BIRD COUNTS IN LOWLAND FORESTS IN THE WESTERN PAPAROAS

By D. J. ONLEY

Birds were counted in four forest areas and an area of cutover forest in early summer. Marked differences in species composition and numbers counted were found. The role of soil fertility and vegetation in determining differences is discussed. Some observations on seasonal movements are given and a comparison is made with counts made at Reefton. The implications of these findings for reserves in Westland forests is discussed.

INTRODUCTION

This study was devised to identify the breeding habitat preferences of native forest birds in lowland forests so as to assist reserve design.

Topographic maps show that lowland forest (below c. 170 m a.s.l.) forms about a tenth of the remaining forested area in the South Island. Many biologists stress the value of these forests for biological conservation. The greatest pressures from logging and exotic conversion are on these lowland forests, and so the greatest urgency to identify reserves is in them.

METHODS

The area studied lies inland from Punakaiki, between Greymouth and Westport on the West Coast of the South Island. The lowland forest is situated in a synclinal formation on the western side of the Paparoa Range between the Punakaiki River and Bullock Creek (Fig. 1). Logging near Bullock Creek allowed bird counts in modified and unmodified forest areas to be directly compared. Three distinct vegetation types within the syncline, and a coastal vegetation type, were also compared.

Five-minute bird counts according to the method described by Dawson & Bull (1975) were carried out in November and December 1977 and in January 1978.

Uncontrolled variables usually limit comparison between bird counts in forests (Dawson *et al.* 1978). The following standard features of this study enabled the birds' preference for different vegetation types to be compared with a high degree of confidence.

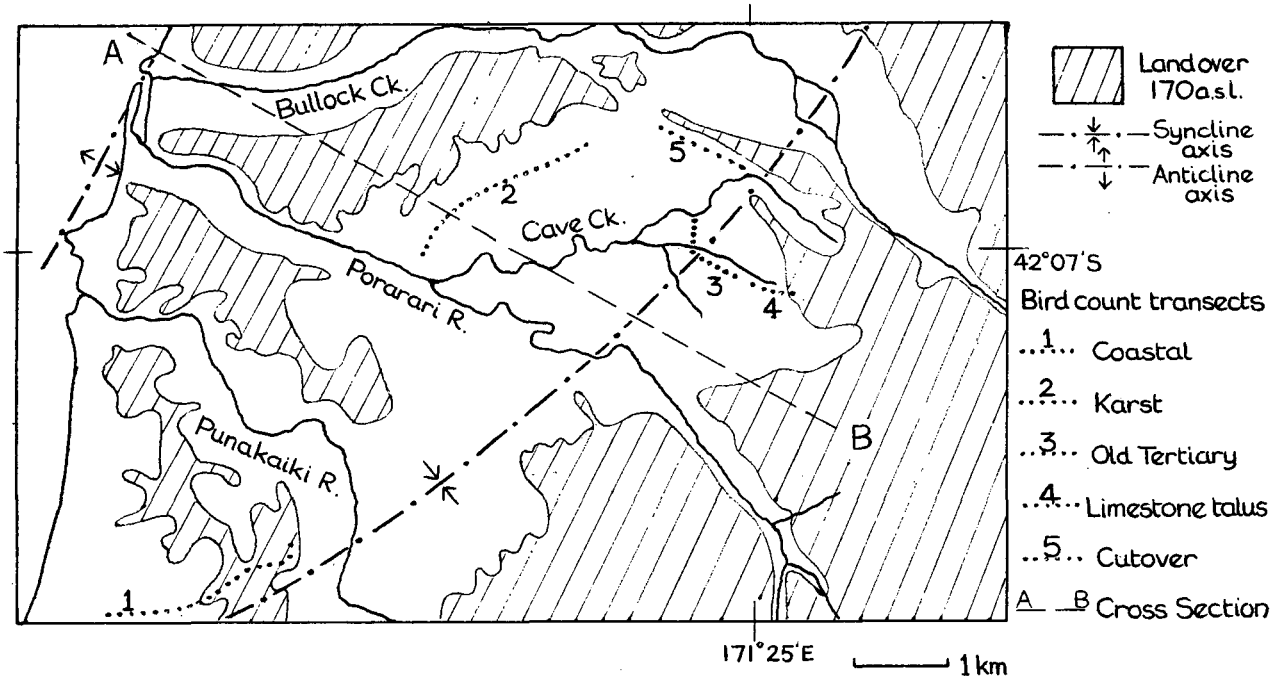

FIGURE 1 — The study area.

1. Selected weather — fine days with little wind or cloud.
2. Time of day — counts were done between 0900 and 1900 hours NZST, omitting the hotter part of the afternoon when song was at a minimum.
3. Breeding season — conspicuousness varies with the stage of breeding, moult, flocking, etc., but most forest birds are easier to count during the breeding season when they are more evenly distributed throughout the forest and males are singing well.
4. Good definition of vegetation types.
5. One observer.

The discussion is supplemented by six years of observations in the area, which often confirmed the generality of a statistically insignificant result.

Caughley (1965) showed that the number of species recorded increased with the number of counts. Figure 2 shows the number of species recorded for a given number of counts for 60 counts taken at random from the vegetation types in this study. Cutover forest near the road was omitted as the species composition was markedly different.

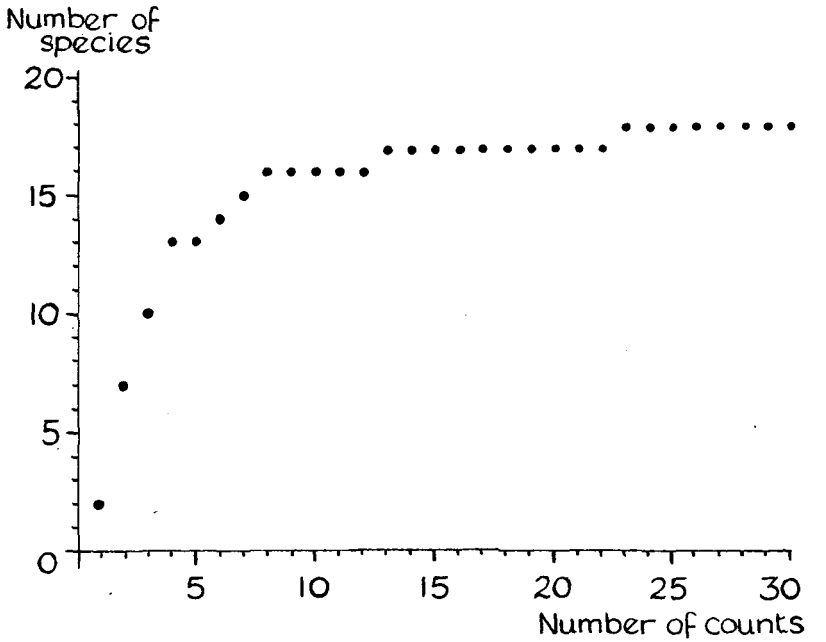

FIGURE 2 — The number of species recorded for a given number of 5-minute counts. 18 species recorded from count 23 to 60.

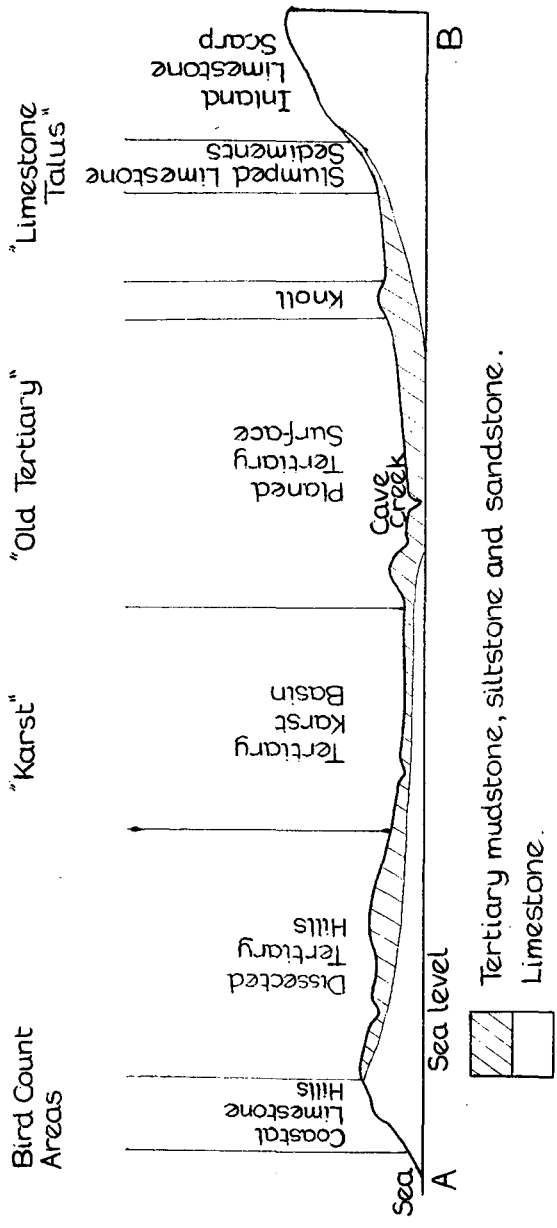

FIGURE 3 — Cross section of the geology, landform and bird count areas.

The graph shows that the number of species recorded increased rapidly until 8 counts were made and then levelled off. The commoner species were recorded early in the counts, whereas the two other species, recorded after 13 and 23 counts, were each noted only once in all 60 counts.

This suggests that for a study of this kind, where observer, seasonal, weather and vegetation variations in counts are kept to a minimum, 8 counts are satisfactory to record the majority of species present, though more are desirable.

VEGETATION TYPES

This study was devised to identify the breeding habitat preferences of birds and detailed preliminary geological and biological work was necessary to separate the forest into consistent, large vegetation types. The work was also useful in explaining the differences in bird counts in vegetation types. The detailed descriptions of the landform and vegetation are given in Appendices I and II, but I would stress their importance for this paper.

The coastal forest occurred on steeply dissected Tertiary hills, while the other lowland forests and cutover areas lay within a syncline of soft mudstone, siltstone and sandstone of Miocene age, overlying harder limestones of Oligocene age (Bowen 1964 and Figure 3). Six

TABLE 1 — A Vegetation Summary.

Vegetative layer		Cutover	Old Tertiary	Coastal	Karst	Limestone Talus
Emergents	Cover	5%	under 50%	few	few	under 10%
	Height	17 m	30 m	40 m	40-45 m	40-45 m
Canopy	Cover	broken	open	moderate/	closed	closed
	Height	10 m	20-25 m	closed 25 m	25-30 m	30-35 m
Subcanopy	Cover	absent	open	sparse	moderate	closed
	Height		15 m	5-20 m	15-20 m	20-25 m
Upper understorey	Cover				moderate	sparse
	Height				3-15 m	10-15 m
Lower understorey	Cover				open	dense
	Height					5-8 m
Shrub	Cover	dense	moderate	dense	open	dense
	Height	3.5 m		2 m		1.5-4 m
Ground	Cover	very dense	open	open	open	very dense
Epiphytes	Cover	few	absent	abundant	some	abundant

vegetation types were chosen for bird counts because of their wide variation in landform, soil fertility, coastal influence and modification by man.

Below, each vegetation type is briefly described and related to landform. Table 1 summarises the vegetation characteristics.

Old Tertiary

Rimu (kahikatea) / hard beech-silver beech forest with some areas of mountain beech and yellow silver pine. Emergents and canopy low and relatively sparse. With the other layers poorly developed, no epiphytes and an open ground cover, the forest appears poor and open. The soils are infertile on the planed Tertiary surface.

Karst

Red beech/silver beech forest with a small amount of emergent rimu. The canopy is red beech dominated, moderately high and relatively closed. There is a good development of subcanopy and upper understorey layers, with the lower layers and the ground relatively open and few epiphytes. The soils are fertile in Karst basins and wider valleys, while on the less fertile ridges a hard beech and rimu element becomes more prominent.

Limestone Talus

Rimu-kahikatea/red beech/silver beech forest. Tall emergent rimu and kahikatea over a high, closed canopy of red beech. Good development of all layers with a dense ground cover and abundant epiphytes. The soils are relatively fertile on slumped limestone sediments.

Coastal

Rimu (northern rata) / (hinau) / kamahi forest. Large emergent rimu and northern rata over a predominantly closed low canopy, mainly of kamahi. There are many representatives of warm forest species. Epiphytes are abundant and shrubs often dense, while the other layers are poorly represented and the ground cover open. This forest occurs on the steeply dissected Tertiary hills, near the coast, south of Punakaiki.

Cutover forest

Remnant rimu and beeches. A forest once mainly of the *Old Tertiary* type, but on discontinuous Pleistocene gravels overlying the Miocene deposits. Soils are infertile and often waterlogged. Low, infrequent rimu and beeches emergent over a low broken canopy, mainly of silver beech. Epiphytes few. Only the shrub and ground layers are well represented, both being very dense. Near logging roads there are more bare areas, small pools and introduced weeds and this was counted under a separate vegetation type: *Cutover near road.*

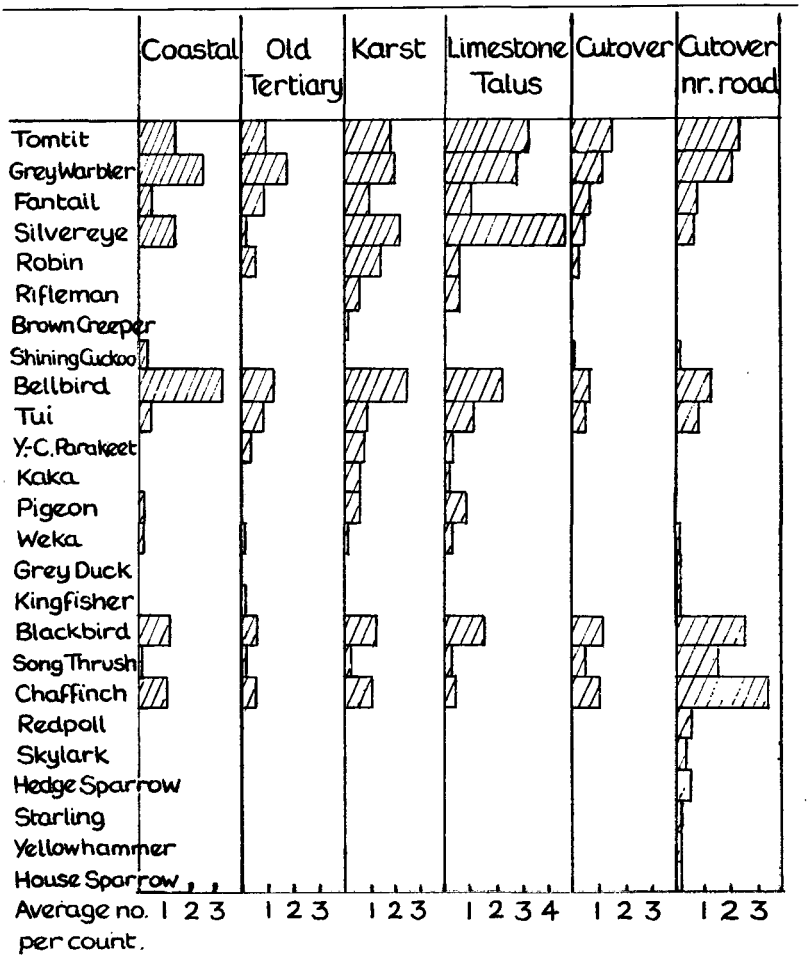

FIGURE 4 — Average number of birds per 5-minute count in each area.

TABLE 2 — Average number of birds counted per five minutes.

	PORARARI AREA						REEFTON		
Species	Coastal	Old Tertiary	Karst	Limestone Talus	Cutover	Cutover near road	Fletcher's Creek	Te Wharau	Reefton Saddle
Tomtit	1.3	0.95	1.8	3.1	1.5	2.3	1.68	1.56	0.79
Grey Warbler	2.5	1.7	2.0	2.8	1.1	2.0	0.93	0.88	0.95
Fantail	0.57	0.79	0.86	1.0	0.62	0.66	1.71	1.02	0.68
Bellbird	3.2	1.2	2.4	2.1	0.75	1.3	3.05	3.52	4.2
Silvereye	1.4	0.21	2.1	4.8	0.38	0.58	2.06	2.95	4.5
Tui	0.41	0.79	0.86	1.1	0.62	0.83	0.54	0.16	0.51
Robin	-	0.63	1.4	0.59	0.25	-	0.55	0.02	0.01
parakeet*	-	0.26	0.69	0.24	-	-	0.09	0.14	0.02
Kaka	-	-	0.50	0.12	-	-	0.09	0.12	0.25
Weka	0.14	0.05	0.07	0.29	-	0.08	0.02	0.01	0.02
Shining Cuckoo	0.33	-	-	-	0.12	0.08	0.09	0.24	0.25
Rifleman	-	-	0.43	0.53	-	-	-	0.29	-
N.Z. Pigeon	0.16	-	0.43	0.94	-	-	0.06	0.01	0.01
Brown Creeper	-	-	0.07	-	-	-	-	-	-
Grey Duck	-	-	-	-	-	0.08	-	-	-
Kingfisher	-	0.05	-	-	-	0.08	0.10	0.02	-
All native species	10.0	6.6	13.6	17.5	5.4	8.1	10.9	12.2	11.0
Number of native species	9	10	13	12	8	10	13	14	12

TABLE 2 — Continued

Blackbird	1.2	0.5	1.1	1.5	1.2	2.6	1.35	0.73	0.50
Chaffinch	1.1	0.5	1.0	0.3	1.0	3.5	0.60	0.68	0.60
Song Thrush	0.1	0.1	0.2	0.2	0.4	1.6	0.75	0.17	0.11
Redpoll	-	-	-	-	-	0.4	0.03	0.11	0.01
Skylark	-	-	-	-	-	0.3	-	-	-
Hedgesparrow	-	-	-	-	-	0.5	0.01	-	-
Starling	-	-	-	-	-	0.1	-	-	-
Yellowhammer	-	-	-	-	-	0.1	-	-	-
House Sparrow	-	-	-	-	-	0.1	-	-	-
All introduced species	2.4	1.1	2.4	2.1	2.6	9.2	2.74	1.69	1.22
Number introduced species	3	3	3	3	3	9	5	4	4
All species	12.4	7.7	16.0	19.6	8.1	17.3	13.6	13.9	12.2
Number of counts	47	19	14	17	8	12	80	80	80

* All the parakeets identified to species were Yellow-crowned.

RESULTS

Table 2 shows the average number of birds counted in five minutes in each area. Figure 4 shows the same in diagrammatic form.

Comparison between Forested Areas

Species composition

Eighteen species were counted in the forested areas and all but three were native. All three introduced species but only seven of the 15 native species occurred in all vegetation types. The *coastal forest* had the fewest species; it lacked Robin, parakeet, Kaka, Rifleman, Brown Creeper and Kingfisher, the *old Tertiary* next so; lacking Kaka, pigeon, Rifleman and Brown Creeper. The fullest representation was found in the *limestone talus* and *karst* areas.

Number counted

Limestone talus appeared to be preferred by many species (Table 3), *karst* and *coastal* next and least *old Tertiary*. Not all of these differences were statistically significant but the trends were confirmed by general observations in the area.

TABLE 3 — The unmodified habitat in which each species reached maximum abundance. The significant test results are given in Appendix III.

Habitat	Limestone Talus	Karst	Coastal	Old Tertiary
	Silvereye***	Robin***	Bellbird**	Kingfisher
	Tomtit**	parakeet*	Chaffinch**	
	Rifleman**	Kaka	Shining Cuckoo	
	N.Z. Pigeon**	Brown Creeper		
	Grey Warbler*	Song Thrush		
	Tui*			
	Blackbird*			
	Fantail			
	Weka			
Number of species	9	5	3	1

*** significantly higher than all other areas ($p < 0.05$),
** significantly higher than two other areas,
* significantly higher than 1 other area
not significantly higher

The *old Tertiary* habitat was preferred by only one species and had the lowest counts of all areas for Tomtit, Grey Warbler, Bellbird, Silvereye, Weka, Blackbird, Chaffinch and Song Thrush. Robin and parakeet were present however.

The coastal area was preferred only by the Bellbird, Chaffinch and Shining Cuckoo and the lowest counts of Fantail and Tui were recorded there.

Although the *karst area* was preferred habitat for only five species, four native species were counted there in the highest numbers (Kaka, parakeet, Robin and Brown Creeper). The high number of Robins was especially notable. Counts of all other species were higher than both *coastal* and *old Tertiary,* with the exception of the Weka.

The *limestone talus* area was the preferred habitat of most species. Exceptionally high counts were recorded for Tomtit, Silvereye and NZ Pigeon.

If the data of Table 2 are used to rank the areas for each species 4 to 1 in order of preference by birds, the following averages result.

Limestone talus	3.1
Karst	3.1
Coastal	2.2
Old Tertiary	1.8

The *karst area* thus proved a more favoured bird habitat than would appear from the previous discussion.

Cutover Areas

Native species found in the cutover areas were Tomtit, Grey Warbler, Fantail, Bellbird, Silvereye, Tui and Shining Cuckoo. Weka, Grey Duck and Kingfisher occurred near the road, while Robins occurred in small numbers only in an area of mature manuka with an open understorey. Blackbird, Chaffinch and Song Thrush were present in both cutover areas, but near the road six other introduced species were recorded in low numbers.

Counts of all species, except Robin and Shining Cuckoo, were higher near the road. Tomtit, Grey Warbler, Bellbird, Blackbird, Chaffinch and Song Thrush counts were especially high near the road. The road forms but a small element in the total cutover area and comparisons between cutover and forested areas should avoid giving undue weight to exceptionally modified areas near logging roads.

Comparison between Cutover and Forested Areas

Comparison is made between *cutover, old Tertiary* and *karst.* Much of the *cutover* once had vegetation similar to *old Tertiary,* but there were some pieces similar to *karst.*

Species composition

Cutover had the lowest number of native species (8), compared with 10 in *old Tertiary* and 13 in *karst.* Although the number of counts was satisfactory, a higher number in *cutover* would make comparison of species numbers more dependable (see Fig. 2). Parakeet, Kaka, Rifleman, NZ Pigeon, Brown Creeper and Weka were not recorded in the *cutover* area and these absences were confirmed by general observations. Robins occurred only in mature manuka. The introduced Blackbird, Chaffinch and Song Thrush occurred in all three areas.

Numbers counted

No native species gave the highest counts in *cutover* (Table 2).

A comparison with the least favoured forested area, *old Tertiary* (Table 4), shows that all but three native species preferred the forested area. The *cutover* area had a poor representation of species, low counts and few species preferring the area.

TABLE 4 — Native species which gave higher counts in **Old Tertiary** and **cutover** forest.

	Old Tertiary	Cutover
	parakeet*	Tomtit
	Grey Warbler	Silvereye
	Fantail	Shining Cuckoo
	Bellbird	
	Tui	
	Robin	
	Weka	
	Kingfisher	
Number of native species	8	3

* Significantly higher.

FACTORS ASSOCIATED WITH THE VARIATION IN BIRD NUMBERS

FORESTED AREAS

The general trend for native species was an increase in counts from *old Tertiary* to *coastal* to *karst* to *limestone talus.* The vegetation summary in Table 1 shows from *cutover* through old *Tertiary, coastal, karst* to *limestone talus:*

1. An increase in emergent and canopy heights,
2. An increase in canopy cover, and
3. An increasing representation of vegetative layers.

Apart from in *cutover,* these factors all reflect an increase in soil fertility in the same sequence.

Table 5 shows that insectivorous species showed a marked and consistent preference for the higher fertility sites within the synclinal basin. The high vegetation volume on fertile sites probably supports a large number of insects.

The dominant species of tree changed markedly in the counted areas. Table 6 is a summary of those trees forming the bulk of the vegetation in the canopy, subcanopy and upper understoreys. Red beech is prominent as a large canopy tree in both the areas most favoured by birds (*karst* and *limestone talus*) and is absent, replaced by a rimu canopy, in the least favoured forested area (*old Tertiary*). Hard beech, often indicative of less fertile sites on ridge tops and terrace edges, is present in all but the most favourable bird habitat in the syncline.

A transect conducted on a single day mainly through *karst* and dissected *Tertiary hill country* supported the view that the best bird habitat is the tall closed-canopy red beech forest and the least

TABLE 5 — Counts of insectivorous species in increasingly fertile sites. (Average number per 5-minute count.)

	Old Tertiary	Karst	Limestone Talus
	increasing		fertility
Tomtit	0.95	1.8	3.1
Grey Warbler	1.7	2.0	2.8
Fantail	0.79	0.86	1.0
Silvereye	0.21	2.1	4.8
Rifleman	0	0.43	0.53

TABLE 6 — Dominant tree species.

Cutover	Old Tertiary	Coastal	Karst	Limestone Talus
rimu	rimu	northern rata	red beech	red beech
hard beech	silver beech	rimu	silver beech	silver beech
silver beech	hard beech	kamahi	hard beech	
	kamahi		kamahi	
	quintinia			

favourable is the relatively low open rimu forest. The results are given in Table 7.

In coastal forests, the relatively low counts of birds agree to some extent with this effect of the structure of the vegetation. The canopy is quite low, though moderately closed and the vegetative layers are not fully represented. The tree species are markedly different (Table 7) and the absence of beech could account for the absence of parakeet, Kaka and Rifleman.

Most of the native species and the Blackbird show some conformity with the pattern of increasing numbers with increased vegetation volume and a larger proportion of red beech. The following species, however, showed some departure from this pattern.

Robin

Robins prefer *karst,* occur in moderate numbers in *old Tertiary* and *limestone talus* and are absent from the *coastal* vegetation apart from an occasional singing male in spring. My observations elsewhere show the distribution of robins in the south-west Paparoas to be patchy. Maximum numbers occur in the lowland forest in the syncline and on the low terraces of the major rivers. Small numbers are thinly distributed over the hill country to the east of the syncline, often associated with saddles or high terraces. Very few have been recorded above 800 m in silver beech forest on greywacke, but small numbers occur in montane forest on granite. A common factor is their preference for gentler topography.

For a predominantly ground-invertebrate feeder an association with a thick litter layer might be expected. Steep slopes and ridge tops are less conducive to litter accumulation than gentler topography. In the *coastal* vegetation ridges are sharp and slopes steep. Possible valley sites for robins have been cleared for agricultural use.

Bellbird

Bellbirds preferred the *coastal* forest, gave lowest counts in *old Tertiary,* and slightly lower counts in *limestone talus* than *karst.* Gravatt (1970) found that on Little Barrier Island, Bellbirds were taking nectar 50.7% of the feeding time and insects 44.4%. An explanation for the coastal preferences would be the abundance of nectar-bearing plants. Northern rata, *Metrosideros fulgens, M. diffusa, M. perforata,* kamahi, kowhai, fuschia, flax, clematis and hinau are all common in or near coastal forest. Only *Metrosideros fulgens* and kamahi are present in the other vegetation types in significant amounts. But Dawson *et al.* (1978) found Bellbird counts as high or significantly higher in areas at Reefton (Table 2) where none of these coastal nectar-

TABLE 7 — A transect through Karst and dissected Tertiary Hill Country The same ten count sites are classified according to first canopy height, then red beech in the canopy, and finally rimu in the canopy. One site was not readily assessed for canopy height and is omitted.

Canopy height	10 m	13 m	17 m	20 m	23 m
Average count	6.5	6	13	14	18.5
Number of species	6	5	9	10	13
Number of counts	2	1	2	2	2

Estimated percentage of red beech in canopy	0	10	15	20	40	60	70	90
Average count	6.5	10	6	15	14	13	12	18.5
Number of species	6	6	5	8	7	8	6	13
Number of counts	2	1	1	1	1	1	1	2

Estimated percentage of rimu in canopy	0	<5	25	30+
Average count	18.5	12.8	6.5	6
Number of species	13	14	6	5
Number of counts	2	5	2	1

bearing trees occur. Honeydew fungus is present at Reefton but is not a common feature in the forests of the Porarari area.

Tui

The Tui might be expected to show the same preference for coastal forest as the Bellbird, especially as Gravatt (1970) found that nectar feeding comprised 81.1% of all observations. But the lowest average counts in this study were from *coastal* forest. This may have been a seasonal anomaly, for Tuis are very mobile throughout the Punakaiki-Porarari area. In October before the counts began Tuis were present in large numbers feeding on nectar in the coastal forest. Gravatt (1970) showed that 96.4% of spring (August to October) observations were of nectar feeding whereas insect feeding increases to 23.4% in summer (November to January). This suggests that Tuis move to areas of maximum insect abundance (? non-coastal forests) to breed.

Other species

The small counts of Kaka and parakeet indicate a preference for *karst,* but the differences were not significant. Continuing casual observations suggest that both species are conservative in their choice of summer (breeding) territories and the differences in counts seem to be real. Their absence in the *coastal* forest could be due to the lack of beech.

Chaffinches show a preference for *coastal* and *karst* over *old Tertiary* and *limestone talus.* Their preference for *coastal* forest could be due to the proximity of cutover and agricultural land, especially as they gave such high counts in the modified *cutover near the road.*

Kaka, parakeet, Bellbird and Chaffinch were seen taking a variety of food: nectar, fruit, buds, insects and seeds. Their habitat preferences seem to be more complex than those of the purely insectivorous species.

CUTOVER AREAS

The low counts in cutover forest fit in well with the general trend to lower numbers in low, open-canopy, poorly layered forest with an absence of red beech. A summary of these vegetation factors is given in Tables 1 and 6, indicating that *cutover* is least favourable.

Those species occurring in *cutover* are common in much of New Zealand and have shown themselves adaptable to isolated patches of native forest, to exotic forest and, in the case of Fantail, Grey Warbler and Silvereye, to farmland and gardens.

Open-country species are present in the most modified area near the road — Grey Duck, Kingfisher, Redpoll, Skylark, Hedge-sparrow, Starling, Yellowhammer and House Sparrow. Blackbird, Chaffinch and Song Thrush also favour the more open areas with bare ground and introduced grasses and seeding herbaceous plants.

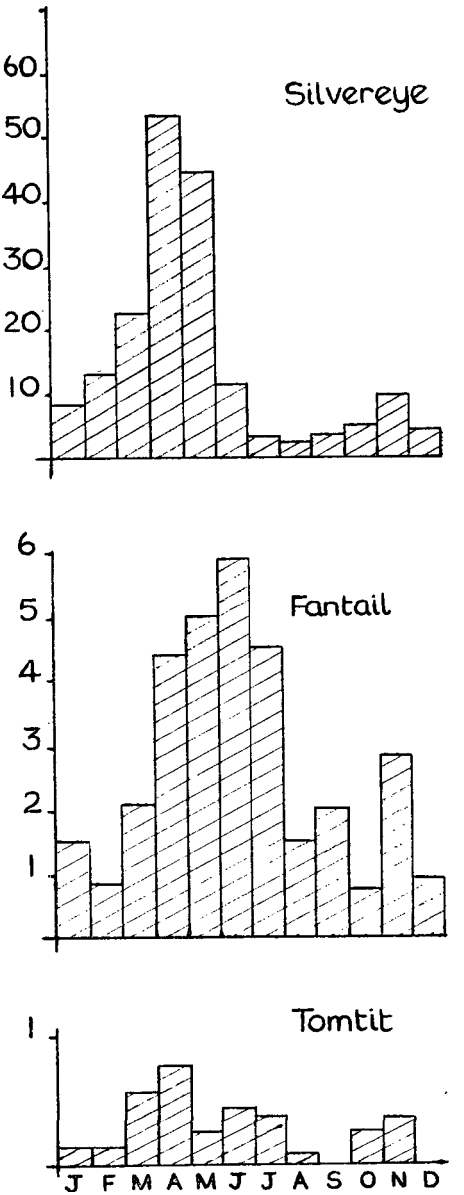

FIGURE 5 — Monthly counts in "Coastal" forest over a 2.8 km transect expressed as birds/km. June 1976 to May 1978. Number of counts, 72.

Relatively high counts of Tomtits occurred in both cutover areas. The flycatching method of feeding by pouncing at prey some distance away from an observation post could benefit from a relatively open parkland-type situation. Tomtits, however, are not successful in nearby farmland; they adapt only partly to modified habitats.

The moderate counts of Tuis and Bellbirds were of birds associated with nearby forested areas feeding on flowering flax near the road. Robins occurred in small numbers in the cutover in an area of mature manuka with an open understorey, uncharacteristic of the area as a whole. As this species does not occur in large expanses of manuka habitat in the Charleston area (20 km to the north), it is probably an overflow population from the nearby *karst*.

SEASONAL DIFFERENCES

Casual observations suggest that there is a partial redistribution of birds in the forest types in autumn, winter and spring.

Figure 5 shows the increase of Fantails, Silvereyes and Tomtits in *coastal* forest in autumn and winter. Fantails and Tomtits are presumably feeding on the more abundant insect life in the warmer, frost-free coastal zone. Silvereyes feed on the abundant small fruits of kahikatea and *Coprosma propinqua, australis, robusta* and *lucida* in March, April and May. Pigeon numbers increase in autumn and winter in *coastal* forest, feeding on hinau, miro and pigeonwood, and in spring on kowhai. Tuis increase in numbers in spring. Brown Creeper records in the *coastal* forest occur after infrequent heavy snowfalls in their favoured habitat of silver beech forest in adjacent hill country.

Within the forests of the syncline, Fantails move to rivers and warmer scarp edges. In some years, small flocks of parakeets occupy the *old Tertiary* forest in winter, feeding on the growing tips of podocarps and seeding grasses. In the winter of 1979, however, many pairs remained in their breeding territories. Introduced finches — Goldfinches, Redpolls and, to a lesser extent, Greenfinches, occur in large numbers in *old Tertiary* forest in autumn and winter. The large numbers of Silvereyes in summer in *limestone talus* forest start to disperse at the end of February at a time when breeding has ended and fruit becomes more important in their diet.

Similar patterns of movement were suggested by Dawson *et al.* (1978) in Reefton forests for Silvereyes, Tomtits, Tuis, NZ Pigeons and parakeets. They found no evidence of Fantail movement but recorded seasonal differences for Grey Warbler and Kingfisher. Most Silvereyes probably leave the Reefton forests in winter for areas similar to the *coastal* vegetation where I found them to increase. Tuis were found to disperse into hill country forest in October, and I noted a similar movement from *coastal* to inland forests in November in the Porarari area. NZ Pigeons were rarely seen in Reefton forests in late winter and spring, when they are numerous in *coastal* forest.

Thus the *coastal* forest and to a lesser extent the *old Tertiary* forests are important for birds in winter.

COMPARISON WITH OTHER AREAS

The only comparable data come from work by Dawson *et al.* (1978) near Reefton, on the eastern side of the Paparoa Range. The Reefton December counts are given in Table 2 for comparison with the forests at Fletcher's Creek, Te Wharau and Reefton Saddle. Interpretation of the contrast should be careful as differences in the observer, year, times and weather conditions would account for some difference.

Species composition

The number of species present in all three Reefton areas was similar to that of the *karst* and *limestone talus* forests of the Porarari. The Reefton areas show better species representation than *old Tertiary* and *coastal* forests. As a species list increases with an increasing number of counts as rarer birds are encountered (Fig. 2), so the Reefton areas are not as rich as a simple comparison would suggest because many more counts were made at Reefton than at Porarari.

TABLE 8 — Preferred habitats.

Porarari area				Reefton area		
Old Tertiary	Coastal	Karst	Limestone Talus	Fletcher's Creek	Te Wharau	Reefton Saddle
	Shining Cuckoo	Robin*	Grey Warbler*	Fantail		
		Para-keet*	Tomtit*	Kingfisher		Bellbird*
		Kaka	Tui*			
		Brown Creeper	Weka*			
			Pigeon*			
			Rifleman			
			Silvereye			
No. of species: 0	1	4	7	2	0	1

* significantly higher than counts on the other side of the Paparoa range.

Numbers counted

Table 8 lists those species preferring one habitat above all others. It again indicates that *limestone talus* is an important area for the commoner native species and *karst* for the species of higher conservation interest, even in this wider context. Grey Warblers are especially numerous on the western side of the range with counts indicating about twice as many birds in all areas as in the east. High numbers of

Robin and parakeet in the *karst* and Tomtit and N.Z. Pigeon in the *limestone talus* are especially notable. Only the Bellbird counts are consistently high in the Reefton areas.

Old Tertiary vegetation had lower counts than all Reefton areas for Bellbird, Silvereye, Blackbird and Chaffinch but higher counts for Grey Warbler, Tui, Robin, parakeet and Weka. It therefore seems regionally important for the native species, Robin and parakeet.

Coastal forest has a lower count than all the Reefton areas for Fantail and Silvereye, and higher counts for Grey Warbler, Weka, Shining Cuckoo, NZ Pigeon and Chaffinch.

Discussion

Limestone talus and *karst* look better bird habitats than those counted at Reefton, and *old Tertiary* and *coastal* forest compare favourably in some respects.

Although temperature records are not available for the Porarari area, the moderating influence of the sea, the lack of cold air drainage, the relatively low incidence of silver beech in the canopy, and the occurrence of certain shrubs (e.g. pigeonwood and *Coprosma australis*) in favoured pockets, suggest that the climate is warmer and subject to fewer extremes than the Reefton forest's.

At Reefton, lower night-time temperatures and especially frosts may depress insect abundance. The insectivorous species, however, do not show a simple preference for the warmer Porarari forests. Tomtit, Fantail, Silvereye, Blackbird and Song Thrush all gave higher counts in some of the Reefton forests than in some of the Porarari forests, as did the partly insectivorous Bellbird and Chaffinch.

An examination of the vegetation descriptions for the Reefton area suggests that low fertility sites were included in all count transects. Red beech forms less than 25% of canopy cover in all areas. Hard beech forms 25% of the canopy at Reefton Saddle and 50% at Te Wharau, while yellow silver pine and southern rata, both indicative of low fertility sites, occur at Te Wharau.

The pattern of bird abundance at Reefton probably agrees with the pattern of low bird numbers in infertile sites as found in the Porarari area. The definition of vegetation types in the Reefton study was not clear enough, however, to show this unambiguously.

CONCLUSION

Reserve Considerations

The comparison between cutover and forested areas shows that intact native forest reserves are necessary for the conservation of a full representation of native bird species in high numbers.

Species that must be given special consideration in reserves are those that do not adapt to modified habitats: Robin, parakeet, Kaka, NZ Pigeon, and to a lesser extent Tui, Bellbird, Brown Creeper, and

Rifleman. Optimal habitat in this district for Brown Creeper and Rifleman is outside the study area in montane silver beech forest (pers. obs.) and is mainly Protection Forest.

High-density areas of the commoner species — Tomtit, Grey Warbler, Fantail, Silvereye, Bellbird, Tui and Weka are also necessary as population reservoirs against times of lowered densities due to weather, disease, etc.

In selecting habitats to reserve, an assessment of the best areas for native birds in the breeding season could be made as follows:

(i) *Limestone talus.* Good species representation with the common species in high numbers and all the special native species in moderate numbers. Preferred habitat for the majority of species.

(ii) *Karst basins.* Good species representation with moderate to high numbers of the common species. The preferred habitat for the special native species Kaka, Robin and parakeet.

(iii) *Coastal.* Poorest species representation. Robin, parakeet and Kaka absent. Moderate counts for most common species. Preferred habitat only for Bellbirds, which, in any case, are common in all other habitats.

(iv) *Old Tertiary.* Moderate species representation with Kaka the only special species absent. Low counts for most species.

The comparison with Reefton forests shows that *karst* and *limestone talus* areas are regionally important bird habitats.

The counts in this study show habitat preferences of breeding birds, but reserves must also take into account birds' requirements throughout the year. Observations on seasonal movements suggest that *coastal* and, to a lesser extent, *old Tertiary* habitats are more important in autumn, winter and spring.

New Zealand already has a remnant bird population with a great decline in abundance of many forest birds and the complete disappearance of others. Locally, Phillips (1948) wrote of prolific quantities of Kaka, parakeet and NZ Pigeon, and the presence late last century of Saddleback, Red-crowned Parakeet, Piopio and Bush Wren. Penniket (1955) adds Kakapo in the 1930s.

In the Paparoa district the Protection Forest does not provide adequately for all the bird species because only Rifleman, Brown Creeper and Bellbird occur in it in high numbers. The remnant lowland forest contains high numbers of birds and has good species representation. This study shows that within lowland forest there are favoured and less favoured bird habitats. Great care must be taken to include these favoured habitats in any reserve proposals, if healthy populations of all native species of birds are to be maintained.

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APPENDIX I. LANDFORM

The non-coastal lowland forest is contained within a syncline of soft mudstones, siltstones and sandstones of Miocene age overlying harder limestones of Oligicene age (Bowen 1964 and Fig. 3).

The major geomorphic processes historically affecting the forests are

1. A marine planation that left a rather flat expanse of soft mudstones, siltstones and sandstones. There is little lateral dissection with Cave Creek South meandering in a steep-sided gorge. Consequently, there is little soil renewal and much leaching to a rather infertile soil. Marked as *Planed Tertiary Surface* on Fig. 3.

2. A gentle ridge system that has developed on thin soft Tertiary deposits overlying limestone, where the limestone drainage pattern is dominant. Leaching is less prominent and soil renewal through lateral erosion greater. Therefore, fertility is generally high and especially so in the inland drainage basin. Marked as *Tertiary Karst Basin* on Fig. 3.

3. A steeper ridge system that has developed where the soft Tertiary deposits are thicker and the limestone drainage pattern is less dominant. Soil fertility is variable; least fertile on the sharp ridge-tops and more fertile in the wider valleys. Marked as *Dissected Tertiary Hills* on Fig. 3.

4. The massive slumping of Miocene and limestone sediments at the base of the inland limestone scarp, over-running the marine planed surface. These sediments are more fertile than the planed surface. Marked as *Slumped Limestone Sediments* on Fig. 3.

5. Deposits of Pleistocene gravels of varying thickness overlying the soft mudstones, siltstones and sandstones to the north of the area, near Bullock Creek. Leaching is considerable on these porous flat gravels and the soil is relatively infertile.

APPENDIX II. VEGETATION

The following information is based on a survey by G. N. Park, Botany Division, DSIR. A full account and detailed map appear in Park & Bartle (1978).

OLD TERTIARY

Rimu (kahikatea)/hard beech-silver beech forest

Rimu trees reaching a height of 30 m are visually dominant, although their canopy cover is usually less than 50%. On well-drained sites hard beech increases. Hall's totara occasionally occurs in the 20-25 m hard beech-silver beech lower canopy. The subcanopy is mainly kamahi and quintinia with a few miro. Important understorey species are quintinia, mountain toatoa, toro, lancewood, *Cyathea smithii* and *Dracophyllum townsoni*. There is little rimu regeneration. Common ground species are *Blechnum discolor, Gleichenia cunninghamii* and *Dianella intermedia.*

On ridge crests, remnant gravels and more poorly drained sites, small areas of the following type were intermixed irregularly with the above.

Rimu (kahikatea)/hard beech-mountain beech-yellow silver pine forest

More poorly drained soils than those with a major hard beech element support mountain beech and yellow silver pine, with a few silver pine, cedar, southern rata and Hall's totara. Hard beech is less important than above and silver beech is rare. Few rimu are greater than 70 cm diameter at breast height (Dbh) and there is little rimu regeneration relative to that of hard beech and mountain beech. The sparse subcanopy of kamahi, together with the very uneven canopy, gives the vegetation a characteristic open structure. Mountain toatoa, manuka, quintinia, broadleaf, *Dracophyllum townsoni, D. longifolium, Coprosma* cf. *parviflora* and *Myrsine divaricata* dominate over an uneven ground layer of *Gahnia procera, Phormium cookianum, Blechnum capense* and an extensive cover of bryophytes.

KARST

Red beech/silver beech forest

This occurs throughout the karst basins west of Cave Creek. It is distinctive because of the virtual absence of rimu. Huge buttressed trees of red beech 25-30 m tall dominate the multitiered forest and contribute about 70% of the crown cover. The other 30% is a 15-20 m subcanopy layer of silver beech, with some kamahi. Kamahi dominates the upper understorey. *Cyathea smithii,* toro and horopito are major elements in the lower layer. An open lower understorey consists of horopito, toro, *Coprosma* cf. *parviflora, Dicksonia squarrosa,* putaputaweta *Neomyrtus pedunculata, Blechnum discolor, Leptopteris*

superba, Microlaena avenacea and *Uncinia* spp. Filmy ferns, *Astelia solandri* and *Phymatosorus diversifolius* are the only epiphytes.

(Rimu)/red beech/silver beech forest

The valley floors in the more dissected low hill country adjoining the karst basins support forest that is very similar except for the addition of rimu and a more open canopy.

(Rimu)/hard beech-red beech-silver beech forest

Much of the lightly dissected hill country supports an open forest where hard, red and silver beech are co-dominant over a wide area. The forest is not otherwise distinctive. The upper and lower understoreys are dominated by kamahi and *Cyathea smithii* respectively over a dense ground layer largely of *Blechnum discolor.*

LIMESTONE TALUS

Rimu-kahikatea/red beech/silver beech forest

At the edge of the debris flow a tall multitiered forest adjoins the *old Tertiary* type.

The dominant tree is rimu, but it contributes as little as 10% to the crown cover . Together with kahikatea, rimu forms an emergent layer 40-45 m tall over the main canopy layer 30-35 m tall formed by very large diameter red beech. Most of the red beech in this very impressive forest are 1.8-2.0 Dbh with a few trees up to 2.5 Dbh. The rimu and kahikatea are largely 0.8-1.0 m Dbh.

Silver beech forms an important subcanopy and upper understorey element in the form of heavy-boled trees 25-30 m tall. The other understorey layers are

10-15 m — sparse kamahi with pole rimu and silver beech;
5-8 m — dense *Cyathea smithii* with toro, quintinia and lancewood; and
1.5-4 m — dense horopito, with toro and *Cyathea smithii.*

There is a very dense ground layer of *Blechnum discolor, Microlaena avenacea* and *Uncinia* spp. Filmy ferns are abundant as trunk epiphytes. *Phymatosorus diversifolius* and *Astelia solandri* occur on the larger trees.

COASTAL FOREST

Rimu (northern rata)/(hinau)/kamahi forest

Large areas of the steeper hill country above the coastal scarp north and south from Punakaiki support a complex forest from which beech is absent. The composition and structure of these forests are variable. As well as rimu, northern rata, hinau and kamahi, miro, matai, quintinia, putaputaweta and pigeonwood can be important. Mahoe, *Coprosma australis,* toro, supplejack and kiekie are the predominant understorey species. The emergent northern rata and rimu are usually large spreading trees with abundant epiphytes — kiekie, supplejack, *Metrosideros fulgens* and *M. diffusa. M. diffusa* often forms a ground cover. Nikau is present in the gully heads.

CUTOVER FOREST

Most of the cutover forest was originally *rimu (kahikatea)/hard beech-mountain beech-yellow silver pine forest* (see *old Tertiary* vegetation description). Exact dates of cutting are not available, but logging appears to have taken place in at least two phases between 2 and 20 years ago. Two distinct types of cutover have been recognised:

(a) *Cutover near the logging road.* The structure of the vegetation is very open with one 10 m tree every 30 m or so and a shrub layer up to 3 m high. The ground tends to be bare or waterlogged. Rimu predominates, with some kahikatea, miro, and the odd yellow silver pine. Manuka, lancewood, *Dracophyllum,* mountain toatoa, kamahi, and *Coprosma* n.sp. aff. *parviflora* are abundant in the shrub layer.

(b) *Cutover away from the road.* The structure of the vegetation is less open, with scattered rimu, miro, red beech and hard beech, emergent over a broken canopy of silver beech. Manuka, mountain toatoa, kamahi, lancewood, rimu, kahikatea and *Coprosma propinqua* are common over a dense layer of flax, cutty grass and *Coprosma* n.sp. aff. *parviflora,* although the density of the ground layer is inversely proportional to the amount of manuka. In places, manuka forms a dense canopy at 5 m with areas of *Gleichenia* or open ground beneath. This type of cutover is simply called *cutover* in the text.

The main difference between these two types of cutover vegetation is in the ground cover. Away from the road the presence of large amounts of dead wood with little subsequent disturbance has led to the development of a thick ground layer (about 1 m tall) of cutty grass, bush lawyer, *Gleichenia* and *Blechnum.* There is very little open ground and no litter layer accessible to birds.

Subsequent disturbance in the form of burning, seeding, and grazing near the road has resulted in an open ground layer with sedges and grasses interspersed with bare gravels and temporary muddy pools. Many introduced species (thistles, ragwort, Compositae) have colonised along the road.

APPENDIX III — MEAN NUMBERS OF SOME SELECTED SPECIES PER STATION AND SIGNIFICANCE TESTS (chi-squared tests) ON SPECIES TOTALS. Significant differences are indicated by breaks in what would otherwise be a continuous line. Vegetation types linked by an unbroken line did not show significant differences in numbers.

Yellow-breasted tit		Silvereye		Kaka	
Limestone talus	3.1	Limestone talus	4.8	Karst	0.5
Cutover near road	2.3	Karst	2.1	Limestone talus	0.1
Karst	1.8	Coastal	1.4	Old Tertiary	0
Cutover	1.5	Cutover near road	0.6	Coastal	0
Coastal	1.3	Cutover	0.4	Cutover near road	0
Old Tertiary	1.0	Old Tertiary	0.2	Cutover	0

Grey Warbler		Tui		Weka	
Limestone talus	2.8	Limestone talus	1.1	Limestone talus	0.3
Coastal	2.5	Karst	0.9	Karst	0.1
Karst	2.0	Old Tertiary	0.8	Coastal	0.1
Cutover near road	2.0	Cutover near road	0.8	Old Tertiary	0.1
Old Tertiary	1.7	Cutover	0.6	Cutover near road	0.1
Cutover	1.1	Coastal	0.4	Cutover	0

Fantail		Robin		Rifleman	
Limestone talus	1.0	Karst	1.4	Limestone talus	0.5
Karst	0.9	Old Tertiary	0.6	Karst	0.4
Old Tertiary	0.8	Limestone talus	0.6	Old Tertiary	0
Cutover near road	0.7	Cutover	0.2	Coastal	0
Coastal	0.6	Cutover near road	0	Cutover near road	0
Cutover	0.6	Coastal	0	Cutover	0

Bellbird		Yellow-crowned Parakeet		N.Z. Pigeon	
Coastal	3.2	Karst	0.7	Limestone talus	0.9
Karst	2.4	Old Tertiary	0.3	Karst	0.4
Limestone talus	2.1	Limestone talus	0.2	Coastal	0.2
Cutover near road	1.3	Coastal	0	Old Tertiary	0
Old Tertiary	1.2	Cutover	0	Cutover	0
Cutover	0.7	Cutover near road	0	Cutover near road	0

Chaffinch		Blackbird		Song Thrush	
Cutover near road	3.5	Cutover near road	2.6	Cutover near road	1.6
Coast	1.1	Limestone talus	1.5	Cutover	0.4
Karst	1.0	Cutover	1.2	Karst	0.2
Cutover	1.0	Coastal	1.2	Limestone talus	0.2
Old Tertiary	0.5	Karst	1.1	Old Tertiary	0.1
Limestone talus	0.3	Old Tertiary	0.5	Coastal	0.1

APPENDIX IV — GLOSSARY OF BIRD NAMES

Grey Duck	*Anas superciliosa*	Grey Warbler	*Gerygone igata*
Weka	*Gallirallus australis*	Fantail	*Rhipidura fuliginosa*
N Z Pigeon	*Hemiphaga novaeseelandiae*	Yellow-breasted tit	*Petroica m. macrocephala*
Kakapo	*Strigops habroptilus*	Robin	*Petroica* (miro) *australis*
Kaka	*Nestor meridionalis*	Song Thrush	*Turdus philomelos*
		Blackbird	*Turdus merula*
Red-crowned Parakeet	*Cyanoramphus novaezelandiae*	Silvereye	*Zosterops lateralis*
Yellow-crowned Parakeet	*Cyanoramphus auriceps*	Bellbird	*Anthornis melanura*
Shining Cuckoo	*Chrysococcyx lucidus*	Tui	*Prosthemadera novaeseelandiae*
Kingfisher	*Halcyon sancta*	Yellowhammer	*Emberiza citrinella*
Rifleman	*Acanthisitta chloris*	Chaffinch	*Fringilla coelebs*
Bush Wren	*Xenicus longipes*	Redpoll	*Carduelis flammea*
Skylark	*Alauda arvensis*	House sparrow	*Passer domesticus*
Hedgesparrow	*Prunella modularis*	Starling	*Sturnus vulgaris*
		Saddleback	*Philesturnus carunculatus*
Brown Creeper	*Finschia novaeseelandiae*	Piopio	*Turnagra capensis*

APPENDIX V — GLOSSARY OF PLANT NAMES

umbrella fern	*Leptopteris superba*
	Gleichenia cunninghamii
	Dicksonia squarrosa
	Cyathea smithii
	Phymatosorus diversifolius
	Blechnum capense
	Blechnum discolor
cedar	*Libocedrus bidwillii*
Hall's totara	*Podocarpus hallii*
miro	*Podocarpus ferrugineus*
matai	*Podocarpus spicatus*
kahikatea	*Podocarpus dacrydioides*
rimu	*Dacrydium cupressinum*
yellow silver pine	*Dacrydium intermedium*
silver pine	*Dacrydium colensoi*
mountain toatoa	*Phyllocladus alpinus*
horopito	*Pseudowintera axillaris*
pigeonwood	*Hedycarya arborea*
mahoe	*Melicytus ramiflorus*
manuka	*Leptospermum scoparium*
southern rata	*Metrosideros umbellata*
northern rata	*Metrosideros robusta*
	Metrosideros fulgens
	Metrosideros diffusa
	Metrosideros perforata
rohutu	*Neomyrtus pedunculata*
hinau	*Elaeocarpus dentatus*
kamahi	*Weinmannia racemosa*
putaputaweta	*Carpodetus serratus*
quintinia	*Quintinia acutifolia*
bush lawyer	*Rubus* sp.
mountain beech	*Nothofagus cliffortioides*
red beech	*Nothofagus fusca*
hard beech	*Nothofagus truncata*
silver beech	*Nothofagus menziesii*
lancewood	*Pseudopanax crassifolium*
broadleaf	*Griselinia littoralis*
inanga	*Dracophyllum longifolium*
	Dracophyllum townsonii
toro	*Myrsine salicina*
	Myrsine divaricata
kanono	*Coprosma australis*
karamu	*Coprosma lucida*
	Coprosma robusta
	Coprosma n.sp. aff. *parviflora*
	Coprosma propinqua
	Senecio jacobaea
	Astelia solandri
	Dianella intermedia
flax	*Phormium cookianum*
nikau	*Rhopalostylis sapida*
supplejack	*Rhipogonum scandens*
kiekie	*Freycinetia banksii*
	Gahnia procera
cutty grass	*Carex coriacea*
bush grass	*Microlaena avenacea*

D. J. ONLEY, *Madman's Farm, Little Totara River, Private Bag, Westport.*