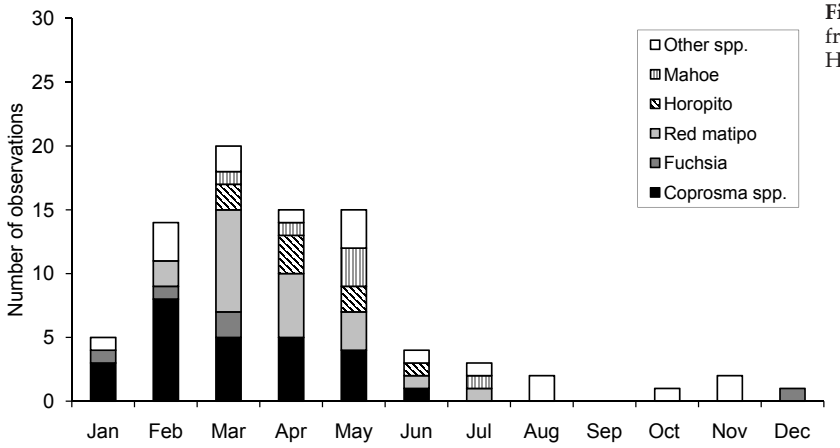

Fig. 5. Plant species used for fruit feeding by bellbirds, Port Hills, Christchurch.

The 4 species most used for nectar feeding by bellbirds in our study (fuchsia, kowhai, five-finger, and flax) have been reported frequently as being used for nectar feeding by bellbirds in other studies (Appendix 1). They were also among the species most used for nectar feeding by bellbirds in studies detailing the proportional use of plant species (O'Donnell & Dilks 1994; Castro & Robertson 1997; Anderson 2003). Some species not seen or seldom seen to be used for nectar feeding by bellbirds in our study have been either not reported or seldom reported elsewhere; *e.g.*, mahoe, horopito, kanuka, pate, red matipo, supplejack, broadleaf, cabbage tree (*Cordyline australis*), and ribbonwood (*Plagianthus regius*) (Appendix 1).

Two of the 4 species most used for fruit feeding by bellbirds on the Port Hills (red matipo and horopito), although frequently reported as used for fruit feeding by bellbirds elsewhere (Appendix 1), were not a major component of the fruit diet of bellbirds in detailed studies in Nelson, South Westland, and South Canterbury (O'Donnell & Dilks 1994; Williams & Karl 1996; Ridley 1998). Presumably this was because these plant species were absent or not a major component of the habitat in those studies. Of the other 2 species commonly used for fruit feeding by bellbirds on the Port Hills, glossy karamu was a relatively major component of the fruit diet of bellbirds in Nelson (Williams & Karl 1996) and round-leaved coprosma was one of the more frequently used species for fruit feeding by bellbirds in South Westland (O'Donnell & Dilks 1994). Five-finger and fuchsia, not often used for fruit feeding by bellbirds in our study, were also not often used in other detailed studies (O'Donnell & Dilks 1994; Williams & Karl 1996; Ridley 1998).

Some species reported as used for fruit feeding by bellbirds elsewhere (Appendix 1) were not seen to be used for fruit feeding in our study. Most, such as kahikatea, rimu, matai (*Prumnopitys taxifolia*), Hall's totara (*Podocarpus totara*), putaputaweta (*Carpodetus serratus*), wineberry, and cabbage tree, were rare in our study areas. Two, lemonwood and kohuhu, reported only once or twice elsewhere, have dry fruit with mucilage-coated seeds, and supplejack, reported only once, generally has fruit too large for bellbirds to swallow whole (Burrows 1994a, 1994b; Kelly *et al.* 2010).

Only 3 species, five-finger, fuchsia, and horopito, were used for both nectar and fruit feeding in our study although, as noted above, five-finger and fuchsia were used mainly for nectar feeding and horopito mainly for fruit feeding. Most species were used for either only nectar feeding or only fruit feeding. This may have been partly a result of our small sample size because some species present in our study areas were used for both purposes in other studies (Appendix 1). However, even in these other studies, most species were used for either only nectar or only fruit feeding; only 32 out of the 219 plant species used for nectar and/or fruit feeding listed in Appendix 1 (15%) were used for both.

Some plant species on the Port Hills were not observed to be used at all by bellbirds for feeding on invertebrates, nectar, or fruit; *e.g.*, blackberry (*Rubus fruticosis*), elderberry (*Sambucus nigra*), mistletoe (*Ileostylus micranthus*), pohuehue (*Muehlenbeckia australis*), hebe (*Veronica* spp.), and tree ferns (*Dicksonia* and *Cyathea* spp.). This may have been because of the availability of more preferred foods, the low incidence of these species in our study areas, and/or our small sample size, because these species have been reported as used by bellbirds for feeding elsewhere, though not often (Appendix 1).

The only adventive species used for feeding by bellbirds in our study was Himalaya honeysuckle (*Leycesteria formosa*), which was used for nectar feeding. This is a new feeding record, although the species has been reported to have been used for fruit feeding (Williams & Karl 1996). Bellbirds have

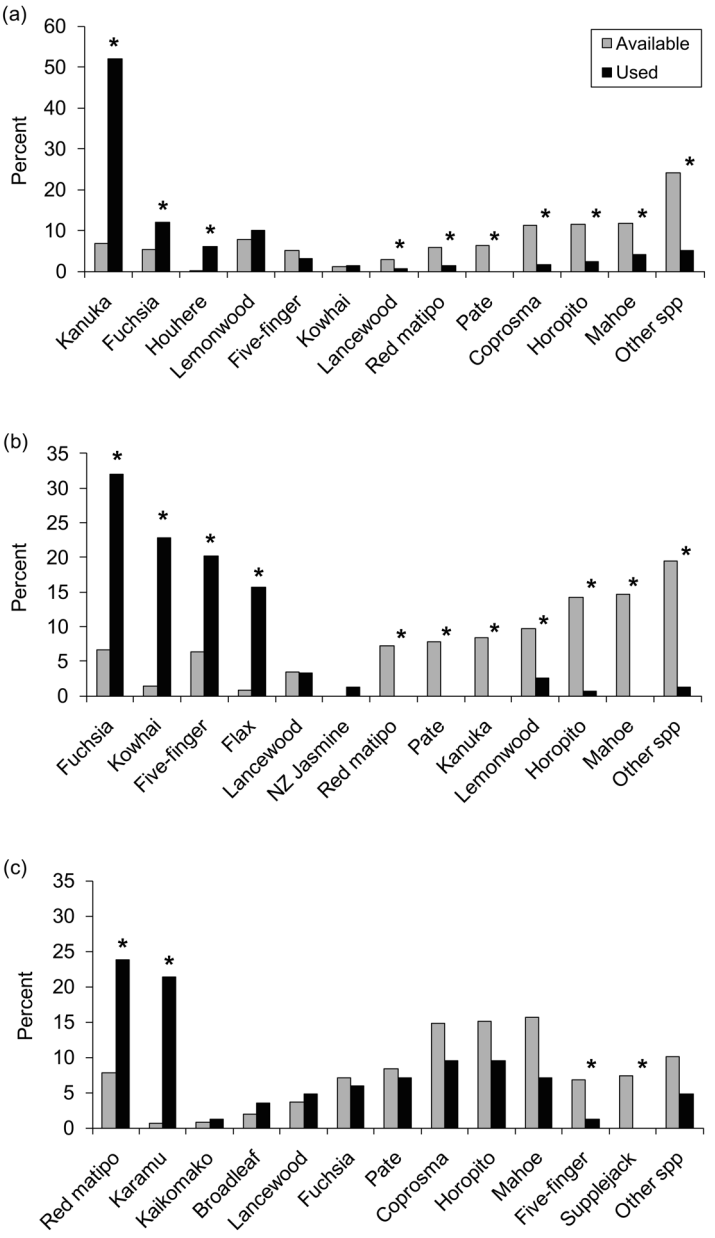

Fig. 6. Plant species availability (percentage of total foliar cover) (light bars) and use by bellbirds for feeding (dark bars) on (a) invertebrates (n = 292), (b) nectar (n = 153), and (c) fleshy fruit (n = 84), Port Hills, Christchurch. Houhere is narrow-leaved houhere, coprosma is round-leaved coprosma, and karamu is glossy karamu and shining karamu. *Indicates significant difference between availability and use (P < 0.05).

been reported feeding from at least 92 adventive species, mainly for nectar (Appendix 1), but few of these occurred in our study areas. However, large numbers of adventives, some of them winter-flowering and with high nectar sugar concentrations (*e.g.*, *Banksia*, *Callistemon*, *Camellia*, *Grevillea*, and *Protea* spp.) occurred a few kilometres away in Christchurch city. This may have been the reason why some bellbirds moved to the city from late autumn to early spring, when nectar was in short supply on the Port Hills (see also Medway 2011).

Use in relation to availability

Our estimates of resource preference were influenced by the method of measuring both the use and the availability of the resource (Spurr & Warburton 1991; Thomas & Taylor 2006). For measurement of use, we recorded the number of times bellbirds were seen feeding on a particular plant species and food type, not, for example, the time spent feeding or amount of food ingested. Use of these latter variables may have given us different measures of bellbird use. For the measurement of plant species availability, we used

foliar cover whereas others have used vegetation surface area (Warburton *et al*. 1992), basal area (Ridley 1998), or the energy value of nectar and fruit (Murphy & Kelly 2003). If we had used one of these other methods we may have obtained a different measure of availability. However, we believe the methods we chose provided reasonable measures of plant species availability to, and use by, bellbirds.

Our study showed that when feeding, bellbirds did not use plant species in proportion to their availability, based on the proportional number of feeding observations and proportional foliar cover. Some plant species were used more than expected (*i.e.*, preferred), some were used as expected, and others less than expected (*i.e.*, avoided). Those used more than expected were also generally used most often, and among those reported most often in the literature as being used by bellbirds for feeding.

Three of the 4 species used more than expected for nectar feeding (fuchsia, kowhai, and flax) have typical bird-pollinated (ornithophilous) flower types (Castro & Robertson 1997; Webb *et al*. 1999; Newstrom & Robertson 2005; Kelly *et al*. 2010), and fuchsia and kowhai start flowering in winter when other sources of nectar are in short supply. The flowers of fuchsia, kowhai, and flax also have high nectar volumes and high sugar concentrations (Delph & Lively 1985; Bergquist 1989; Castro & Robertson 1997). Flowers of the 4th species used more than expected for nectar feeding (five-finger) are more typical of insect-pollinated (entomophilous) flower types (Castro & Robertson 1997; Webb *et al*. 1999; Newstrom & Robertson 2005). However, the compactness of the inflorescences, called 'knob' flowers by Newstrom & Robertson (2005), collectively presents a relatively rich source of nectar accessible from a single perch in quantities that are probably sufficient to sustain bellbird energy requirements (Castro & Robertson 1997), and so may be considered generalist bird/insect-pollinated flowers (Newstrom & Robertson 2005; Kelly *et al*. 2010). Five-finger also starts flowering in winter when other sources of nectar are in short supply. The species used less than expected for nectar feeding all have entomophilous flower types (*e.g.*, red matipo, pate, kanuka, lemonwood, horopito, and mahoe), and start flowering later than most of the preferred species above. Entomophilous flowers are generally less rewarding in nectar per flower than ornithophilous flowers (Castro & Robertson 1997).

Most plant species used for fruit feeding were used as expected from their proportional availability. Two species, red matipo and glossy karamu, were used more than expected though we cannot explain why. Both species do not have particularly hard endocarps, but red matipo has only a thin-fleshed pericarp (Burrows 1994a, 1994b). Both have been reported frequently as used for fruit feeding by bellbirds elsewhere (Appendix 1). Of the 2 species used less than expected for fruit feeding, five-finger has a thick and somewhat dry pericarp (Burrows 1994a), and as noted above, supplejack generally has fruit larger than bellbirds can swallow whole (Burrows 1994a, 1994b; Kelly *et al.* 2010).

Plant species used for invertebrate feeding more than expected (*e.g.*, kanuka, fuchsia, and narrow-leaved houhere) have rough, scaly, or flaky bark, whereas those used less than expected (*e.g.*, lancewood, red matipo, pate, horopito, and mahoe) have smooth bark. We assume the rougher-barked species have more potential invertebrate prey than the smoother-barked species.

The 3 other studies that investigated bellbird feeding in relation to the availability of food resources were undertaken in quite different habitats with different plant species to ours (Warburton *et al*. 1992; Ridley 1998; Murphy & Kelly 2003). The only plant species in common used by bellbirds more than expected was red matipo, which was used more than expected for fruit feeding both in our study on the Port Hills and in a forest remnant in South Canterbury (Ridley 1998). Kohuhu was also used more than expected for fruit feeding in the study by Ridley (1998) but was not observed to be used at all for fruit feeding in our study (although it was used for nectar feeding).

We were unable to determine bellbird preferences for nectar compared with fruit or invertebrates from our use/availability data because we did not measure availability of the 3 resources in the same units. We found invertebrate feeding was more common than nectar and fruit feeding, probably because nectar and fruit resources were limited, but other observations we made indicated that, when available, nectar was preferred to the other foods. For example, when nectar first became available in Jun, bellbirds switched from feeding on still-present fruit to feeding on nectar. They also flew long distances (at least 500 m) outside their core home range to patches of flowering kowhai and flax (Spurr *et al*. 2010), preferred nectar sources that were rare in our study areas. Other studies on bellbird feeding have also provided evidence that nectar is preferred to fruit and invertebrates. For example, most studies found that most feeding was on nectar (especially in late winter and spring), and when nectar was available all year round it was eaten all year round (Gravatt 1971; Angehr 1986; Rasch & Craig 1988; O'Donnell & Dilks 1994). These studies were all done where bellbirds co-existed with tui (*Prosthemadera novaeseelandiae*), a larger and more dominant honeyeater that excludes bellbirds from the best nectar sources (Craig *et al*. 1981), leaving unanswered the question on whether bellbirds

would be even more nectarivorous in the absence of tui. Only 3 studies have been undertaken where tui were absent, and all found bellbirds feeding on nectar less than in the other studies (and 2 found them feeding on nectar less than on invertebrates), but preferred nectar resources were scarce in these 3 studies (Ridley 1998; Murphy & Kelly 2001; our study).

Several studies have reported that bellbirds will fly long distances to nectar when sources are sparse (Gravatt 1970; Craig *et al*. 1981; Sagar 1985; Angehr 1986; Rasch & Craig 1988; Anderson & Craig 2003; this study), but no studies have reported bellbirds flying long distances to fruit. Perhaps the strongest evidence supporting bellbird preference for nectar comes from the one study (in mountain beech forest at Craigieburn) that measured the availability of the 3 resources in the same units of measurement, *viz.* energy (Murphy & Kelly 2003). This showed the order of preference (from use divided by availability) to be nectar then fruit, both of which were used more than expected from their availability, and then invertebrates, which despite being the most-used resource was used less than expected from its availability. However, despite an apparent preference for nectar when it is available, bellbirds need both basic food types; carbohydrate (nectar, honeydew, and/or fruit) for energy and protein (invertebrates) for growth and for feeding to developing young (Higgins *et al*. 2001).

Nectar resources from preferred plant species such as kowhai, fuchsia, and five-finger, though limited in availability especially in winter, are unlikely to have been limiting the bellbird population on the Port Hills. Experimental manipulations such as supplementary feeding of artificial nectar (*e.g*., sugar-water) would be necessary to test this hypothesis (Armstrong & Ewen 2001; Innes *et al*. 2010). Bellbirds are generalists, feeding on different food types from a wide variety of plant species, and appear able to switch between food types and to other plant species when preferred ones are unavailable. Being more insectivorous than tui, they are better able to survive in low-nectar and low-fruit habitats such as the forest remnants on the Port Hills. It is more likely that predators, such as the brushtail possum (*Trichosurus vulpecula*), ship rat (*Rattus rattus*), and stoat (*Mustela erminea*), all of which occurred in our study areas, were limiting the bellbird population (Murphy & Kelly 2001; Kelly *et al*. 2005; Innes *et al*. 2010). The low availability of nectar from late autumn to early spring may have influenced some bellbirds, especially juveniles, to move away from the Port Hills temporarily into Christchurch city in search of nectar resources there. However, more research is needed on the influence of temperature on these altitudinal movements and on the resources used by bellbirds in the city.

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Appendix 1. Plant species reported to be used by bellbirds for obtaining nectar, fruit, invertebrates, and honeydew (*indicates adventive species; numbers refer to references at foot of table). Most names from New Zealand Plant Names database (http://nzflora.landcareresearch.co.nz) (see also footnotes 3 and 4).

Species (and common name)	Nectar	Fruit	Invertebrates	Honeydew
Abutilon ×hybridum (Chinese lantern)*	66			
Acacia spp. (wattle)*	11; 19; 54			
A. melanoxylon (Tasmanian blackwood)*	17			
Acer pseudoplatanus (sycamore)*		49		
Alepis flavida (mistletoe)	47; 48	43; 48		
Aloe spp.*	54			
Alseuosmia macrophylla (toropapa)	18; 31; 56			
Arbutus unedo (strawberry tree)*	32	39; 44		
Arctostaphylos manzanita (common manzanita)*	32			
Aristotelia fruticosa (mountain wineberry)		44		
A. serrata (wineberry)	54	15; 18; 37; 40; 41; 42; 49; 56		
Ascarina lucida (hutu)		42	42	
Astelia fragrans (bush astelia)		68	42	
A. grandis (swamp astelia)			42	
A. nervosa (mountain astelia)			42	
Banksia spp. (banksia)*	19; 32; 54			
B. integrifolia (coastal banksia)*	59; 62			
Beilschmiedia tarairi (taraire)	27			
Beschorneria yuccoides (Mexican lily)*	32			
Bomarea multiflora (climbing alstroemeria)*	32; 56			
Callistemon spp. (bottlebrush)*	15; 32			
C. citrinus (crimson bottlebrush)*	54			
Calothamnus spp.*	15			
Camellia spp. (camellia)*	56			
*C. cuspidata**	56			
*C. fraterna**	56			
*C. japonica**	54; 56			
*C. pitardii**	56			
*C. reticulata**	56			
*C. saluenensis**	56			
*C. sasanqua**	56			
*C. transnokoensis**	56			
*C. tsaii**	56			
*C. ×williamsii**	32			
Cantua buxifolia (Flower-of-the-Incas)*	63			
Carmichaelia williamsii (giant flowered broom)	51			
Carpodetus serratus (putaputaweta)	54	20; 41; 42; 50; 54		
Cestrum fasciculatum 'Newellii' (red cestrum)*	59			
Chaenomeles japonica (Japanese flowering quince)*	59			
Chamaecytisus palmensis (tree lucerne)*	19; 54			
*C. proliferus**	32			
Chiranthodendron pentadactylon (Mexican hand tree)*	32			
Citrus spp.*	18; 54			
Clethra delavayi (Delavay summersweet)*	56			
Clianthus puniceus (kaka beak)	2; 21; 37; 50			

Appendix 1. Continued.

Colquhounia coccinea var. *mollis* (prain)*	32		
Coprosma spp.		11; 15; 19; 20; 28; 37; 49; 54	
C. areolata		50; 55	
C. crassifolia		50	
C. cuneata		42	42
C. foetidissima		42	
C. grandifolia		44; 50; 56	
C. linariifolia		50	
C. lucida (shining karamu)		10; 17; 40; 41; 42; 50; 54; 68	
C. macrocarpa		30	
C. parviflora		48; 50	
C. propinqua (mingimingi)		50	68
C. pseudocuneata		42	42
C. repens (taupata)		45; 50	
C. rhamnoides		42; 45; 50; 55	42
C. robusta (glossy karamu)		41; 44; 45; 50; 54; 56; 68	
C. rotundifolia (round-leaved coprosma)		15; 41; 42; 44; 50; 68	68
C. tayloriae		67	
C. tenuifolia		50; 56	
Cordyline australis (cabbage tree)	27; 55	11; 19; 37; 50	68
Coriaria arborea (tutu)		42; 44; 50	42
Cornus capitata (Himalayan strawberry tree)*		39	
Corokia spp. (corokia)		37; 50	
Correa spp.*	32		
Corynocarpus laevigatus (karaka)	16; 18; 46		
Crassula arborescens (silver dollar plant)*	60		
Crataegus spp. (hawthorn)*		54	
*Crinodendron hookeranum**	32		
Crocosmia spp.*	56		
Cyathea smithii (soft tree fern)			42
Dacrycarpus dacrydioides (kahikatea)	54	14; 20; 41; 42; 44; 49; 50; 54	42; 68
Dacrydium cupressinum (rimu)		20; 42	42
Dicksonia squarrosa (wheki tree fern)			42
Digitalis purpurea (foxglove)*	17		
Dracophyllum spp.	11		
Dysoxylum spectabile (kohekohe)	9; 16; 18; 19; 27; 45; 46; 54	45	
Earina autumnalis (Easter orchid)	42		
Echium candicans (Pride of Madeira)*	64		
E. pininana (giant bugloss)*	60		
Elaeocarpus dentatus (hinau)	27; 46		
E. hookerianus (pokaka)		42	
Entelea arborescens (whau)	54	54	
Erica 'Wilmorei'*	32		
Eriobotrya japonica (loquat)*	65		
Erythrina spp. (coral or flame tree)*	10		
Eucalyptus spp.*	15; 19; 27; 32; 49; 54		
E. globulus (blue gum)*	11		
E. leucoxylon (red-flowered yellow gum)*	54		

Appendix 1. Continued.

Ficus spp. (fig)*		1; 7; 11; 18; 19		
Fraxinus excelsior (ash)*		49		
Freycinetia banksii (kiekie)	42			
Fuchsia spp. (exotic fuchsia)*	11; 32; 56			
Fuchsia spp. (endemic fuchsia)	11; 19; 36; 54	9; 11; 19; 54		
F. excorticata (fuchsia)	2; 3; 4; 8; 10; 15; 17; 18; 20; 21; 26; 29; 32; 37; 42; 46; 50; 56; 57; 68	18; 20; 28; 40; 41; 42; 44; 49; 68	15; 42; 68	
F. perscandens (creeping fuchsia)		41		
Geniostoma ligustrifolium var. *ligustrifolium* (hangehange)	45; 46; 55	45; 55		
Grevillea spp.*	32; 54			
Griselinia littoralis (broadleaf)	46	40; 41; 42; 50; 68	42	
Hedycarya arborea (pigeonwood)		42		
Hoheria spp.	37; 50			
H. angustifolia (narrow-leaved houhere)	11; 15	49	68	
Hymenosporum flavum (Australian frangipani)*	32			
Ileostylus micranthus (mistletoe)		41; 43; 44; 50		
Ilex aquifolium (holly)*		44		
Ixerba brexioides (tawari)	18; 31			
Knightia excelsa (rewarewa)	2; 11; 18; 19; 21; 27; 37; 46; 55			
Kniphofia spp. (red hot poker)*	32; 56			
Kunzea ericoides (kanuka)	46; 55		15; 68	30
Lachenalia spp. (Cape cowslip)*	58			
Lapageria rosea (Chilean bellflower)*	32			
Laurelia novae-zelandiae (pukatea)	46			
Leptecophylla juniperina (prickly mingimingi)	18			
Leptospermum scoparium (manuka)	27; 55		15	
Leucopogon fasciculatus (tall mingimingi)	18	37; 48		
Leycesteria formosa (Himalaya honeysuckle)*	68	44		
Ligustrum vulgare (privet)*		54		
Lophomyrtus bullata (ramarama)		37; 50		
L. obcordata (rohutu, New Zealand myrtle)		41; 50; 56; 68		
Macropiper excelsum (kawakawa)		30; 44		
Mahonia spp. (oregon grape)*	32			
*M. ×media**	56			
Malus domestica (apple)*		11; 19; 49		
Manoao colensoi (silver pine)			42	
Melaleuca spp.*	32			
Melicytus spp.		37		
M. alpinus (porcupine shrub)		50		
M. lanceolatus (narrow-leaved mahoe)		49		
M. obovatus (New Zealand shrubby violet)		50		
M. ramiflorus (mahoe)	18; 55	15; 28; 40; 41; 44; 45; 49; 50; 68	42; 68	
Meryta sinclairii (puka)			58	
Metrosideros spp.	2; 4; 11; 19; 27; 32; 37			
M. diffusa (white rata)	18; 42		42	
M. excelsa (pohutukawa)	18; 19; 27; 30; 35; 45; 46; 50; 53; 54; 55			
M. fulgens (rata vine)	18; 24; 42; 46; 56		42	
M. parkinsonii (Parkinson's rata)	56			

Appendix 1. Continued.

M. perforata (small white rata)	18; 42		42	
M. robusta (northern rata)	9; 18; 46; 50; 54			
M. umbellata (southern rata)	6; 18; 42; 50		42	42
Mitraria coccinea (Chilean mitre flower)*	56			
Moss			42; 68	
Muehlenbeckia australis (pohuehue)	49	37; 44; 50		
Myoporum laetum (ngaio)	27; 46; 55	37; 41; 50		
Myrsine spp.		37		
M. australis (red matipo)	55	15; 28; 42; 49; 50; 54; 68	68	
M. divaricata (weeping matipo)		16; 41; 42	42	
Neomyrtus pedunculata (myrtle)		42		
Nertera depressa (bead plant)		11		
Nestegis spp. (maire)	18			
Nothofagus menziesii (silver beech)			42	
N. solandri var. *cliffortioides* (mountain beech)				15; 23; 34; 48
N. solandri var. *solandri* (black beech)				23
N. truncata (hard beech)				25; 26
Oenothera glazioviana (large-flowered evening primrose)*	56			
Olea spp. (olive)*	54			
Olearia paniculata (akiraho, golden akeake)			68	
*Paraserianthes lophantha** (brush wattle)	32			
Parsonsia heterophylla (New Zealand jasmine)	27; 55; 68			
Pennantia corymbosa (kaikomako)	49	40; 41; 49; 50; 54; 68		
Peraxilla colensoi (mistletoe)	42; 47; 52	42; 43		
P. tetrapetala (mistletoe)	42; 47; 48; 52	42; 43; 48		
Philesia magellanica (Austral bellflower)*	56			
Phormium spp.	4; 11; 19; 32; 36; 37; 50			
Phormium tenax (lowland flax)	2; 6; 9; 12; 17; 18; 27; 33; 46; 55; 56; 68			
P. cookianum (mountain flax)	5; 18			
Phygelius aequalis (Cape fuchsia)*	56			
Phyllocladus alpinus (mountain toatoa)			42	
Phytolacca otandra (inkweed)*	18	45		
Pittosporum spp.	37	28		
P. cornifolium (perching kohuhu)	46			
P. crassifolium (karo)	13; 18; 27; 45; 46; 50	45		
P. eugenioides (tarata, lemonwood)	27; 46; 50; 68	15; 49	68	
P. tenuifolium (kohuhu)	15; 18; 27; 46; 68	15; 49	68	
P. umbellatum (haekaro)	18; 31; 32; 45; 46; 50			
Plagianthus regius (ribbonwood)			68	
Plumeria spp. (frangipani)*	62			
Podocarpus spp.		37		
P. hallii (Hall's totara)		40; 41; 42; 44	42; 68	
P. totara (totara)		41; 49; 54		
Protea spp.*	32			
Prumnopitys ferruginea (miro)		42	42	
P. taxifolia (matai)		20; 40; 41; 49; 54	68	
Prunus spp.*	54; 56			

Appendix 1. Continued.

P. campanulata (Taiwan cherry)*	56		
P. laurocerasus (cherry laurel)*		49	
P. persica (peach)*	54	1; 11; 19	
P. ×subhirtella 'Autumnalis' (flowering cherry)*	32		
P. ×yedoenis (Yoshino cherry)*	56		
Pseudopanax spp.	27; 32; 37; 50; 54	15; 28; 50	
P. arboreus (five-finger)	18; 45; 46; 54; 56; 68	40; 41; 44; 45; 49; 68	68
P. colensoi (mountain five-finger)			42
P. crassifolius (lancewood)	42; 68	40; 41; 42; 49; 56; 68	42; 68
P. lessonii (houpara)		16	
Pseudowintera axillaris (lowland horopito)		22	
P. colorata (horopito)	42; 68	40; 41; 42; 68	42; 68
Psidium spp. (guava)*		18	
P. cattleianum (cherry purple guava)*		59	
Puya alpestris (sapphire tower)*	56		
Raukaua edgerleyi (raukawa)		42	
R. simplex (haumakoroa)	42	42	42
Rhabdothamnus solandri (New Zealand gloxinia)	16; 35; 45; 54		
Rhododendron spp. (rhododendron)*	32; 56		
*R. arboreum**	56		
Ribes spp.*		54	
Ribes sanguineum (flowering currant)*	32		
Ripogonum scandens (supplejack)		42	42
Rosmarinus officinalis (rosemary)*	58		
Rubus cissoides (bush lawyer)		40; 41; 68	42
R. fruticosus (blackberry)*		40; 49	
R. schmidelioides (white-leaved lawyer)		49	42
R. squarrosus (leafless lawyer)		41	
Salix glaucophylloides (willow)*	48		
S. nigra (black willow)*	54		
Sambucus nigra (elderberry)*		40; 49	
Schefflera digitata (pate)	18; 42	40; 41; 68	42
Solanum laciniatum (poroporo)		37; 50	
S. nigrum (black nightshade)*		45	
Sophora spp. (kowhai)	11; 19; 32; 36; 37; 46; 50		
S. microphylla (small-leaved kowhai)	10; 13; 15; 21; 22; 27; 45; 54; 56; 68		68
S. tetraptera (large-leaved kowhai)	2; 56		
Stachyurus spp.*	59		
Streblus heterophyllus (milk tree)		37; 50	
Styrax japonica (Japanese snowbell)*	32		
Syzygium paniculatum (scrub cherry)*	32		
Tropaeolum speciosum (Chilean flame creeper)*	49; 56	49	
Tupeia antarctica (mistletoe)		37; 43; 50	
Veronica spp. (hebe)	18; 37; 50		
V. speciosa (titirangi, purple hebe)	38		
V. stricta (koromiko)	35		
*Viburnum cylindricum**	56		

Appendix 1. Continued.

Vitex lucens (puriri)	16; 18; 19; 24; 27; 31; 32; 37; 45; 46; 50; 35; 54; 55			
Vitis spp. (grape)*		18; 19		
Watsonia spp.*	54			
Weinmannia racemosa (kamahi)	21; 42; 46		42	42

References: [1](Oliver 1922); [2](Thomson 1927); [3](Wilkinson 1927); [4](Stead 1932); [5](Sibson 1947); [6](Dunckley & Todd 1949); [7](Potter 1949); [8](McCann 1952); [9](Wilkinson & Wilkinson 1952); [10](Turbott 1953); [11](Oliver 1955); [12](Black 1956); [13](Edgar 1962); [14](Beveridge 1964); [15](Kikkawa 1966); [16](Merton 1966); [17](Turbott 1967); [18](Gravatt 1969, 1970, 1971); [19](Falla *et al*. 1970, 1979); [20](St. Paul 1975); [21](Godley 1979); [22](Norton 1980); [23](Crozier 1981); [24](Gaze & Fitzgerald 1982); [25](Gaze & Clout 1983); [26](Clout & Gaze 1984); [27](Craig & Douglas 1984a, 1984b, 1986; Craig 1985); [28](Wardle 1984); [29](Delph & Lively 1985); [30](Sagar 1985); [31](Angehr 1986); [32](Baker 1986); [33](Craig & Stewart 1988); [34](Fegley 1988); [35](Rasch & Craig 1988); [36](Clout & Hay 1989); [37](Baker 1992); [38](de Lange & Cameron 1992); [39](Sibson 1993); [40](Burrows 1994a); [41](Burrows 1994b); [42](O'Donnell & Dilks 1994); [43](Ladley & Kelly 1996); [44](Williams & Karl 1996); [45](Anderson 1997, 2003); [46](Castro & Robertson 1997); [47](Ladley *et al*. 1997); [48](Murphy 1998; Murphy & Kelly 2001, 2003); [49](Ridley 1998, *pers. comm*.; Ridley *et al*. 1999); [50](Baker 1999); [51](Heenan & de Lange 1999); [52](Robertson *et al*. 1999); [53](Schmidt-Adam *et al*. 2000, 2009); [54](Higgins *et al*. 2001 and references therein); [55](Anderson & Craig 2003); [56](Medway 2006, 2011); [57](Robertson *et al*. 2008); [58](M. Galbraith, Auckland, *pers. comm*.); [59](E. Lawton, Katikati, *pers. comm*.); [60](J. McIlroy, Akaroa, *pers. comm*.); [61](S. Mitchell, Waihopai Valley, pers. comm.); [62](L. Molles, Christchurch, *pers. comm*.); [63](E. Shaw, Nelson, *pers. comm*.); [64](J. Walker, Christchurch, *pers. comm*.); [65](E. Anderson, Palmerston North, *pers. comm*.); [66](R. Frew, Ngaruawahia, *pers. comm*.); [67](G. Henderson, Rangiora, *pers. comm*.); [68](this study).

Footnotes: (1) Godley (1979), Craig *et al*. (1981), Newstrom & Robertson (2005), and Kelly *et al*. (2010) provide lists of "bird-visited" flowers that include species not listed above because they did not state whether bellbirds visited the flowers. (2) Reports of bellbirds feeding on fruit of *Acer pseudoplatanus* (sycamore) and *Fraxinus excelsior* (ash) are questionable because these species have dry fruit. Perhaps the bellbirds were feeding on invertebrates? (3) Reported names different from preferred names include *Albizia lophantha* now *Paraserianthes lophantha*, *Coprosma astonii* now *Coprosma cuneata*, *Cyathodes fasciculata* now *Leucopogon fasciculatus*, *Cyathodes juniperina* now *Leptecophylla juniperina*, *Freycinetia baueriana* should be *F. banksii*, *Geniostoma rupestre* var. *ligustrifolium* now *Geniostoma ligustrifolium* var. *ligustrifolium* (P. de Lange pers. comm.), *Hebe speciosa* now *Veronica speciosa*, *Hebe stricta* now *Veronica stricta*, *Myrtus bullata* now *Lophomyrtus bullata*, *Metrosideros albiflora* now *Metrosideros diffusa*, *Oenothera lamarckiana* now *Oenothera glazioviana*, *Phormium colensoi* now *Phormium cookianum*. (4) Some adventive species were not found in the New Zealand Plant Names database (e.g. *Calothamnus* spp., *Camellia cuspidata*, *C. fraterna*, *C. pitardii*, *C. reticulata*, *C. saluenensis*, *C. transnokoensis*, *C. tsaii*, *Lapageria rosea*, *Prunus subhirtella*, *Stachyurus* spp., *Styrax japonica*, *Viburnum cylindricum*).