WINDY HILL ROSALIE BAY CATCHMENT TRUST

BIRD COUNTS

DECEMBER 2008

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INTRODUCTION

This report is the first in which data analysis and reporting has not been carried out by by ECoRAP (Dr S. Ferreira; sometimes in association with Anne-Marie Smit). It describes the monitoring results for December 2008. The previous reports cover the period from the commencement of monitoring in 2000 to June 2008. The overall conclusions to be drawn from these earlier reports are:

(1) that total bird numbers increased in the year following the introduction of pest management, but;
(2) the rate of increase was not continued, although the greater abundance of birds after pest management was maintained for at least 4 years[1] and probably longer.
(3) The effectiveness of pest control in the management area was further confirmed by monitoring a control (unmanaged) area, which was found to have fewer bird species generally at lower densities.
(4) The proportion of introduced bird species appeared to decline over the eight year period.

A summary of the main conclusions from the previous work is given in EcoRAP report: EC0006/12-8. *Bird Counts June 2008* (September 2008[2]). Other conclusions regarding differences in bird communities between ridges and valleys, or between transects at Benthorn farm, the 'Robin Area'[3] and the 'Control Area', can be drawn from the various EcoRAP reports, but a full analysis and critical discussion of these is outside the scope of this report.

The Little Windy Hill Trust (WHT) is a private conservation organisation concerned with pest eradication and ecosystem restoration on several properties in south-east Great Barrier Island covering c. 300ha. The trust employs a small staff, mainly engaged in pest eradication, but also monitoring birds and other organisms.

The management of pests on the properties at Little Windy Hill (WH) began in 1999, and has been expanded to cover progressively larger areas and the additional property at Benthorn Farm. A Report on the success of rat eradication was prepared in 2005 (Ogden, J. & Gilbert, J. 2005. *Rodent trapping results from Windy Hill and Benthorn farm, Great Barrier Island: 1999-2004*.). The conclusions from that report, the imperative to protect newly introduced robins, and marked improvements in the technology for effectively controlling rats with poisons, led to the commencement of pulsed toxin applications in 2005. The initial success of this regime of trapping with pulsed toxins has apparently been maintained. Further studies of the Windy Hill ecosystem indicate improvements in vegetation (seedling density), and greater numbers of wetas, other large invertebrates and skinks compared to the control site (Ogden, J. & Gilbert, J. 2009. *Prospects for the eradication of rats from a large inhabited island: community based ecosystem studies on Great Barrier Island, New Zealand*. Biological Invasions: *In press.).*

[1] Pest management was instigated in different years in different parts of the Windy Hill area.
[2] Not all the conclusions therein are obviously supported by the earlier Reports.
[3] North Island Robins (*Petroica longipes*) were introduced to Windy Hill in 2004.

The vegetation of most of the Windy Hill area comprises tall 'scrub' – relatively young forest dominated by manuka (*Leptospermum scoparium*) and kanuka (*Kunzea ericoides*). This mostly dates from the abandonment of farming in the 1940s. Manuka was the first forest cover to establish, and is now predominantly on the ridges. Kanuka tends to invade later and live longer, and is now the dominant canopy over most of the landscape, especially in mid-slope positions. Remnants of broadleaf (mostly Taraire *Beilschmeidia tarairi*, Kohekohe *Dysoxylum spectabile* and Puriri *Vitex lucens*) and podocarp (mostly Kahikatea *Dacrycarpus dacrydioides*) forest survived the farming on some upper slopes and in gullies. These species, and other successional trees such as *Coprosma arborea,* are currently establishing populations within the mature kanuka. Thus, as a first approximation, we can describe the vegetation as forest, forming a continuum from manuka dominance on ridges, through kanuka, to progressively richer and taller forest, especially in the valleys (Davy, unpublished thesis 2008; Perry, Davy & Ogden, in preparation). However, the composition and structure of all the forest types is changing as succession towards more mature canopies continues, and this needs to be kept in mind when assessing changing bird abundances.

Bird monitoring has played an important part in evaluating the management actions of the WH Trust since 2000. Monitoring has been carried out over (some of) the same transects over this whole period. Although some additions to the sample transects have been made through time, the necessity to compare different areas and vegetation types, and to replicate bird counts both spatially within a locality (eg ridge or valley) and at different seasons, has been recognised throughout the study, making this one of the longest and most comprehensive bird monitoring studies on private land in New Zealand.

Data Collection

The eighteen bird transects are each 150m in length, with four counting stations (points marked by a stake) separated by 50m. The stations are counted at least twice per year (June and December)[4]. At each counting station in each season, six repeats are made over a period of c. one week (Table 1). The survey technique is as follows:

- At each station, birds are counted for 3 minutes.
- Individuals heard and seen are recorded, with care taken to ensure that each individual is recorded once only.
- For each bird recorded, the distance from the station to the bird is estimated in 5m classes as follows: 0 -5m, <5-10m, <10-15m, <15-20m, <20-25m.
- No birds are recorded if beyond 25m, nor are birds recorded between stations.

Thus, bearing in mind the difficult of visually or audibly assessing station-bird distances, each station surveys an area of approximately $50m^2$, and the four stations on transect cover approximately one hectare (actually 0.78 ha.)

[4] Stations were surveyed more frequently early in the study (2000 – 2002).

Data analysis

In previous reports, various statistical tests have been applied in an attempt to draw rigorous conclusions. However, those reports also emphasise the variability and non-normality inherent in the data. Generally only tentative conclusions have been reached. The tendency has been to rely more on consistency of trends, both in comparing changes following pest treatments, and in comparisons between locations and with the 'control' (un-managed) area. Consistent trends over time might have ecological meaning even when high sample variances rule out strict statistical significance. This approach is followed in this report, although full comparison of trends over the whole period of the study is not included.

Table 1. Summary of sample arrangement and numbers

Location	Total number of transects	Total number of stations	Total number of Counts per seasonal sample	Notes
Windy Hill, ridges	6	24	144	3 transects each in two catchments
Windy Hill, valleys	6	24	144	3 transects each in two catchments
Benthorn farm	2	8	48	One ridge, one valley
Robin area	2	8	48	Replicate transects
Control	2[5]	8	48	Replicate transects
Totals	18	72	432	Total = 18 x 4 x 6

One important reason for adopting a simplified approach to data analysis and presentation is that there are serious doubts as to how reliable the data are for estimating 'true' density (numbers per ha.). This is because what is really being measured is the 'conspicuousness' of the different species.

Conspicuousness can vary with season, for example many birds sing in spring but not in late summer, so that even relative values between species, or between counts of the same species at different times of year, are often difficult to interpret: they do not usually reflect the *actual number* of birds present. Also, there is quite a big element of chance in what is present at any site for the three minutes counted, which varies with time of day, weather conditions etc. Consequently it is important to replicate counts and to be cautious in interpretation. Ideally counts should all be made by the same observer, and replication should be at the same time of day.

In the WH study a total survey sample comprises 432 three-minute counts, representing a total of 21.6 hours of actual observation. Getting to and from the transects, and

[5] In 2008 this was reduced to 1 transect, ie 24 total counts.

between the stations, doubles or trebles the person-hours actually involved in each survey. Spreading the work between three or four observers over a week has the advantage of 'averaging out' differences due to weather and possible differences in observer ability[6].

For assessing trends over years, the counts should all be made at the same stations and season. Although additional transects have been added, this protocol has been followed, with some counts made in June and December at the same stations in each year since 2001.

Two ways of summarizing the data are possible:

1) *Count frequency:* frequency for a species based on the number of times a species was recorded as present at a site, divided by the total number of site-counts (eg, if a bird was seen or heard on 25 occasions at the 144 station counts on Windy Hill ridges, it would have a frequency (on WH ridges) of 25/144 = 17.4%)
2) *Density(estimated number per hectare)*: based on the sum of the numbers counted on transect lines at any one time (rather than simply 'present'). Because each transect of four stations samples .78 hectare and is replicated six times at each sample period, a crude estimate of the mean and standard deviation of the density is possible[7]. The mean is the average of the six counts and the standard deviation measures the variation between the six samples.

The first measure (count frequency) cannot exceed 1.0 (100%) for any species. It is simple and easy to interpret. When based on a large sample size (as here) the percentage value relates directly to the *probability* of recording the species at a site. Moreover, it is an easier measure to compare between sites and times, and is robust when carried out by different observers. Of course it still suffers from the problems of conspicuousness already mentioned.

Density is theoretically a preferable measure because it relates to the actual numbers. However it is even more vulnerable to differences in conspicuousness and, when most data sets contain many zero entries, is likely to have a wide variance. I have estimated density for each species in each location by: (1) assuming that the number of entries for a species at a station in the field data represent the number of individuals < 25m from the station, and (2) converting the number of birds in the circle represented by 25m radius to a hectare sample by multiplying by 5.0929. This method takes no account of the detailed 'distance' measures (other than 'within 25m') and as such it may underestimate small inconspicuous birds compared to the previous analyses. It gives equal weight to a sighting or hearing at 5m as to one at 25m. When details of the analysis method used in previous surveys has been elucidated these results may be recalculated to allow a stricter comparison between these and earlier results. However,

[6] Assuming that observers are allocated 'at random' to different transect lines.
[7] It is not clear exactly how Smit & Ferriera estimated density. They used a 'modified distance sampling analysis' and refer to Buckland, S. T. et al. 1993. *Distance Sampling: Estimating abundance of biological populations.* Chapman & Hall, New York.

given the different behavioural characteristics of the species, such as fantails and robins coming to 'investigate' the observer, or silvereyes in fast-moving loose flocks, and the fact that two-thirds of the observations are auditory rather than visual, it seems unlikely that calculation of densities based on estimated distance will achieve precision for individual species, and could be misleading in some cases.

RESULTS

Total bird density

The results in Fig 1 give the average total number of birds (density) per hectare estimated from the six repeat counts for each location in December 2008. The 95% Confidence limits (95% CL) are a measure of the variability of the average estimate in the repeated counts. Where confidence limits overlap, as, for example between WH Ridges and WH Valleys in Fig 1, we can generally say that there is no statistically significant difference between them. Where 95% CL*s do not* overlap, as between WH Ridges and Control in Fig 1, there is likely to be a real (significant) difference in numbers.

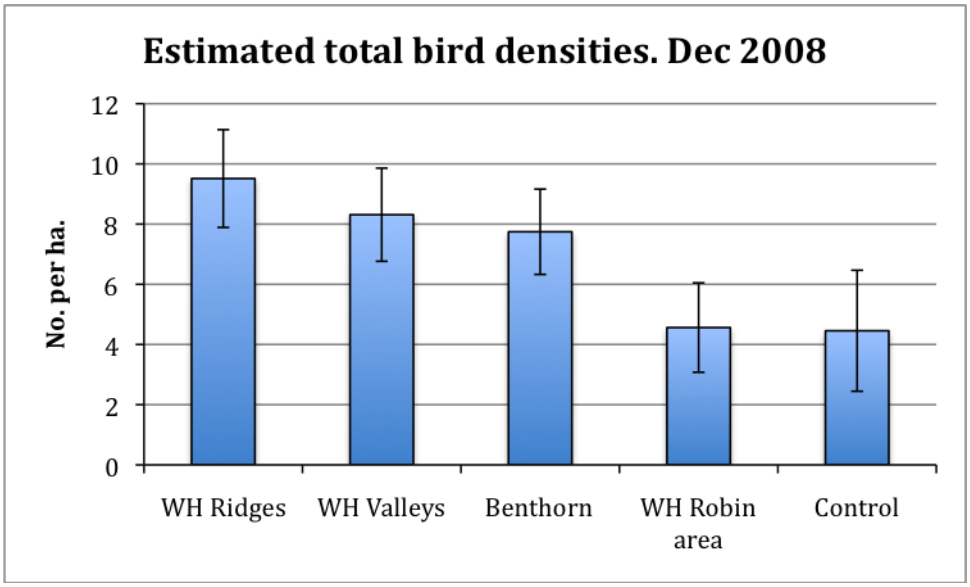

Fig. 1. Overall average density of all bird species in the five locations, with 95% Confidence Intervals (vertical lines above and below the average).

Fig 1 indicates bird densities at Windy Hill and Benthorn are generally between c. 8 to 10 birds per hectare, with the highest numbers recorded on ridges rather than in gullies. However, none of these three locations are statistically different in total numbers. They do however appear to differ significantly from the area where robins have settled, and from the control area. These two areas are similar in terms of total bird numbers recorded, but differ from the other locations.

Densities of selected common bird species

Fig 2 gives the estimated average 'densities' for most of the species recorded and allows comparison with the control counts. However, it also demonstrates that the method measures conspicuousness rather than true abundance: surely there must be many times more grey warblers at Windy Hill than there are kereru!

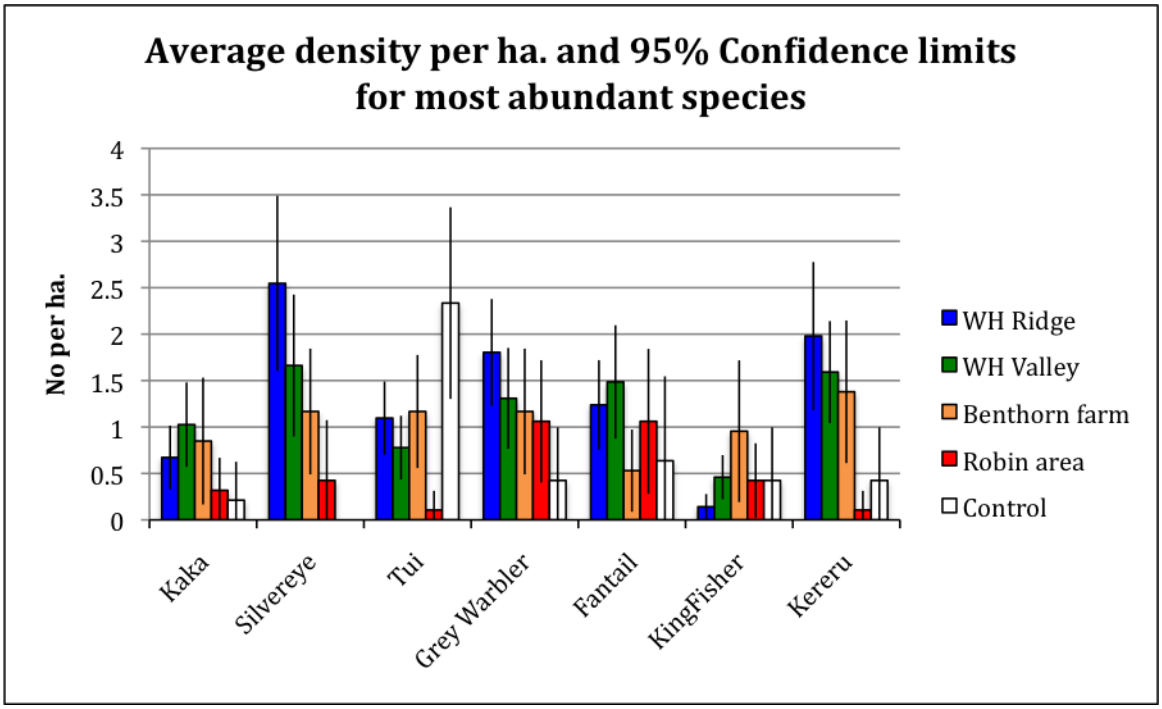

Fig 2. Average densities/ha. for the seven main bird species in all five areas.

Although most species were more abundant at Windy Hill (Ridges and Gullies) than elsewhere, this did not necessarily apply to all species. For example tui were recorded as significantly commoner in the control site than in the valley samples (and robin area) at Windy Hill. In contrast, kereru were commoner in sites at Windy Hill and Benthorn farm than in the control (or robin area) samples. Summarising the data in Fig 2: kaka are present in low numbers (average less than 1 per hectare) in all locations, with no significant differences. Silvereye and grey warbler both show decreasing numbers from WH ridges, through valleys, Benthorn farm and the robin and control areas. Silvereye, was overall the most abundant bird, but was not recorded at all in the control area. Tui was significantly more abundant (or noisily conspicuous?) in the control area, especially compared to the robin area. Fantails were conspicuous everywhere (one or two per hectare); although slightly more were recorded in valleys compared to ridges, this difference is not significant. Kingfishers appeared more abundant on Benthorn farm than elsewhere, but again this difference has no significance. Kereru were most abundantly recorded in ridge samples at WH, with significantly fewer records in the robin area. The WH values for this species were also significantly greater than the control values.

Other species

Shining cuckoos were heard singing once in a ridge sample at Windy Hill, and three times at Benthorn farm. A morepoke owl was heard once in the robin area. These were the only records of native birds other than those already discussed. A blackbird was recorded twice at Benthorn farm, but other introduced birds (chaffinches, house sparrows, dunnocks, songthrushes, starlings etc) were not recorded.

Frequencies in different locations

The values in Table 1 can be interpreted as the probability (%) of hearing or seeing the species in question on a 3 minute stop in the various locations in December 2008. Thus, we would expect to hear or see grey warbler on c. 26% of stops on ridges at Windy Hill, but only on 8.3% of stops in the control area.

Location	Ridges	Valleys	Benthorn	Robin	Control
Count no.	*144*	*144*	*48*	*48*	*24*
Kaka	10.4	14.6	12.5	6.3	4.2
Silvereye	20.8	15.3	20.8	4.2	0.0
Tui	19.4	13.2	22.9	2.1	45.8
Shining Cuckoo	0.7	0.0	6.3	0.0	0.0
Grey Warbler	26.4	18.8	20.8	18.8	8.3
Fantail	18.8	19.4	10.4	16.7	8.3
KingFisher	2.8	9.0	14.6	8.3	8.3
Kereru	22.9	22.2	22.9	2.1	8.3
Robin	0.0	0.0	0.0	14.6	0.0
Other	0.0	0.0	4.2	2.1	0.0

Table 1. Relative frequency: times recorded as a % of total possible times given in row 1 (count no.). Colour shows most frequent species at locations.

Grey warblers were the most conspicuous bird on the ridges at Windy Hill, followed by kereru and silvereye. Kereru were the most frequently noted species in the valleys, where kaka and fantail also reached their maximum frequencies. On Benthorn farm kereru and tui were equally frequent. Robins were only recorded in the robin area, where they were seen or heard on 14.6% of occasions. Grey warblers were somewhat more conspicuous than robins in that area. Tui were by far the most frequently recorded bird in the control area, being noted on 45.8% of the three minute stops. All other species had frequencies < 10% in the control area. The frequency results given in Table 1 correlate very highly with the density estimates for the same species, except in the case of silvereye, where flocking causes density to exceed frequency in many cases[8].

[8] R^2 values between frequency and density estimates: kaka 0.996; silvereye 0.749; tui 0.995; grey warbler 0.938; fantail 0.903; kingfisher 0.962; kereru 0.923.

DISCUSSION

Comparison of densities per ha. with earlier counts at Windy Hill

As outlined in the Methods, the analyses presented here are not strictly comparable with those presented previously. It is hoped to rectify this in subsequent reports. However, some comparisons can be made.

Fig 1 of Ferreira (2008) summarises trends in total bird numbers since the start of monitoring (2000). The twelve ridge and valley transects at Windy Hill show increases in seven cases, decreases in four, and no change in one case. However, in the four cases suggesting an *overall decrease*, there appears to be an *increasing* trend if the last four years only are considered.

The figures for June 2008[9] indicate total bird densities ranging from c. 10 – 30 birds per hectare. These figures are notably larger than those given in this report (Fig 1). Thus, taken at face value the results here seem to suggest a notable decline in bird numbers since the previous count. However, this difference is almost certainly due to differences in the method of calculating density: my method gives equal weight to birds at any distance, while the earlier method weights nearer birds more highly than those seen or heard at the extremity of the sampling radius (25m). Once the previous method is available the results presented here will be recalculated using that method. The internal comparisons within the Dec 2008 data, (eg. between species, or between valleys and ridges, control site etc.), are not effected by the different method used here.

Fig 2 in the same Report (Ferreira 2008), shows the number of species (rather than individual birds) counted over the same time period. The figure has no trend lines, but gives the general impression that the number of species recorded has decreased slightly, especially on the ridge transects. As noted in the text, this is due to a decline in the presence of non-native species: several species recorded in the first few years of monitoring have not been recorded subsequently. For example, house sparrow (21), dunnock (5), blackbird (9) and starling (10) were all recorded in 2005 counts (number of times in brackets) but only blackbird (2 at Benthorn) was recorded in December 2008.

Nearly all the graphs in Fig 2 of Ferreira 2008 show a 'saw tooth' effect, with higher bird species numbers in the December counts than in the June counts, by one, two or three species. Whether this is due to movement of some species away from native bush habitats in the winter, or simply reflects changes in vocalisation (conspicuousness) warrants further study. Kingfishers are known to move from inland bush to coast during the winter, when they also stop calling.

[9] The "number of birds" given in Fig 1 of Ferreira 2008 are presumed to be $no.ha^{-1}$.

Comparisons between locations at Windy Hill

Fig 1 demonstrates that bird densities are generally higher over the ridge/valley landscape at Windy Hill, and at Benthorn farm, than they are either in the 'robin area' or in the control (unmanaged) area. Ferreira (2008) also noted the lower bird density in the control area, and it was additionally confirmed by an independent survey in September 2008 (Fig 3). Thus there is little doubt that the control area has a lesser bird density than the ridges and valleys of Windy Hill and Benthorn farm; but whether this difference is due to the differences in rodent management or a result of other habitat differences is not so clear. Recent work on the vegetation of Windy Hill (Stacey Lockie 2008, *Unpublished Report;* Perry & Ogden *in prep.)* indicates that the control area is representative of the older forest at Windy Hill in terms of species composition, but it differs in structure: the control area has more numerous, but smaller, trees (higher tree density but lower basal area) than the equivalent managed sites. This suggests the vegetation on the control site is either younger, or slower growing, than the sites for which it is supposedly acting as a control. Consequently the difference in bird

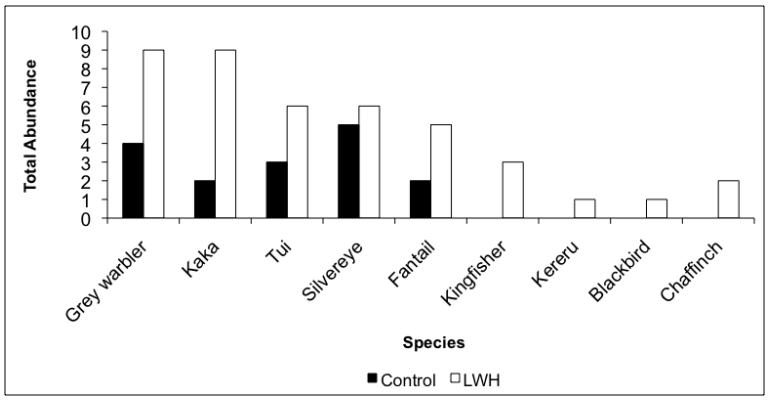

Fig 3. Comparison of control area and Little Windy Hill. Independent study by students on University of Auckland, Environmental Science 737 Field Course, September 2008. Total abundance is sum of all times the species was recorded.

abundances between the control and the remainder of Windy Hill may be due to habitat differences rather than rodent management.

The robin area is intensely managed, but never-the-less has low bird density and diversity like the control. The relatively low densities of the insectivorous grey warbler and fantail are noteworthy. The vegetation here is generally younger manuka/kanuka scrub, with a relatively high frequency of ponga (*Cyathea dealbata*) and tanekaha (*Phyllocladus trichomanoides*), both of which produce abundant slowly decomposing litter. Maybe the robins chose this area because it offers a ground-based food supply and relatively little competition with other insectivores.

Comparison with other bird counts on Great Barrier

All other bird counts on Great Barrier have been made using a five-minute count rather than three minutes. Moreover, these other counts have not dealt with a restricted radius, but have recorded birds heard or seen more than 25m away, often much further away. There are other differences involving the placing of count sites, the years and seasons of the counts, and the number of observers counting at any one counting point. These methodological differences mean that the other counts are likely to have recorded *more* birds than at Windy Hill. For these reasons apparently lower bird frequencies at Windy Hill are to be expected, and do not necessarily mean anything. However, where *higher* values are recorded at Windy Hill, this is likely to be a real difference.

The only species apparently more frequent at Windy Hill than elsewhere is Kereru. This is possibly a significant finding, because kereru is the characteristic species of the mature forest, both at Windy Hill and Glenfern.

Other trends

As noted earlier the composition and structure of all the forest types at Windy Hill is changing as succession towards more mature canopies continues, and this needs to be kept in mind when assessing changing bird abundances. Increased vegetation maturity will favour the larger fruit eaters (eg. kereru) but may act against the smaller insectivorous species, such as grey warbler, which utilise the younger manuka/kanuka stands. A possible, but statistically insignificant, decline in grey warbler since 2000 at Windy Hill (where the kanuka forest is declining) was noted by Ferreira (2008), while the same species may have increased at Glenfern (2002 – 2006), where relatively young kanuka forest is colonising former paddocks (Ogden, J. 2008. *Analysis of 5-minute Bird Counts from Glenfern Sanctuary, Great Barrier Island: 2002-2006.* Unpublished report to Glenfern Sanctuary). Another interesting trend is the decline in introduced passerines (sparrows, finches, blackbirds, starlings etc.) at Windy Hill. These birds are clearly associated with man-made habitats and generally do not thrive in dense native bush.

Gradual vegetation change, changes in the abundance of introduced birds which are possible competitors for limited food supplies, and rodent control, all act to influence the results obtained from the bi-annual bird counts. Superimposed too are seasonal fluctuations, and possible effects of extreme climatic events, such as the big storms in the winter of 2008. However, in assessing the results from year to year, and in comparison with other areas, differences in methodological and analytical techniques are of primary importance. It is essential to maintain these techniques, or, if changes are deemed necessary, to critically assess the effect of the change on the interpretation of the data.

CONCLUSIONS

° The method employed measures 'conspicuousness' rather than absolute abundance, and this needs to be considered in assessing trends.
° Total bird conspicuousness at Windy Hill appears to have increased slightly over the last four years; this can be interpreted as an increase in numbers.
° Total species diversity has declined slightly, probably due mainly to a reduction of non-native species.
° The data are intrinsically variable and non-normal. Methodological and analytical differences, and external factors such as weather events, impose additional variability. Consequently, small changes in numbers are hard to interpret; consistency of trend is likely to be the best approach to assessing significance.
° There are consistent small differences between winter and summer counts, and these should be explained.
° There are consistent differences in bird conspicuousness (density and frequency) between the unmanaged control site and the remainder of Windy Hill. These differences are consistent with, but not necessarily caused by, the lack of rodent control in the former. (There are also subtle vegetation differences to consider).
° There are consistent differences in the bird density etc between the 'robin area' and the remainder. Again, there are vegetation differences, but the reduced bird numbers in the robin area might be a reason why it was chosen by the robins.
° Trends for 'indicator species' such as a possible increase for kereru (in mature forest) and decrease for grey warbler (in kanuka scrub) may reflect the subtle changes in forest structure occurring at Windy hill as the forest cover matures.
° The Windy Hill results are difficult to compare with those from elsewhere on Great Barrier due to differences in timing and methodology.

RECOMMENDATIONS

1. A more formal comparison with the previous data is required. For this to be achieved a clearer picture of the analytical techniques used is required.
2. The bi-annual recording should be continued. If it is necessary to curtail it, then the winter count could be cut out.
3. The control should continue to be monitored and the additional transect there re-instated. This would improve the estimate of Confidence Limits (which rely on 'n') and hence the statistical comparison with other places.
4. Consideration should be given to making identical counts over the same time period in places other than Windy Hill (eg at Glenfern Sanctuary). This would help to set the Windy Hill (and Glenfern) data into a wider context.
5. The field recording sheets should be restructured slightly to allow for ease of transcription!