Manaaki Whenua - Landcare Research, PO Box 31-011, Christchurch, New Zealand.

PLANT SPECIES PREFERENCES OF BIRDS IN LOWLAND RIMU *(DACRYDIUM CUPRESSINUM)* FOREST—IMPLICATIONS FOR SELECTIVE-LOGGING

Summary: Plant species preferences of birds were determined by comparing the proportional bird use of plant species during direct observations with the proportions of plant species present on point-height intercepts in lowland rimu *(Dacrydium cupressinum)* forest in North Okarito, Westland. Plant species and bird use of plant species were divided into 5 m height classes, and rimu trees were divided into four age classes (sapling, pole, mature, and old). The frugivorous New Zealand pigeon *(Hemiphaga novaeseelandiae)* used mature and old rimu more than expected from the proportion of these age classes present, and it preferred the upper tiers of the forest. The omnivorous tui *(Prosthemadera novaeseelandiae)* had similar preferences to the pigeon. Other omnivorous species, *viz.,* the bellbird *(Anthornis melanura)* and silvereye *(Zosterops lateralis),* shared preferences with both the pigeon and insectivorous species. Most insectivorous species, *viz.,* the brown creeper *(Mohoua novaeseelandiae),* grey warbler *(Gerygone igata),* New Zealand fantail *(Rhipidurafuliginosa),* New Zealand tomtit *(Petroica macrocephala),* and rifleman *(Acanthisitta chloris),* used pole rimu more than expected and preferred the middle and lowest tiers. The insectivorous New Zealand robin *(Petroica australis)* had no preference for any plant species but had a strong preference for deadwood and the lowest tier of the forest. Of the 10 species s.ufficiently abundant to be monitored, the pigeon, bellbird, and tui are most likely to be detrimentally affected by selective-logging of mature and old rimu.

Keywords: Westland; podocarp forest; *Dacrydium cupressinum;* logging; birds; plant species preferences; forest management.

Introduction

North Okarito is a lowland podocarp forest comprising a mosaic of even-aged stands of rimu *(Dacrydium cupressinum* *). It has been gazetted for sustained-yield management, which could involve either coupe-logging of old stands or selective-logging of old rimu trees (James, 1987). The potential effects of coupe-logging on birds were predicted by Spurr, Warburton and Drew (1992). The objective of the present paper is to predict the likely effects of selective-logging on birds.

Most studies examining the effects of logging on bird populations have compared the numbers of species and their abundance between logged and unlogged forest (Pattemore and Kikkawa, 1975; Crook, Best and Harrison, 1977; Onley, 1983; Spurr, 1985; Forest Research Institute, 1987). An alternative approach used by Franzreb (1978; 1983), Holmes and Robinson (1981), and Peck (1989) and followed in this study is to examine the bird use of specific tree species and then predict the likely consequences of altering the availability of these trees by selective-logging.

Study Area

The study area covered 25 ha within the 100 ha used by Spurr *et al*. (1992). The principal merchantable species was rimu, with miro *(Prumnopitysferruginea),* Hall's totara *(Podocarpus hallii*), and silver pine *(Lagarostrobos colensoi)* being less frequent. The dominant hardwoods were kamahi *(Weinmannia racemosa)* and quintinia *(Quintinia acutifolia)*.

Methods

Proportions of plant species present

An index of the surface area of each plant species was estimated from the number of vegetation intercepts recorded on 1040 randomly located plots using a point-height intercept technique (Spurr and Warburton, 1991). The number of intercepts on plant species was recorded on a scale of 1-10 within 1 m height intervals on vertical sight lines at each plot. This index was used as a measure of the proportions of each plant species available to birds. Rimu trees were divided into four

* Plant nomenclature follows Allan (1961) and Connor and Edgar (1987), and bird nomenclature follows Turbott (1990).

age-classes based on their height and form; sapling, less than 10 m tall; pole, taller than 10 m, with narrow elongated crown; mature, taller than 25 m, with large dense crown; and old, taller than 25 m, crown less dense than for mature trees, with some broken branches, and trees often leaning.

Bird use of plant species

The activities of birds were recorded along transects 600 m long and 100 m apart from dawn to dusk on six days every second month for two years, starting in April 1984. When a bird was first sighted, its activity, height above ground, and the plant species and substratum it was using were recorded. For statistical reasons, only first observations were used to examine habitat use, because sequential observations of the same bird were found to be dependent, although there was no difference between the distribution of activities determined from first and subsequent observations *(unpubl. data)*. Activities recorded were roosting (resting or sleeping). perching (perched bird awake and alert), singing, calling, comforting (preening, bathing, or defecating), flying, interacting (with another bird), gleaning (searching and feeding; bird and prey on same substratum), hovering (searching and feeding; bird hovering over prey on substratum), hawking (searching and feeding; bird and prey flying), and ripping (searching and feeding; bird tearing substratum). Substrata recorded were: aerial (bird flying), foliage (leaves and twigs <2 cm diameter), small branches (2-8 cm diameter), large branches (>8 cm diameter), trunk, bare ground, litter (on ground), and moss (on ground).

To satisfy sample size demands of statistical tests. some habitat components were grouped; e.g, heights were grouped into 5-m classes, and minor plant species (those with less than 1 % occurrence) were grouped as "others" (see Appendix 1). Two merchantable species, Hall's totara and silver pine, although having less than 1 % occurrences were kept separate.

Bird preferences for plant species

Bird preferences for plant species and other habitat components were determined by comparing the observed frequencies of bird use with expected frequencies obtained from the proportions of vegetation intercepts recorded for each habitat component. Differences between the observed and expected frequencies were tested using chi-square goodness of fit tests and when a significant difference was found, Bonferroni-adjusted confidence intervals *($P < 0.05$)* were used to determine which specific components had observed frequencies significantly different from their expected (Byers, Steinhorst and Krausman, 1984). If the observed frequencies were significantly greater or less than expected, the bird species was over-using (selecting) or under-using (avoiding) the habitat component. Expected values for aerial, moss, litter, and bare ground were not available because their occurrences had not been recorded during the vegetation intercept survey. The only substrata that could be compared with expected values were foliage. small branches, large branches, and trunks.

Results

Proportions of plant species present

The main contributors to vegetation surface area were rimu, kamahi, and quintinia (Appendix 1). The upper levels of the forest (> 15 m) were dominated by rimu, which contributed 80% of the vegetation intercepts above 15 m and more than 90% above 20 m. Other canopy species included miro, silver pine, Hall's totara, and southern rata *(Metrosideros umbellata)*. Of the 35 species recorded below 15 m, seven, *viz*.. rimu. miro. kamahi, quintinia. mountain toatoa *(Phyllocladus aspleniifolius* var. *alpinus),* rohutu *(Neomyrtus pedunculata),* and rata vine *(Metrosideros diffusa* and *M .fulgens),* contributed 80% of the vegetation intercepts. Intercepts were predominantly on foliage (94%), with 3.5% on branches, and 2.5% on trunks.

Bird use of plant species

A total of 3614 observations were made of 16 bird species (scientific names of birds are given in Appendix 2). Species were not equally abundant, with the number of observations ranging from 675 for bellbirds to two for South Island kaka. For convenience, bird species were divided into four groups based on their predominant food type (Appendix 2). Sample sizes of the granivorous species as well as blackbird, kaka, and yellow-crowned parakeet were insufficient to enable analysis of habitat use.

Frugivorous species

Pigeons used mature rimu, old rimu, and miro more than expected (Fig. 1) and used the upper tiers of the forest more than expected (Fig. 2). Of the remaining predominant plant species, kamahi, rohutu, and pokaka were not used, and quintinia was used less than expected. Although foliage was used extensively it was still used less than expected (Fig. 3). Branches, both small and large, although used less than foliage, were used more than expected (mainly for perching). Of all the bird species observed, pigeons had the highest percentage (58%) of non-feeding observations, mainly perching (Fig. 4). Gleaning was the predominant feeding activity.

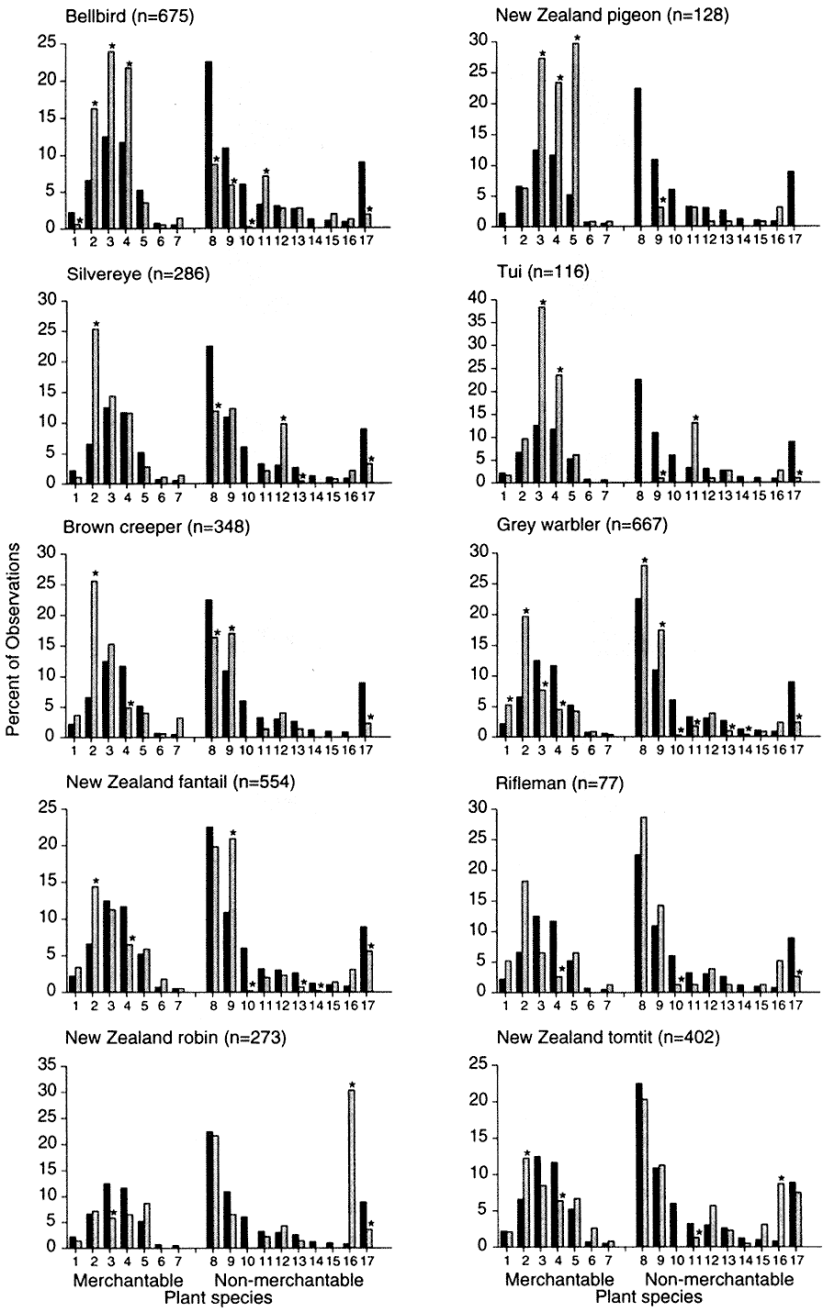

Figure 1: *Expected (dark bars) and observed (light bars) distribution of bird observations* on *plant species* in *North Okarito Forest. Plant species have been grouped into merchantable and non-merchantable. 1 = sapling rimu,* 2 = *pole rimu,* 3 = *mature rimu,* 4 = *old rimu,* 5 = *miro,* 6 = *Hall's totara,* 7 = *silver pine,* 8 = *kamahi,* 9 = *quintinia, 1O = rohutu, 11 = southern rata, 12 = mountain toatoa, 13 = rata ,vine, 14 = pokaka, 15 = mapou, 16 = deadwood. 17 = others.* n = *sample* size. * = *a significant difference between expected and observed at the 0.05 level. Note different ,vertical scales.*

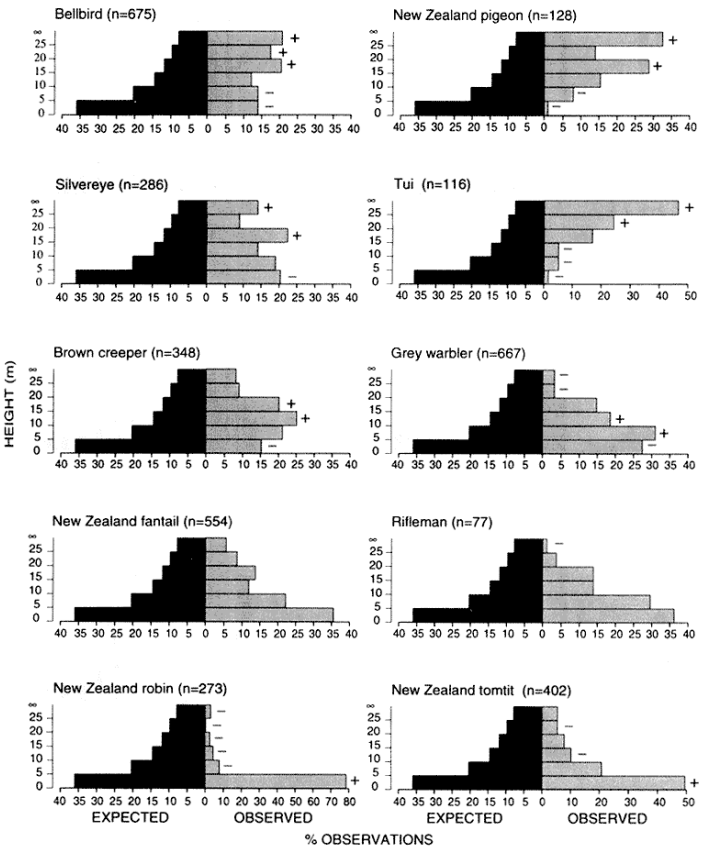

Figure 2: *Expected (dark bars) and observed (light bars) distribution of bird observations in six height tiers in North Okarito Forest. n = sample size. + or - = a significant positive or negative difference between expected and observed at the 0.05 level. Note different horizontal scales.*

Omnivorous species

Bellbirds, silvereyes, and tui fed on both plants (nectar and fruit) and invertebrates, but they differed in the extent to which they relied on these two food sources. Bellbirds and tui were similar to pigeons, and used mature and old rimu more than expected (Fig. I). They also used southern rata more than expected. Silvereyes used mature and old rimu only as frequently as expected, although more so than strictly insectivorous species (see below). However, bellbirds and silvereyes used pole rimu more than expected, like insectivorous species. Kamahi, quintinia, and rohutu were used less than expected by all three bird species, except for silvereyes which used quintinia as expected. All three omnivorous species favoured the upper tiers of the forest (Fig. 2). However, bellbirds and silvereyes were also observed frequently in the lower tiers. Foliage was the major substratum used, although it was used less than expected by bellbirds and tui (Fig. 3). Bellbirds and tui used branches more than expected, and bellbirds also used trunks more than expected. All three species fed predominantly by gleaning (Fig 4).

Insectivorous species

Most insectivorous species used pole rimu more than expected and old rimu less than expected (Fig. 1). Grey warblers also over-used sapling rimu, and grey warblers and robins under-used mature rimu. The non-merchantable plant species, especially kamahi and quintinia, were used more frequently by insectivorous species than by the frugivorous and omnivorous species. Tomtits and robins used deadwood significantly more than expected.

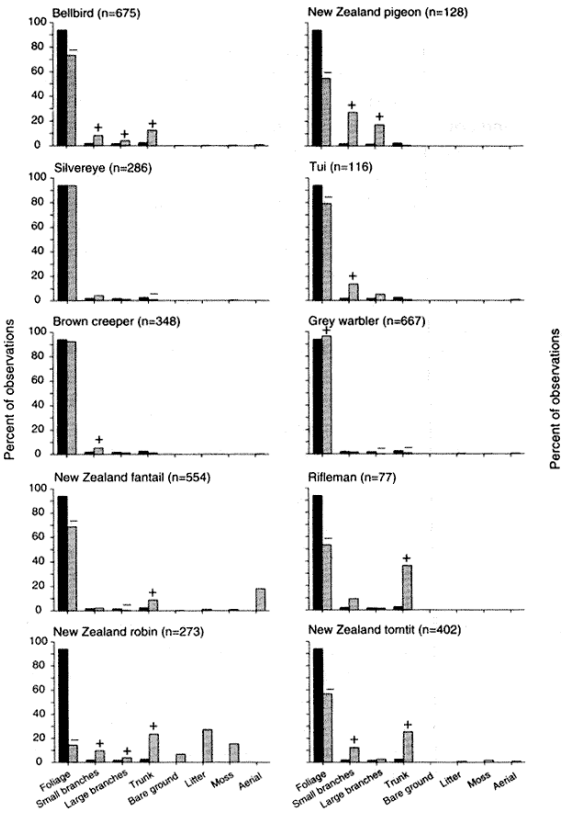

Figure 3: *Expected (dark bars) and observed (light bars) distribution of bird observations on eight substrata in North Okarito Forest. n = sample size. + or - = a significant positive or negative difference between expected and observed at the 0.05 level. Expected values were available only for foliage, small branches, large branches, and trunks.*

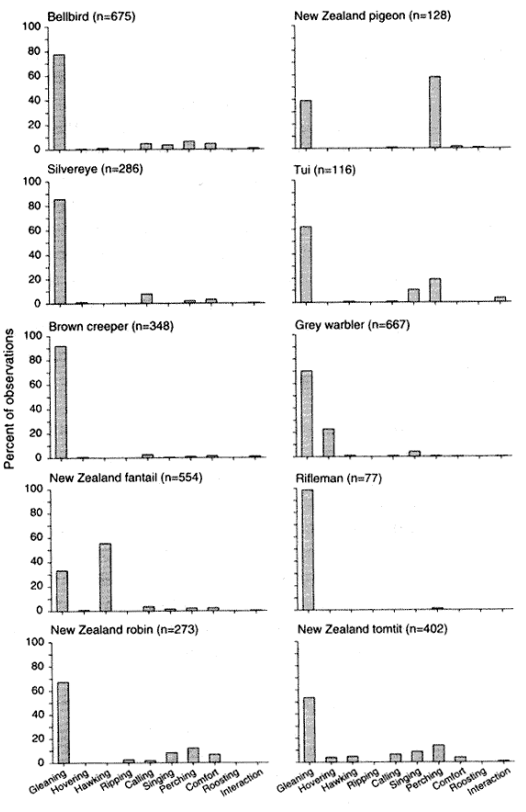

Figure 4: *Percentage distribution of bird activities in North Okarito Forest. n = sample size.*

The vertical distribution of insectivorous species, unlike that of the frugivorous and omnivorous species, was either similar to the vertical distribution of vegetation (rifleman and fantail), concentrated in the middle tiers (brown creeper and grey warbler), or concentrated in the lower tiers (tomtit and robin) (Fig. 2). Apart from robins which extensively foraged on the ground (bare ground, litter, and moss), all insectivorous species used foliage more frequently than other substrata, although the extent of this use differed between species (Fig. 3). Brown creepers, robins, and tomtits used branches more than expected. Fantails, riflemen, robins, and tomtits used trunks more than expected. Most insectivorous species fed by gleaning, although hawking contributed 55% of fantail observations, and hovering contributed 23% of grey warbler observations (Fig. 4).

Discussion

The 10 native bird species monitored in North Okarito Forest made variable use of the plant species, height tiers, and/or substrata. Bird activities and heights, and substrata used, were similar to those recorded by O'Donnell and Dilks (1986) for birds in beech-podocarp-hardwood forest some 60 km south of our study area. However, as a consequence of the different forest composition in the two study areas, the plant species used by birds differed. O'Donnell and Dilks found silver beech *(Nothofagus menziesii),* which was absent from North Okarito Forest, and kamahi were used more frequently than other plant species, whereas we found rimu was used most frequently. Also, in North Okarito Forest, despite rimu having the greatest vegetation surface area of any of the plant species, most birds used it more than expected from its availability.

Native birds in North Okarito Forest could be classified into two broad groups which basically

reflected their degree of frugivory or insectivory. Thus, the frugivorous and omnivorous species selected mature and old rimu, avoided species such as kamahi and quintinia that do not bear fleshy fruit, and used the upper tiers of the forest more than expected from their availability. Additional plant species selected were miro by pigeons for its source of fruit, and southern rata by bellbirds and tui for its source of nectar. In contrast, the insectivorous species selected the younger age-classes of rimu, especially pole rimu, often using the older age-classes of rimu less than expected. Quintinia and to a lesser extent kamahi, were also used more than expected by some insectivorous species. Insectivorous species favoured the middle and lower tiers of the forest.

Variable use of different tree species, height tiers, and substrata by birds depends on their morphological characteristics, the abundance and accessibility of the preferred prey (Holmes and Robinson, 1981), and the degree of interspecific competition (Ford and Paton, 1976). In a concurrent study, invertebrate abundance was evaluated from trunk traps on pole, mature, and old rimu, kamahi, and quintinia. Invertebrates were most abundant on trunks of kamahi, quintinia, and pole rimu, and least on trunks of mature and old rimu *(unpubl. data)*. Thus, at least in part, insectivorous birds' preferences for tree species can be attributed to prey abundance. Similarly, phenology records of fruiting during the study period *(unpubl. data)* show high fruit production on mature and old rimu, which indicates why frugivorous birds preferentially use these two age classes of rimu.

In this study we have identified the preferred plant species and other habitat components (height and substrata) of bird species in North Okarito Forest, but were unable to identify which of these components are critical; i.e., which components limit population numbers. Only experimental removal of the preferred components would enable us to determine this (Holmes, 1981). The extent to which such components become critical to a bird species depends on their ability to switch to other components (i.e., whether they are generalists or specialists) and their current level of use of the components. For example, although pigeons used old rimu more than expected, we do not know if this particular component is limiting. If the -quantity of fruit and vegetation available on old rimu exceeds the pigeons' demands, some other habitat component (perhaps not even present in North Okarito Forest) must be limiting their population size below the number of birds that could potentially be utilising old rimu. Additionally, plant species that are used only as frequently as expected, and therefore not regarded as critical, may become critical if their availability is reduced. Thus, because a plant species is not preferred (not used more than expected from its availability) this does not mean that it is not important (perhaps critical) to birds (Airola and Barrett, 1985). Furthermore, this study was restricted to non-breeding use of the habitat and could not elucidate whether other requirements such as breeding sites were limiting.

Logging on a sustained-yield basis, selectively removing a proportion of mature and old rimu, is likely to have greatest impact on pigeons, bellbirds, and tui because they have a disproportionately high use of these trees. The degree of impact will depend on the volume of timber removed and the amount of disturbance to the forest. The same species are also likely to be detrimentally affected by coupe-logging (Spurr *et al.,* 1992). This is not suprising because the preferred trees occur most frequently in the old stands targeted for coupe-logging. None of these bird species, however, is considered rare or endangered (Williams and Given, 1981). The pigeon, bellbird, and tui are widely distributed throughout New Zealand (Bull, Gaze and Robertson, 1985), are relatively common, and have a good dispersal ability (Spurr, 1979). Other frugivorous or omnivorous species such as the kaka and yellow-crowned parakeet occur in very low numbers in North Okarito Forest. They have a patchy distribution and are poor dispersers (Spurr, 1979). O'Donnell and Dilks (1986) found that both kaka (seasonally) and parakeets frequently used large (presumably old) rimu. Consequently, these species may be even more adversely affected by selective and coupe-logging than pigeon, bellbird and tui.

Acknowledgements

The authors wish to thank K. Drew for assistance throughout the field work; D. Hilliard for logistic support; B. Fredric and C. Frampton for statistical advice; and l. Parkes and J. Orwin for commenting on drafts of the manuscript.

References

Airola, D.A.; Barrett, R.H. 1985. Foraging and habitat relationships of insect-gleaning birds in a Sierra Nevada mixed-conifer forest. *Condor* 87: 205-216.

Allan, H.H. 1961. *Flora of New Zealand Volume* 1. Government Printer, Wellington, New Zealand. 1085 pp.

Bull, P.C.; Gaze, P.D.; Robertson, C.J.R. 1985. *The atlas of bird distribution in New Zealand*. Ornithological Society of New Zealand Inc., Wellington, New Zealand. 295 pp.

Byers, C.R; Steinhorst, R.K.; Krausman, P.R. 1984. Clarification of a technique for analysis of utilization-availability data. *Journal of Wildlife Management 48*: 1050-1053.

Connor, H.E.; Edgar, E. 1987. Name changes in the indigenous New Zealand flora, 1960-1986 and Nomina Nova IV, 1983-1986. *New Zealand Journal of Botany 25*: 115-170.

Crook, I.G.; Best, H.A.; Harrison, M. 1977. A survey of the native bird fauna of forests in the proposed beech project area of North Westland. *Proceedings of the New Zealand Ecological Society 24*: 113-126.

Ford, H.A.; Paton, D.C. 1976. Resource partitioning and competition in honeyeaters of the genus *Meliphaga*. *Australian Journal of Ecology 1*: 281-287.

Forest Research Institute, 1987. *Beech management – its effects on bird populations*. What's New in Forest Research No. 146. Forest Research Institute, Rotorua, New Zealand. 4 pp.

Franzreb, K.E. 1978. Tree species used by birds in logged and unlogged mixed-coniferous forests. *Wilson Bulletin 90:* 221-238.

Franzreb, K.E. 1983. A comparison of foliage use and tree height selection by birds in unlogged and logged mixed-coniferous forest. *Biological Conservation 27*: 259-275.

Holmes, R.T. 1981. Theoretical aspects of habitat use by birds. *In:* Capen, D.E. (Editor), *The use of multivariate statistics in studies of wildlife habitat,* pp.33-37. USDA Forest Service General Technical Report RM-87. Fort Collins, Colorado, U.S.A. 249 pp.

Holmes, RT.; Robinson, S.K. 19H1. Tree species preferences of foraging insectivorous birds in a northern hardwoods forest. *Oecologia (Berlin) 48*: 31-35.

James, I.L. 1987. *Silvicultural management of the rimu forests of South Westland*. FRI Bulletin No. 121. Forest Research Institute, Rotorua, New Zealand. 32 pp.

O'Donnell, C.F.J.; Dilks, P.J. 1986. *Forest birds in South Westland. Status, distribution and habitat use*. Occasional Publication No. 10, New Zealand Wildlife Service, Wellington, New Zealand. 179 pp.

Onley, D.J. 1983. The effects of logging on winter bird populations near Karamea. *Notornis 30:* 187-198.

Panemore, V.; Kikkawa. J. 1975. Comparison of bird populations in logged and unlogged rain forest at Wiangarie State Forest, N.S.W. *Australian Forestry 37*: 188-198.

Peck, K.M. 1989. Tree species preferences shown by foraging birds in forest plantations in northern England. *Biological Conservation 48*: 41-57.

Spurr, E.B. 1979. A theoretical assessment of the ability of bird species to recover from an imposed reduction in numbers, with particular reference to 1080 poisoning. *New Zealand Journal of Ecology 2*: 46-63.

Spurr, E.B. 1985. Effects of beech forest management on bird populations. *New Zealand Journal of Ecology 8*: 145.

Spurr, E.B.; Warburton, B. 1991. Methods of measuring the proportions of plant species present in forest and their effect on estimates of bird preferences for plant species. *New Zealand Journal of Ecology 15*: 171-175.

Spurr, E.B.; Warburton, B; Drew, K.W. 1992. Bird abundance in different-aged stands of rimu *(Dacrydium cupressinum)* - implications for coupe-logging. *New Zealand Journal of Ecology 16*: 109-118.

Turbon, E.G. 1990. *Checklist of the birds of New Zealand*. Ornithological Society, Wellington, New Zealand. 247 pp.

Williams, G.R.; Given, D.R 1981. *The red data book of New Zealand*. Nature Conservation Council, Wellington, New Zealand. 175 pp.

Appendix 1. *Common and scientific names and percent frequency of vegetation surface area of plant species used* by *birds* in *North Okarito Forest. Less commonly used species are grouped* as *others (see text).* and *include* Adiantum cunninghamii, Ascarina lucida, Astelia fragrans, Blechnum capense, Blechnum discolor, Cardiomanes reniforme, Coprosma foetidissima, Coprosma lucida, Dicksonia squarrosa, Earina autumnalis, Gahnia procerum, Griselinia littoralis, Hedycarya arborea, Luzuriaga parviflora, Myrsine divaricata, Myrsine salicina, Polystichum vestitum, Pseudopanax colensoi, Pseudopanax crassifolium, Pseudopanax simplex, Pseudowintera colorata, Rhipogonum scandens, and Trichomanes reniforme.

Common name	Scientific name	Percent frequency
Rimu	*Dacrydium cupressinum*	33.0
Kamahi	*Weinmannia racemosa*	22.5
Quintinia	*Quintinia acutifolia*	10.9
Rohutu	*Neomyrtus pedunculata*	6.0
Miro	*Prumnopitys ferruginea*	5.2
Southern rala	*Metrosideros umbellata*	3.2
Mountain toatoa	*Phyllocladus aspleniifolius* var. *alpinus*	3.1
Rata vine	*Metrosiderosfulgens* and M. *dijfusa*	2.6
Pokaka	*Elaeocarpus hookerianus*	1.2
Mapou	*Myrsine australis*	1.0
Hall's totara	*Podocarpus hallii*	0.7
Silver pine		0.5
Others		9.7

Appendix 2. *Common and scientific names of the birds observed* in *North Okarito Forest. with numbers of observations.*

Common name	Scientific name	Number of observations
Frugivorous/omnivorous species		
Bellbird	*Anthornis melanura*	675
Blackbird	*Turdus merula*	30
Kaka	*Nestor meridionalis*	2
New Zealand pigeon	*Hemiphaga novaeseelandiae*	128
Silvereye	*Zosterops lateralis*	286
Tui	*Prosthemadera novaeseelandiae*	116
Yellow-crowned parakeet	*Cyanoramphus auriceps*	7
Insectivorous species		
Brown creeper Grey	*Mohoua novaeseelandiae*	348
warbler	*Gerygone igata*	667
New Zealand fantail	*Rhipidura fuliginosa*	554
New Zealand robin	*Petroica australis*	273
New Zealand tomtit	*Petroica macrocephala*	402
Rifleman	*Acanthisitta chloris*	77
Granivorous species		
Chaffinch	*Fringilla coelebs*	23
Greenfinch	*Carduelis chloris*	6
Redpoll	*Carduelis flammea*	20