MONITORING BIRDS AT TIROMOANA BUSH (KATE VALLEY CONSERVATION MANAGEMENT AREA), CANTERBURY

FOURTH PRE-TREATMENT MONITOR

OCTOBER 2008

prepared for Transwaste Canterbury Ltd

by

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Cover photo: Male bellbird singing, Tiromoana Bush, October 2008.

EXECUTIVE SUMMARY

Bird monitoring has been carried out at Tiromoana Bush (also known as the Kate Valley Conservation Management Area) each October since 2005 to determine bird count trends over time. Tiromoana Bush is located in the Motunau Ecological District in coastal North Canterbury.

Field methods and analysis

Monitoring birds has involved modified five-minute bird counts (after Dawson & Bull 1975 and Moffat & Minot 1994) for measuring the relative abundance of forest birds. Analysis has been carried out to evaluate statistical power and trends over a four-year monitoring period.

Results

Up to 2007, results had shown an inexplicable decline of counts of most species of birds (indigenous and introduced) including a steady decline of bellbirds, fantails and total indigenous individuals. However in 2008, counts of bellbirds and most other birds had increased, though not quite to the high levels of the 2005 season.

Analysis of data carried out by Andrew Holster found conclusive evidence for statistically significant fluctuations in bird counts for practically all species reported, suggesting a cyclic process in bird numbers or conspicuousness. The data also show that for some species, notably fantail, counts have steadily declined over the four-year monitoring period for unknown reasons.

Other results of the monitor have shown bellbird and total indigenous individual counts to be higher in kanuka forest with a rich understorey of broadleaved shrubs, while counts of grey warbler and some introduced species were higher in more open kanuka forests. No kereru or tomtits were observed during 2008 (one individual of each recorded only once—in 2007). The only new record was Australasian shoveler, of which approximately eight individuals were seen on ponds at Kate valley.

Discussion

The fluctuations in bird counts between years may be associated with differences in weather, food availability, breeding dynamics, predator abundance, etc. Given that windiness was thought to be the most likely cause of count variation between years, analysis of data in 2008 looked particularly at the wind factor. The relatively calm weather conditions in 2005 and 2008 coincided with the highest counts recorded. Counts of introduced birds in particular appear to be most affected by windiness. However, after controlling for wind (and other factors), variations in bird counts were still quite large and significant.

Fantails have also shown patterns of decline in other areas over the past few years. However, count trends for fantails monitored at the Lake Rotoiti Recovery Project (Nelson Lakes) between 1997 and 2008 show wide fluctuations between years with good signs of recovery even when counts approach zero some years. This further suggests that counts at Tiromoana Bush may show a cyclic process over the years.

Recent research has shown that predators (particularly stoats and rats) are causing declines of birds (especially threatened birds and small insectivorous birds) within

forests on the mainland. Predators (and other limiting influences) are likely to have more impact on birds occupying small forest patches than larger contiguous forests.

Declines of small indigenous passerine birds such as grey warblers, tomtits and fantails have been recorded at other forest areas in New Zealand, even in areas where intensive control of mammalian predators is being carried out. The reasons for these declines are not clear but may be due to an increased frequency of rat irruptions and/or the inability of existing rat control mechanisms to effectively reduce rats to a level where birds are able to maintain their populations. Genetic effects (e.g. reduced genetic diversity, inbreeding etc) may also be contributing to these declines.

The removal of stock resulting in lush growth of pasture grass may lead to an increase in numbers of rodents and other mammalian predators, which consequently may impact on some birds. However, the removal of stock and the control of other browsing mammals such as possums and hares will encourage the regeneration of forest shrubs and trees providing favourable habitat for bellbirds and other fauna.

Recommendations

The main recommendations are:

- For the purposes of modelling cyclic behaviour in bird counts, species interactions, and other factor interactions such as climate effects, it is recommended that monitoring be continued annually for at least two more years.
- If there is further indication that numbers of fantails or other indigenous species are declining, or if introduced mammalian predators are indicated to be at high levels, consideration should be given to carrying out intensive control of possums, rats and stoats.

Plate 1 Part of Tiromoana Bush, looking north-east toward lower Kate valley

1. Background

Transwaste Canterbury Ltd have committed to a comprehensive ecological restoration project as part of the mitigation for the establishment of the Canterbury regional landfill at Kate Valley for which a 35-year resource consent has been granted. This project is being carried out in a designated Kate Valley Conservation Management Area (CMA) also known as Tiromoana Bush, which is located in the Motunau Ecological District in coastal North Canterbury (Plate 1).

The proposed conservation, protection and restoration over a 35-year period will result in a substantial increase in the overall biodiversity values in this area (Norton 2004). In particular, the restoration of Tiromoana Bush will result in the protection and enhancement of a substantial area of lowland forest, which is a nationally rare and poorly represented vegetation type. Conservation management involves removal of domestic stock, animal and plant pest control, and the establishment of restoration plantings (Norton 2004).

Since the initial bird monitor in 2005, domestic stock had been excluded from the conservation area, and restoration planting has commenced. Predator control has not yet been established for restoration purposes, although possums and mustelids (ferrets) are controlled for Tb purposes. Notwithstanding this Tb-based control, this bird monitor can effectively be described as the fourth-year pre-treatment monitor as there is no intensive predator control presently in place.

It is proposed that population trends of common indigenous forest birds (particularly bellbirds[1] and grey warblers) are monitored from the outset of conservation management for the duration of this management. Methods to measure these population trends are described in detail in Section 3. Detailed statistical analysis of bird count trends are carried out after approximately 3-4 years of each data collection.

This report describes the results of the fourth-year field monitoring survey carried out by the author between 6th and 11th October 2008, and discusses bird count trends through the first four years of monitoring.

2. Objectives

- To evaluate trends in the relative abundance of bird populations;
- To evaluate any changes in the composition of bird species, and report on other observations of note;
- To offer conservation management advice based on the objectives above.

[1] Scientific names of birds are given in Appendix 1

3. Field Methods

Monitoring birds involved the same methodology as used during previous surveys (Buckingham 2006 a&b, 2008a). This involved modified five-minute bird counts (Dawson & Bull 1975) for measuring the relative abundance of forest birds. Modifications included a simplified distance sampling technique (Barraclough 2000; Buckland *et al* 1993; Moffat & Minot 1994) where bird registrations were stratified into lateral distance delimiters. In addition, five-minute bird-call audio atmospheres were recorded once at each count during mornings (between 0800 hrs and 1200 hrs, New Zealand Daylight Saving Time (NZDT)) (Plate 2). Counts were carried out between 0800 hrs and 1530 hrs NZDT during appropriate weather conditions (Dawson & Bull 1975).

During each five-minute bird count all individuals of all species were counted within a radius of 200m from the observer (note that species such as welcome swallow, scaup or spur-winged plover that are not associated with forest or scrub habitat were excluded from counts). Birds were recorded as first heard or first seen to provide a simple measure of conspicuousness (Gibb 1996).

Lateral distances of each bird from the observer (count station) were estimated and stratified into the following radial delimiters: 0-5m; >5-20m; >20-50m; and >50-200m. Given the very low number of registrations within the 0-5m delimiter these registrations will be combined with the >5-20m data, thus providing three lateral distance estimates for each count ("near", "moderately close" and "far"). A rangefinder and tape measure were used when the lateral distance to a particular bird was uncertain.

Audio samples (Plate 2) were taken once at each count station during fine, calm mornings when birds tended to be most vocal. In 2005 and 2006, a portable Minidisc™ recorder (Sony MZ-R909) and Vizivox "Hammerhead"™ stereo omnidirectional microphone was set up to record bird calls within an approximate 100m radius during the five-minute count. In 2007 the MZ-R909 recorder was upgraded to Sony Hi-MD MZ-M100 for higher-quality professional recordings, and this was also used in 2008. Differences in the quality of recordings between the two models of Minidisc™ will not however affect the results for comparative analysis. External noise (e.g. wind, aeroplanes, land vehicles and machinery) affects the sound quality of the recordings. Using the latest model Hi-MD recorder (Sony MZ-RH1) and SONICSTAGE software, recordings from either standard minidiscs or Hi-minidiscs are uploaded to a computer and burned on to CD.

A total of 13 transects (each in a different forest or scrub patch) with three count stations each was established in 2005 (Buckingham 2006a). The GPS locations and locality/habitat descriptions of these count stations are given in Appendix 3 (see also attached map). Each year, all forest transects are counted three times and the scrub transect (Transect 5) up to five times, providing a total of c. 123 counts (108 forest counts and 15 scrub counts).

4. Data analysis

The programme MONITOR was used to estimate power using the first three years of data by Dr J. Brown (Data Design). This involved calculating power to detect a significant increase or decrease of counts over a ten-year period.

Dr Andrew Holster carried out detailed trend analysis in December 2008, using data from each year's monitor from 2005. He also undertook statistical analyses to estimate measurement reliability, construct validity, and the effect of wind and other variables.

Trend analysis involved examining yearly trends in bird relative conspicuousness levels (using controls for wind, precipitation and other relevant factors). Appropriate tests were used to measure significance (paired and unpaired t-tests, and chi-squared tests). Specifically, analysis involved four main methods:

1. Unpaired t-tests of raw bird counts, across years
2. Paired and unpaired t-tests between *matched ungrouped samples* across years
3. Paired and unpaired t-tests between *matched group samples* across years, clustering within transects on the count parameter
4. Chi-squared tests for differences between years on matched samples

Other trends such as habitat preference were examined using simple analysis. This involved calculating mean counts and standard errors of bird species/individuals and plotting the data on charts to observe trends and patterns. Means were derived by averaging counts within each transect and treating transects (forest patches) as statistically independent.

Plate 2 Recording five-minute samples of bird calls at five-minute bird count stations

5. Results

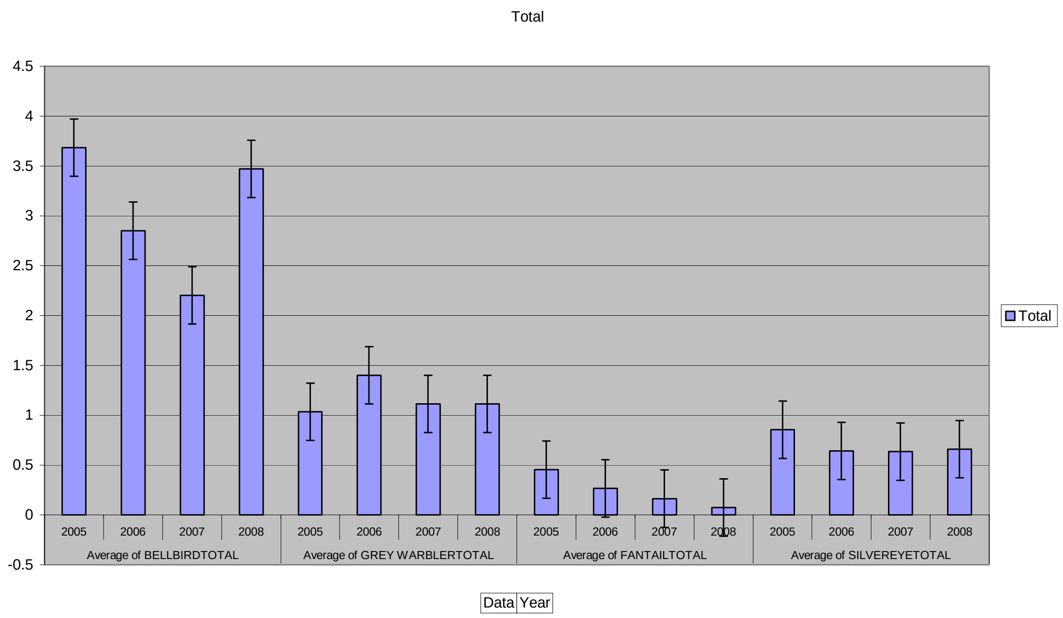
5.1. Count trends of birds 2005 to 2008

Monitoring from 2005 to 2007 had shown an inexplicable decline in mean counts of bellbirds, fantails, indigenous individuals and species, and introduced individuals and species (Buckingham 2008a). In 2008, bird counts for most species (including bellbird and grey warbler) returned to similar levels as during the first monitor (2005), however fantail counts continued to decline (Figures 1 and 2; Table 1; Appendix 3).

Statistical analysis found conclusive evidence for strong yearly fluctuations in bird conspicuousness for practically all species counted. Changes in counts of individual indigenous species are generally significant and often quite large each year (Appendix 3). Fantail counts have dropped every year, with strong and significant reductions in 2006-2007 and 2007-2008 (Figure 1). In October 2008 they were only at 13% of their October 2005 counts. Silvereye counts have also dropped significantly, but silvereyes are known to fluctuate widely in number seasonally and annually in response to food availability.

Other results of the analysis found that total indigenous and introduced bird count means fell significantly from 2005-06-07 then recovered again in 2007-08 (Figure 2). Bird species counts showed a similar pattern to individual counts with a modest drop in 2005-06 (significant for exotic but not for indigenous), a large and significant drop in 2006-07, and a modest recovery in 2007-2008. Tables and charts of detailed statistical analysis are given in Appendix 3.

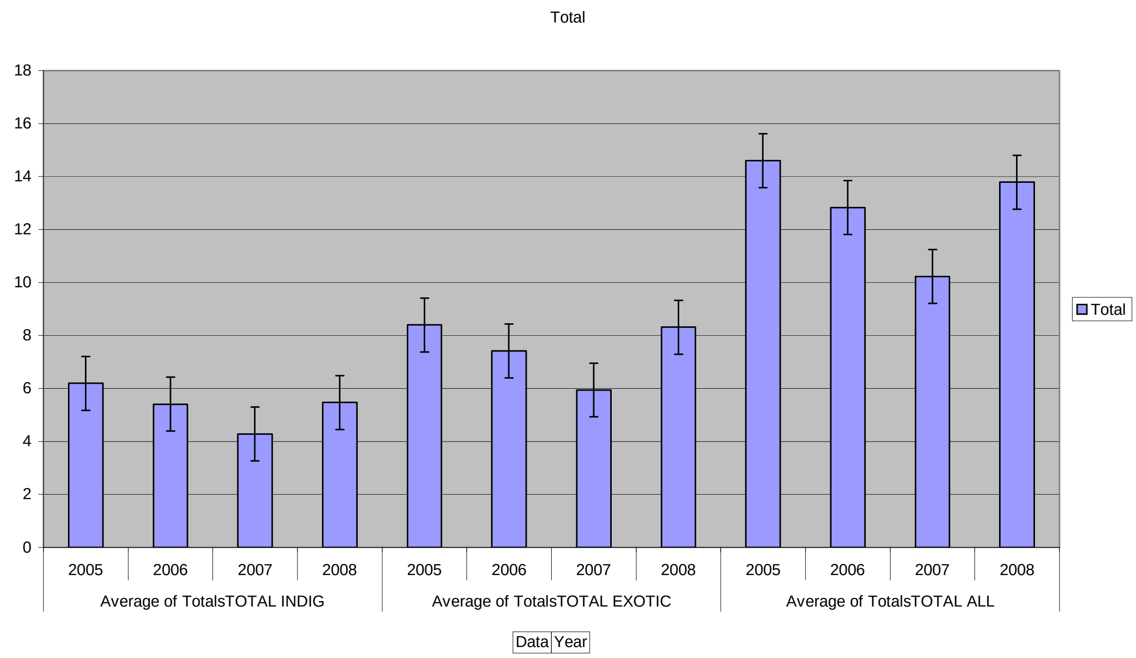
Figure 1 Count trends 2005-2008 for common indigenous species



Note: error bars are only a rough indication of the scale of standard error for the total sample. This chart is produced from raw data where controls for wind and other factors are not included in the analysis.

The 2008 species counts are about 85% of 2005 counts for indigenous and exotic birds, but are not significantly different from 2005-08 when controlled for wind and other factors.

Figure 2 Count trends 2005-2008 for total individuals



Note: error bars are only a rough indication of the scale of standard error for the total sample. This chart is produced from raw data where controls for wind and other factors are not included in the analysis.

Windiness appears to strongly influence bird counts, with the windiest years (2006 and 2007) having the lowest bird counts. This may explain the downward trend of counts for most species through to 2007 (Buckingham 2008a). However, after controlling for wind and other factors (e.g. precipitation and time), variations of bird counts between years still proved large and significant suggesting that the 2005-07 decrease and subsequent increase to 2008 are real patterns (Appendix 3).

The effect of wind on conspicuousness was greater for exotic birds than indigenous birds (close to significant difference even for minor change in wind intensity). In contrast, the effect of windiness on the conspicuousness of indigenous birds generally only becomes significant for changes in wind intensity from Wind=0 to Wind=3 (modified Beaufort scale—see Dawson & Bull 1975). Wind factor appears greater for fantails than other indigenous birds, but in fact the effect is not significant until wind changes from Wind=0 or 1 to Wind=3 (Appendix 3/1).

When counts from 2005 are compared with those from 2008 (raw data without controls for wind and other factors), changes between individual species' counts and totals are not dramatic (and probably not significant), except for fantail (Figures 3 and 4).

Figure 3 Means counts of common indigenous birds (excluding scrub patch) between 2005 and 2008

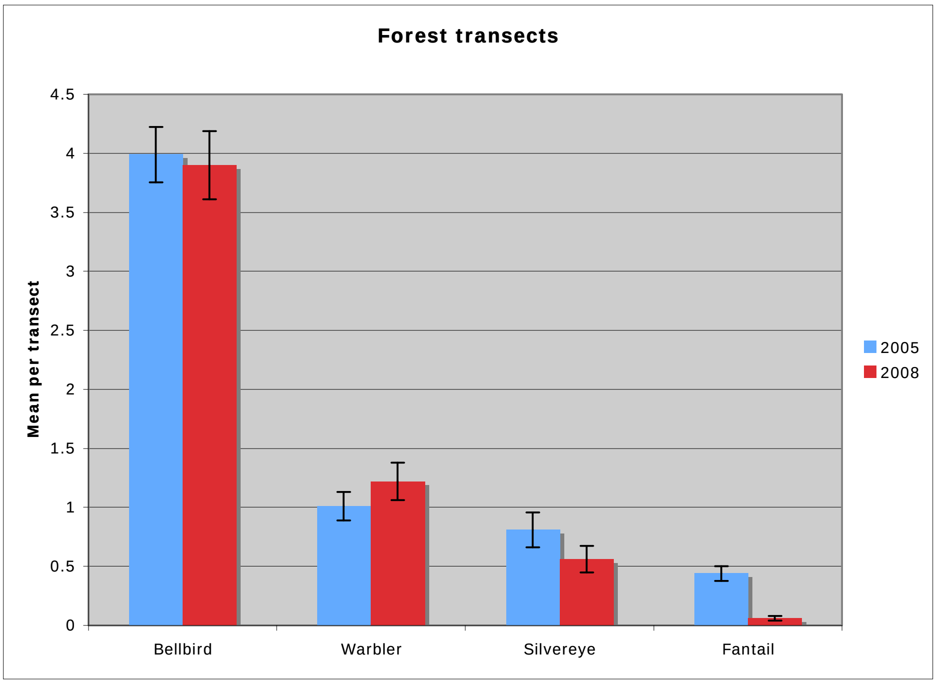
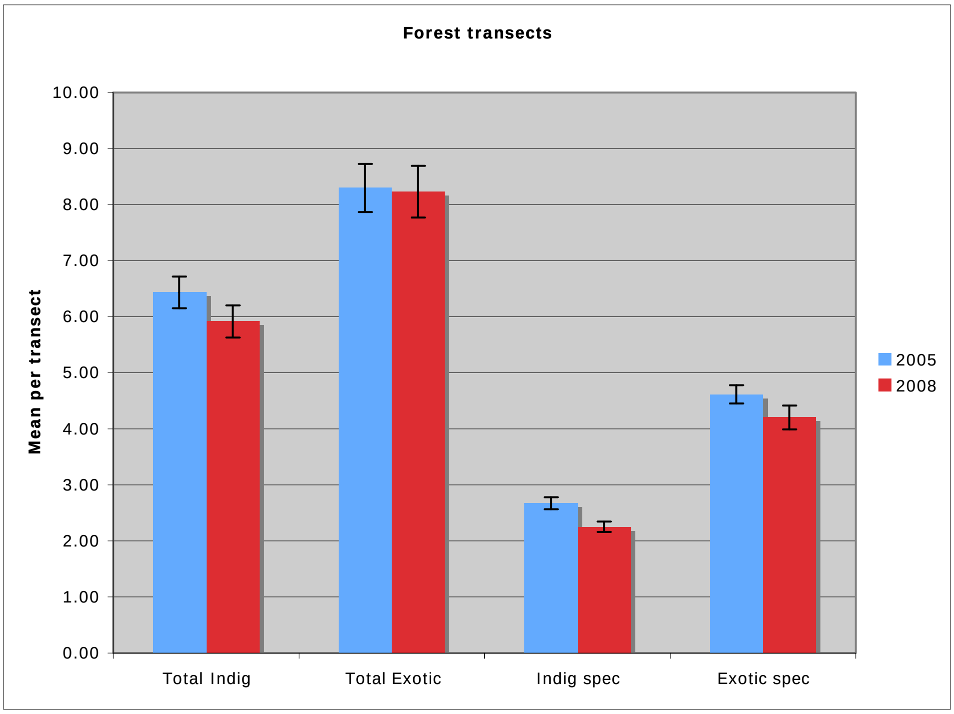


Figure 4 Means counts of total birds (excluding scrub patch) between 2005 and 2008



Note for Figures 3 and 4: standard error bars are calculated from averages of counts within transects. This chart is produced from raw data where controls for wind and other factors are not included in the analysis (noting that 2005 and 2008 were the calmest years).

Table 1 Bird Count Trends Tiromoana Bush (uncorrected means)

Mean numbers per count

Species/Group	2005	2006	2007	2008
Bellbird	3.68	2.85	2.20	3.47
Grey warbler	1.03	1.40	1.11	1.11
Fantail	0.45	0.27	0.16	0.07
Silvereye	0.85	0.64	0.63	0.66
Kingfisher	0.06	0.04	0.03	0.04
Shining cuckoo	0.04	0.07	0.10	0.06
Total indigenous*	6.20	5.41	4.28	5.47
Indigenous species	2.62	2.49	2.08	2.15
Total introduced*	8.40	7.42	5.94	8.32
Introduced species	4.67	4.18	3.34	4.08

* all individuals

5.2. Weather conditions

When viewing the summary of weather conditions for each monitoring year (Table 2) note that the monitoring in 2005 was carried out later in the month (October) than subsequent monitors. A higher percentage of counts were carried out in sunnier conditions in 2006 and 2008 whereas temperatures were hotter during 2005 and 2007. Wind was thought to be the main influence of counts, as windier conditions coincided with overall lower bird counts in 2006 and 2007 (see discussion in Section 6.1). There was not a great variation in rainfall between years though counts were not carried out on very wet days. Given the typical persistent windy conditions in North Canterbury during spring it would be costly to attempt to monitor birds only during calm or light wind conditions.

Table 2 Weather conditions summary for bird monitoring periods at Tiromoana Bush Reserve, North Canterbury, 2005-2008 (expressed as percentage of counts experiencing specified weather condition)

Weather parameter	October 2005	October 2006	October 2007	October 2008
n (bird counts)	117	120	123	123
Sunny counts (5)	58%	82%	52%	67%
Hot counts (5 & 6)	15%	5%	13%	5%
Calm counts (0)	59%	20%	36%	50%
Windy counts (2 & 3)	15%	51%	41%	25%
Dry counts (0)	94%	96%	73%	96%
Wet counts (2+)	3%	0%	2%	0%

Note: Bracketed values refer to Dawson & Bull (1975) and are defined below.

Legend

Sun: Record approximate duration (on minutes) of bright sun on the canopy immediately overhead.

Temperature:

1. Freezing (<0°C)
2. Cold (0-5°C)
3. Cool (5-11°C)
4. Mild (11-16°C)
5. Warm (16-22°C)
6. Hot (>22°C)

Wind: Uses a modified Beaufort scale:

0. Leaves still or move without noise (Beaufort 0 and 1)
1. Leaves rustle (2)
2. Leaves and branches in constant motion (3 and 4)
3. Branches and trees sway (5, 6 and 7)

Rain:

0. None
1. Dripping foliage
2. Drizzle
3. Light
4. Moderate
5. Heavy

5.3. Comparison of bird counts in different habitats

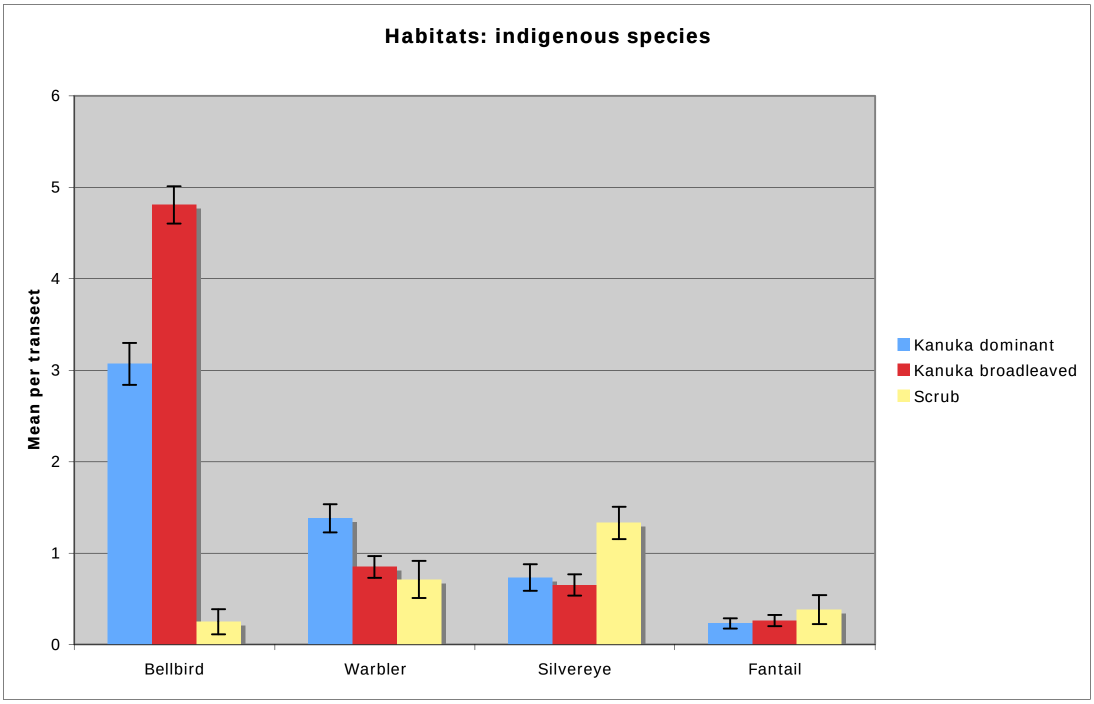
To investigate indicative habitat preferences for various birds, counts were stratified between three habitat types defined by predominant vegetation traversed by each transect. These habitat types were kanuka-dominant (relatively open understorey), kanuka/broadleaved (understorey shrubs prominent), and scrub (dense low-stature

vegetation). Transects 4, 6, 10, 11, 12 and 13 were classified as kanuka-dominant, transects 1, 2, 3, 7, 8 and 9 as kanuka/broadleaved and only one transect (5) was within scrub habitat. Counts of individual birds (and totals) were compared in these different habitat types over the first three monitoring years (Buckingham 2008a).

For this report, 2005 and 2008 data were combined to examine habitat preference for different birds. These years were chosen as providing overall more consistent count results probably as they were the calmest monitoring years (see Section 5.1).

As found in 2005-07 counts (Buckingham 2008a), bellbirds were present in all habitat types being notably (probably significantly) more conspicuous in kanuka/broadleaved forest than other habitats and rarely encountered in the scrub habitat (a few during 2007 and 2008). In contrast, mean counts of grey warblers tended to be higher in kanuka-dominant habitat than kanuka/broadleaved habitat, while silvereyes appeared to prefer scrub to the other habitats (Figure 5). Scrub has an unusual pattern for fantails, which strengthen there in 2007 and 2008 while reducing in other habitats.

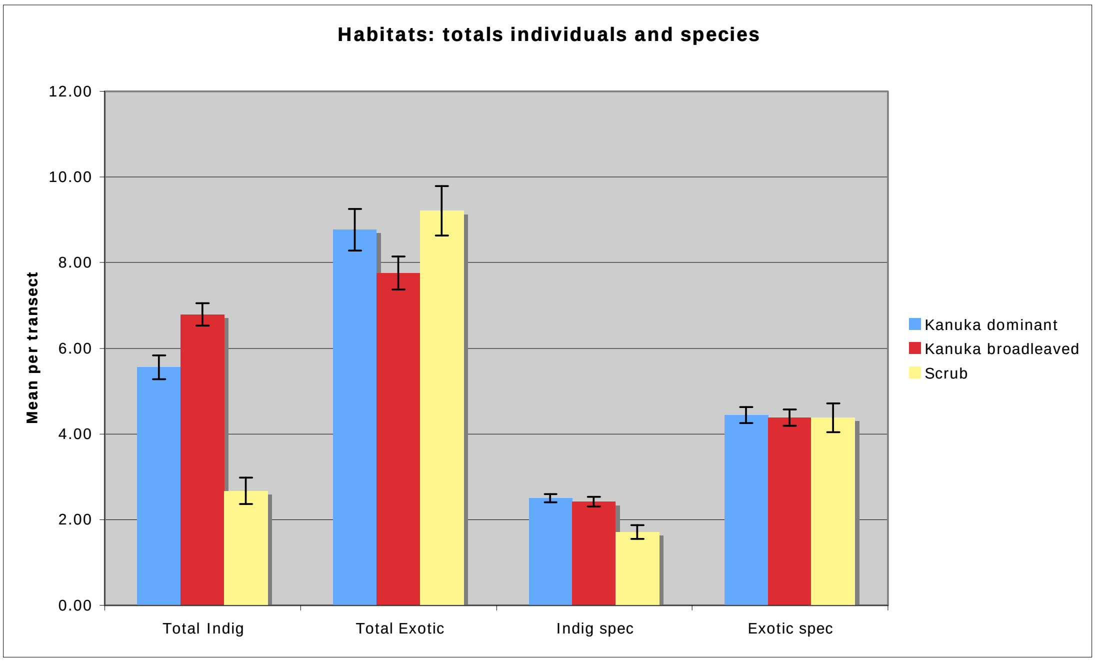
Figure 5 Mean counts of common indigenous species in different habitats



Note: standard error bars are calculated from averages of counts within transects. This chart is produced from raw data (combined 2005 and 2008 counts) where controls for wind and other factors are not included in the analysis.

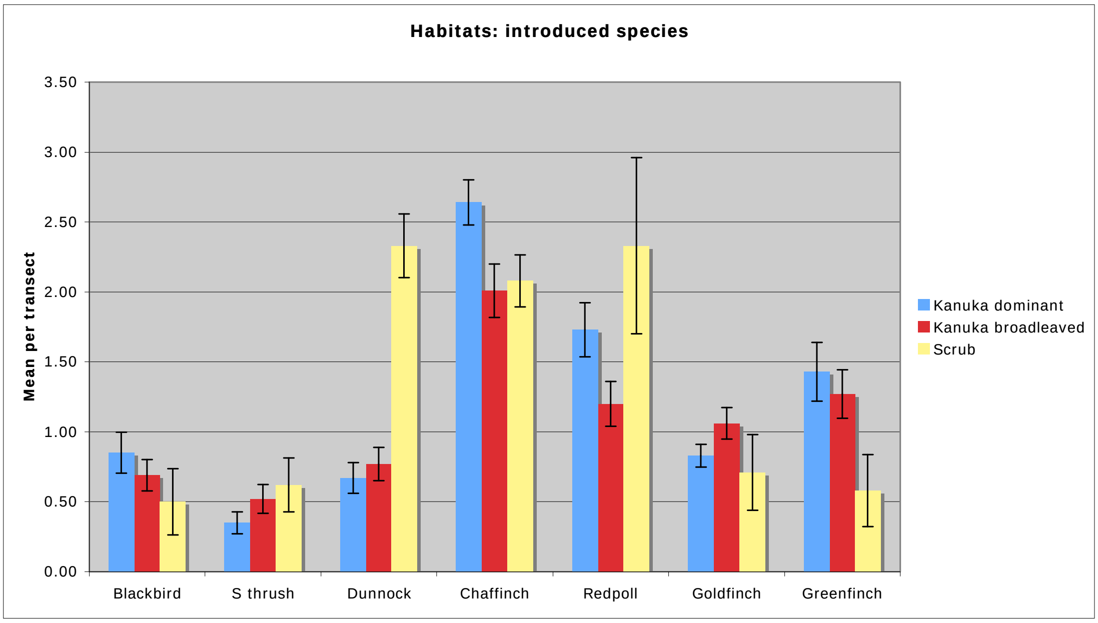
Mean counts of total indigenous individuals were notably higher in kanuka/broadleaved forest than the other habitats with counts in scrub habitat being lowest. Differences in counts between habitats were less noticeable for indigenous species, exotic individuals, and particularly exotic species that were recorded in similar numbers in each habitat (Figure 6). These results were similar to those given in Buckingham (2008a) for 2005-2007 data.

Figure 6 Mean counts of total individuals and species in different habitats



Note: standard error bars are calculated from averages of counts within transects. This chart is produced from raw data (combined 2005 and 2008 counts) where controls for wind and other factors are not included in the analysis.

Figure 7 Mean counts of common introduced species in different habitats



Note: standard error bars are calculated from averages of counts within transects. This chart is produced from raw data (combined 2005 and 2008 counts) where controls for wind and other factors are not included in the analysis.

Mean counts of individual introduced birds varied between habitats, sometimes markedly (Figure 7). Scrub habitat appeared to be preferred over other habitats by dunnocks (hedge sparrows), and perhaps also by redpolls and song thrush.

Chaffinches showed a preference for kanuka-dominant forest over the other habitats while redpoll counts were higher in kanuka-dominant forest than kanuka-broadleaved forest. Counts of greenfinches were higher in forest habitat than scrub. Neighbouring habitat to the forest patches probably highly influenced the patterns of bird abundance (e.g. greenfinches were often more conspicuous in patches neighbouring pine plantation).

5.4. Miscellaneous results

Six indigenous bird species were recorded in forest and scrub patches within the survey area, being the same species that are regularly counted during other years (Table 1). Throughout each monitoring year, bellbirds were the most conspicuous indigenous species, with a mean count of 3.47 in 2008 (Table 1). Grey warblers and silvereyes were moderately conspicuous (1.11/count and 0.66/count respectively, in 2008) while fantails, kingfishers, and shining cuckoos were relatively infrequent (<0.1/count). As mentioned earlier, fantails have shown a steady decline in counts, falling to 35% of numbers counted in 2005 (Table 1).

Threatened species listed by Hitchmough *et al*. (2007), recorded at Tiromoana Bush, have included black shag (Sparse) and kereru (Gradual Decline). However, neither these or tomtits were recorded in 2008. Single individuals of each of these species were recorded in October 2007. Kaka, kakariki, falcons, robins, brown creepers, and riflemen have not been recorded and a presumed tui heard on Transect 8 in 2005 has not been heard since. Kereru and perhaps tui visit the area from time to time.

Eleven introduced species have been recorded as being associated with forest or scrub patches, the most common being chaffinches, redpolls, goldfinches, greenfinches, blackbirds, song thrushes and dunnocks, all of which are widespread (Figure 7).

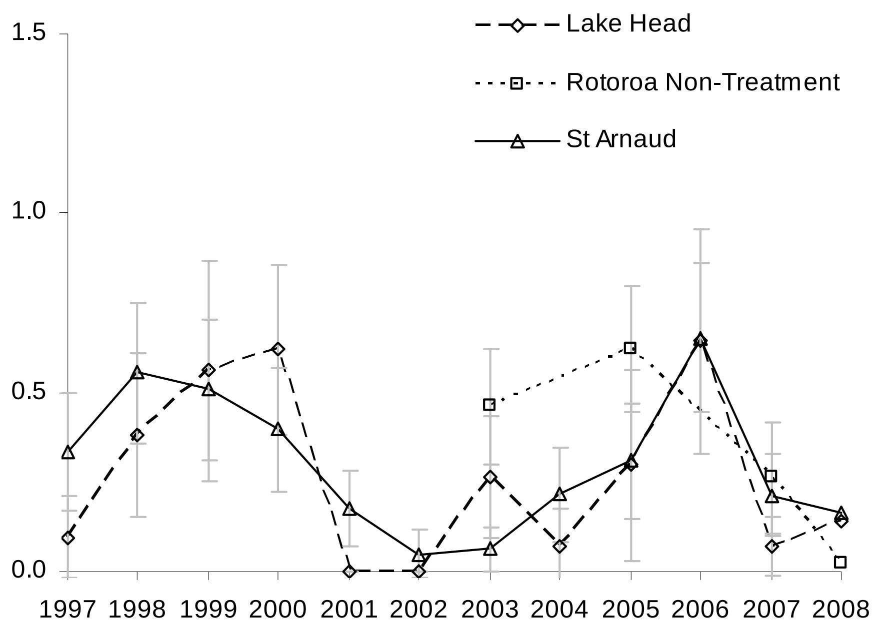
Indigenous species observed on the ponds and lagoons included paradise shelducks (occasionally with ducklings), Australasian shoveler (first-time record), New Zealand scaup, and pied stilt (Plate 3). Grey teal have not been seen on annual surveys since October 2006. Introduced species included black swan, Canada geese and mallard ducks. Welcome swallows were commonly seen flying around the ponds as well as other parts of the valley.

6. Discussion

6.1. Trend analysis

Resolving issues of measuring bird abundance trends involved controlling for wind, precipitation and other relevant factors in the trend analysis carried out by Dr Andrew Holster, in December 2008. It was thought that the wind factor, rather than significant variations in abundance, was influential in the outcome of yearly trends. This would explain why the lowest bird counts were recorded on the windiest years (2006-07) (Table 2). However, after controlling for wind, counts between years were still generally large and significant. Although the reasons for these variations are unclear, an examination of data over four years of monitoring suggests a cyclical process, with an exception perhaps of fantail where counts are declining steadily. However, count trends for fantails monitored at the Lake Rotoiti Recovery Project (Nelson Lakes) between 1997 and 2008 show wide fluctuations between years with good signs of recovery even when counts approach zero some years (e.g. 2001-2002 in Figure 8).

Figure 8 Count trends for fantail at the Rotoiti Nature Recovery Programme: May counts, 1997 to 2008*



*Unpublished data courtesy of Anne Brow, Dept of Conservation, St Arnaud.

Variations in bird counts between years is usual and may be due to a number of reasons such as food availability, seasonal weather patterns, predator abundance, breeding success (e.g. governed by predator levels or genetic effects), or environmental changes etc. Given that mammalian predators are implicated as being the main continuing threat to indigenous birds (e.g. Elliott & Suggate 2007; Innes & Hay 1991, Moorhouse *et al.* 2003; O'Donnell 1996), predation (particularly by rats, stoats and possums) may be contributing to the annual fluctuations of bird numbers, or even the decline of some bird species (e.g. fantail), within the Tiromoana Bush.

The quantitative results were generally consistent with field observations, e.g. the lower counts of bellbirds in 2007 and the progressively lower counts of fantails each year. However, given the difficulties of distinguishing bird conspicuousness from abundance (Gibb 1996; Moffat & Minot 1994; Scott *et al*. 1981) caution should be taken in interpreting trends. Also it should be noted that counts of introduced birds (and silvereyes) are generally subject to wide fluctuations due to flocking behaviour and seasonal conspicuousness, thus making trend patterns for these difficult to interpret.

A downward trend in counts for fantails has similarly been recorded at Nelson Lakes between May 2006 and 2008 (Figure 8) and since 2005 at the Rainy Creek (upper Inangahua valley) area being managed by Oceana Gold Ltd (unpublished information). However, the long-term trend data at Nelson Lakes strongly indicate a cyclical pattern for fantail that show good recovery of numbers even after populations seemingly crash to almost zero.

Over time, these variations may show some regularity, allowing population trends to become evident. However, it may be difficult to precisely evaluate causes of variation due to management practice (e.g. habitat enhancement or predator control) when paired non-managed areas are not being monitored. This is because the factors of change unrelated to management cannot easily be distinguished from changes caused by management.

Overall, the results provide good baseline data for estimating long-term abundance levels but on current evidence, interpretation of data for a specific year is generally only reliable in the context of cyclic events (A. Holster, pers. comm., December 2008). It is cautioned that cyclic effects are suggested but not able to be confirmed from the current data. Further monitoring over at least two more years should be particularly valuable to confirm or disconfirm cyclic patterns (see Section 7). This additional monitoring would also probably provide sufficient data to carry out distance analysis to more precisely evaluate trends if required.

6.2. Other observations

The higher counts of bellbirds in kanuka forests with a rich understorey component of broadleaved species is not surprising considering that bellbirds are omnivorous, and the understorey supplies a seasonal food source. This result has implications for management in that planting suitable berrying shrubs and allowing natural regeneration to occur without stock browse may have long-term benefits for bellbirds and other indigenous species.

The small water bodies present within the Tiromoana Bush have value for a range of indigenous birds—some which appear to use the ponds at different seasons or years (Plate 3). Although the water birds are not specifically monitored during this study, the value of these wetlands should not be understated.

6.3. Conservation management—predicted impacts on indigenous fauna

Since 2005 domestic stock have been excluded from the conservation area, and restoration planting has commenced. The plantings are very young and have not at

this stage contributed to significant habitat for birds. Recent research has shown the occurrence of understorey regeneration since stock exclusion (D. Norton, pers. comm, 2009) (Plate 4). Surrounding pasture grasses were noticeably lusher in 2007 and 2008 than in 2005.

Predator control for restoration purposes has not yet been established in Tiromoana Bush, although Tb-based predator control has been undertaken, and some control of feral cats and hares. Although the counts trends do not particularly suggest that indigenous birds (with the possible exception of fantail) are under threat from predators in the monitoring area, the possibility should not be overlooked, especially in context with current knowledge of the impacts of mammalian predators on birds within New Zealand (see Section 6.1).

It is expected that indigenous bird populations in smaller fragmented forest patches are more vulnerable than those in larger contiguous forests, due to more restricted food availability, genetic isolation, higher risk of disease and predation, etc. It is well accepted that indigenous species diversity is less in smaller areas (patches) of forest than larger areas (e.g. MacArthur 1964; MacArthur & Wilson 1967). It is also accepted that inbreeding depression and loss of genetic variation can lead to an increased risk of extinction, as species become less adapted through natural selection to cope with environmental perturbations such as outbreaks of disease, predator irruptions or catastrophic weather events (Jamieson *et al.* 2008).

The scarcity or absence of many indigenous bird species in the Tiromoana Bush Reserve reflects the small patch size and fragmentation of the original forest area, modification of this forest (direct and indirect), and probably an increase in mammalian predators brought about by these events.

Although increases in numbers of some birds (e.g. bellbirds, kaka, kakariki and kereru) result from intensive “mainland island” predator control (e.g. Butler 2003; Greene *et al*. 2004; Moorhouse *et al*. 2003; Paton *et al.* 2004a & b, 2005, 2007), other birds (mainly small passerines such as grey warblers, tomtits, fantails, and riflemen) don’t seem to respond beneficially to this predator control (Buckingham 2008b; Butler 2003; Paton *et al.* 2007; Smith & Westbrooke 2004).

The reasons for declines of smaller indigenous birds are not clear, but may be due to an increased frequency of rat irruptions and/or the inability of existing rat control mechanisms to effectively reduce rats to a level where birds are able to maintain their populations. There are implications that rats are limiting small insectivorous birds (Butler 2003; Paton *et al*. 2004a & b, 2005, 2007) and the threat to these birds could become serious if the frequency of rat irruption cycles increases (likely to occur with global warming), allowing little ability for these birds to recover in-between plague years. Also, as stated above, genetic effects, which are harder to determine than ecological effects, may be influential in these patterns of decline.

On the other hand, species such as bellbirds and indigenous parrots appear to be limited more by stoats than by rats (Butler 2003; Elliott & Suggate 2007; Greene *et al*. 2004; Moorhouse *et al*. 2003; Paton *et al.* 2004a & b, 2005, 2007). Predator control operations that successfully maintain stoats at low abundance levels have shown positive response from these birds (Buckingham 2008b and above references).

The removal of stock and the consequent increased growth of pasture grass may result in certain environmental changes affecting fauna, such as providing more abundant seasonal food supply for rodents and finches (Buckingham 2008a). For example,

removal of grazing stock at the Pukerua Bay Scientific Reserve in 1987 in an attempt to increase populations of Whitaker's skink (*Cyclodina whitakeri*) resulted in decreased abundance of this skink and the copper skink (*C. aenea*) that was also monitored (Hoare *et al* 2007). It was thought that proliferating seeding grasses after stock were removed may have led to periodic irruptions of rodents followed by a suite of other mammalian predators causing populations of lizards to decline. Similarly, removal of stock may not benefit indigenous forest birds if numbers of predators increase as a consequence. However, the removal of stock and the control of other browsing mammals such as possums and hares will encourage the regeneration of forest shrubs and trees (Plate 4) providing favourable habitat for many species of fauna (e.g. bellbirds) in the longer-term.

Plate 3 Ponds are important havens for many waterfowl including pied stilt and several species of duck (e.g. NZ scaup, in photo foreground). Introduced waterfowl include Canada geese (common species pictured) and black swan.

7. Recommendations

The monitoring surveys to date have set a baseline for bird counts prior to major conservation management (large-scale rehabilitation of shrubs, grasses and trees, and predator/pest control). Statistical analysis has shown good power to detect significant changes of bellbirds and total indigenous birds over a ten-year period.

Given the results of the 2008 statistical analysis, it is recommended that monitoring of birds be carried out for at least two more years (October 2009 and October 2010). This is to enable the modelling of the cyclic behaviour in bird counts, species interactions, and other factor interactions such as climate effects. Although ideally, monitoring should be carried out annually (D. Butler, pers. comm.), it may be appropriate to carry out monitoring at 3-5 year intervals, with each monitoring period involving 3-5 consecutive years (a pulsed monitoring regime).

Detailed statistical analysis will again be required after the 2010 monitor, thence at 2-5 yearly periods. This analysis may also require examining distance sampling and first heard/first seen data for bellbirds and grey warblers for a more precise examination of population trends.

Recommendations regarding conservation management are given below.

- Carry out a baseline survey/s to evaluate population indices of key mammalian predators of birds; i.e. possums, mustelids, rodents and hedgehogs;
- If there is further indication that numbers of fantails or other indigenous species are declining, and/or numbers of mammalian predators are of concern, consideration should be given to carrying out intensive control of possums, rats and stoats;
- Further planting of shrubs and trees such as coprosmas, kowhai, pigeonwood, mahoe and flax would help to enhance bellbird populations and possibly attract kereru and tui into the area.
- A study of conservation genetics in populations of birds occupying forest patches such as at Tiromoana Bush is encouraged in order to help evaluate avian population trends.

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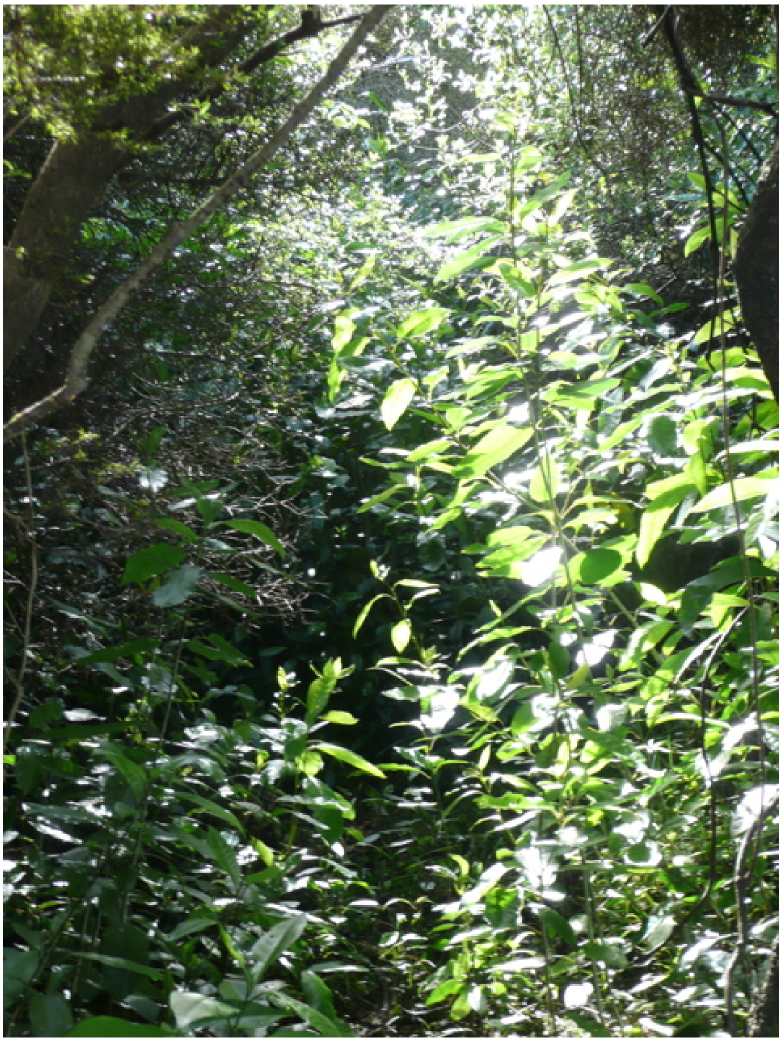
Plate 4 Lush regeneration of mahoe (*Melicytus ramiflorus*) beneath kanuka canopy. Regeneration has become more noticeable after removal of stock from surrounding pasture



APPENDICES

Appendix 1a Scientific names of birds recorded in Tiromoana Bush (2005-2008) (order of names after Heather & Robertson 1996)

Black shag	*Phalacrocorax carbo*
Canada goose	*Branta canadensis*
Paradise shelduck	*Tadorna variegata*
Mallard	*Anas platyrhynchos*
Grey teal*	*Anas gracilis*
Australasian shoveler**	*Anas rhynchotis*
New Zealand scaup	*Aythya novaeseelandiae*
Australasian harrier	*Circus approximans*
California quail	*Callepepla californica*
Pied stilt	*Himantopus himantopus*
Spur-winged plover	*Vanellus miles novaehollandiae*
Southern black-backed gull	*Larus dominicanus*
Kereru (NZ pigeon)***	*Hemiphaga novaeseelandiae*
Shining cuckoo	*Chrysococcyx lucidus*
New Zealand kingfisher	*Halcyon sancta vagans*
Skylark	*Alauda arvensis*
Welcome swallow	*Hirundo tahitica*
Dunnock (hedge sparrow)	*Prunella modularis*
Blackbird	*Turdus merula*
Song thrush	*Turdus philomelos*
Grey warbler	*Gerygone igata*
South Island fantail	*Rhipidura fuliginosa fuliginosa*
South Island tomtit****	*Petroica macrocephala macrocephala*
Silvereye	*Zosterops lateralis*
Bellbird	*Anthornis melanura*
Tui*****	*Prosthemadera novaeseelandiae*
Yellowhammer	*Emberiza citrinella*
Chaffinch	*Fringilla coelebs*
Greenfinch	*Carduelis chloris*
Goldfinch	*Carduelis carduelis*
Redpoll	*Acantha flammea*

Starling	*Sturnus vulgaris*
Australian magpie	*Gymnorhina tibicen*

Notes: * Grey teal recorded on largest pond, Kate valley in 2006 only

** Approximately eight shoveler seen on main pond area in 2008

*** One kereru seen flying over Kate valley in October 2007

**** One male tomtit seen at Transect 11 on one occasion in October 2007

***** Presumed tui heard on three or so occasions on transect 8 in 2004

Appendix 1b Scientific names of other birds, and plants referred to in document

Birds

NZ falcon	*Falco novaeseelandiae*
South Island kaka	*Nestor meridionalis meridionalis*
Yellow-crowned kakariki	*Cyanoramphus auriceps*
South Island rifleman	*Acanthisitta chloris chloris*
Brown creeper	*Mohoua novaeseelandiae*
South Island robin	*Petroica australis australis*

Plants

Flax	*Phormium tenax*
Kanuka	*Kunzea ericoides*
Kowhai	*Sophora microphylla*
Mahoe	*Melicytus ramiflorus*
Pigeonwood	*Hedycarya arborea*

Appendix 2 Locations of Tiromoana Bush bird count stations

(Updated in 2008 using Garmin GPSmap 60CSx™)

CMA area	Locality area	Habitat	Transect	Count	Easting	Northing
4	Coastal	Forest	1	1	2499255	5789836
4	Coastal	Forest	1	2	2499254	5789886
4	Coastal	Forest	1	3	2499250	5789915
4	Coastal	Forest	2	1	2499254	5790121
4	Coastal	Forest	2	2	2499212	5790134
4	Coastal	Forest	2	3	2499158	5790149
4	Coastal	Forest	3	1	2498936	5789591
4	Coastal	Forest	3	2	2498897	5789563
4	Coastal	Forest	3	3	2498840	5789550
4	Coastal	Forest	4	1	2498547	5789100
4	Coastal	Forest	4	2	2498570	5789080
4	Coastal	Forest	4	3	2498602	5789064
2	Mid Kate	Scrub	5	1	2498542	5790117
2	Mid Kate	Scrub	5	2	2498520	5790155
2	Mid Kate	Scrub	5	3	2498460	5790172
2	Mid Kate	Forest	6	1	2498025	5790209
2	Mid Kate	Forest	6	2	2497978	5790219
2	Mid Kate	Forest	6	3	2497936	5790259
2	Mid Kate	Forest	7	1	2497570	5790199
2	Mid Kate	Forest	7	2	2497574	5790160
2	Mid Kate	Forest	7	3	2497615	5790109

CMA area	Locality area	Habitat	Transect	Count	Easting	Northing
1	Mid Kate	Forest	8	1	2497526	5789827
1	Mid Kate	Forest	8	2	2497471	5789823
1	Mid Kate	Forest	8	3	2497427	5789850
7	Top Kate	Forest	9	1	2496768	5789542
7	Top Kate	Forest	9	2	2496733	5789571
7	Top Kate	Forest	9	3	2496692	5789534
7	Top Kate	Forest	10	1	2497221	5789185
7	Top Kate	Forest	10	2	2497207	5789139
7	Top Kate	Forest	10	3	2497173	5789110
7	Top Kate	Forest	11	1	2496852	5788876
7	Top Kate	Forest	11	2	2496858	5788829
7	Top Kate	Forest	11	3	2496885	5788779
7	Top Kate	Forest	12	1	2496740	5789043
7	Top Kate	Forest	12	2	2496736	5789083
7	Top Kate	Forest	12	3	2496746	5789124
6	Selby Rd	Forest	13	1	2495388	5789320
6	Selby Rd	Forest	13	2	2495349	5789366
6	Selby Rd	Forest	13	3	2495299	5789369

Appendix 3 Statistical Analysis: tables and charts (prepared by Dr Andrew Holster)

1 Effects of wind factor on birds

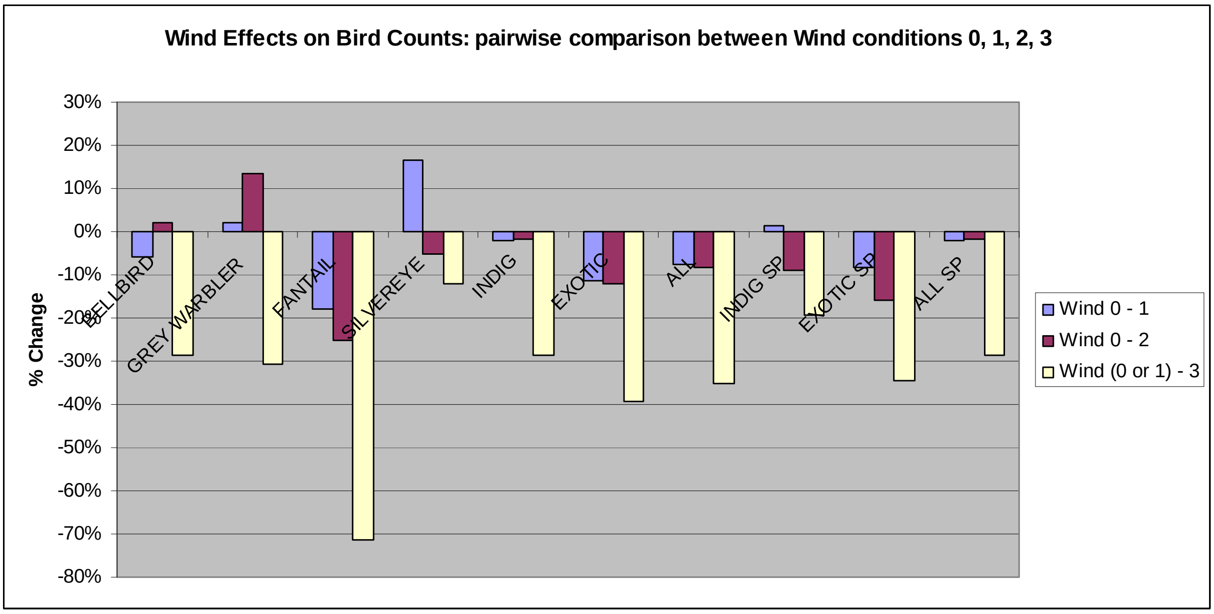
Groups matched across Wind on: Year, Transec, Precip; Group Averages across Counts within Transecs

Best Estimate: Comparisions between matched groups of Wind factors brouped by Counts within Transecs

2-tail non-pair homoscedastic ttests	BELLBIRD	GREY WARBLER	FANTAIL	SILVEREYE	INDIG	EXOTIC	ALL	INDIG SP	EXOTIC SP	ALL SP
Wind 0 - 1	0.6019	0.9076	0.5578	0.4920	0.7783	0.0638	0.0964	0.8261	0.1032	0.2169
Wind 0 - 2	0.8591	0.4599	0.3365	0.8185	0.8125	0.0517	0.0738	0.1612	0.0035	0.0007
Wind (0 or 1) - 3	0.0384	0.0356	0.0677	0.7157	0.0035	0.0000	0.0000	0.0105	0.0000	0.0000

% Changes in Avg Counts

(WIND 2 Avg - WIND 1 Avg) /WIND 1 Avg	BELLBIRD	GREY WARBLER	FANTAIL	SILVEREYE	INDIG	EXOTIC	ALL	INDIG SP	EXOTIC SP	ALL SP
Wind 0 - 1	-6%	2%	-18%	17%	-2%	-11%	-8%	1%	-8%	-2%
Wind 0 - 2	2%	13%	-25%	-5%	-2%	-12%	-8%	-9%	-16%	-2%
Wind (0 or 1) - 3	-29%	-31%	-71%	-12%	-29%	-39%	-35%	-19%	-35%	-29%



2. Trend analysis summaries and data

Best Estimate: Average Change 1 - (Yr_2_Avg - Yr_1_Avg)/Yr_1_Avg	BELLBIRDTOTAL	GREY WARBLERTOTAL	FANTAILTOTAL	SILVEREYETOTAL
1-year steps 2005-2006	-16%	35%	-15%	-31%
2006-2007	-22%	-30%	-59%	-3%
2007-2008	51%	6%	-56%	-36%
3-year steps 2005-2008	-1%	11%	-87%	-36%

Groups matched across Years on: Transec, Wind, Precip, Count

Best Estimate: Matched Grouped ttests of Year Differences - grouped by Averages of Counts within Transecs

2-tail non-pair homoscedastic ttests	BELLBIRDTOTAL	GREY WARBLERTOTAL	FANTAILTOTAL	SILVEREYETOTAL
1-year steps 2005-2006	0.1286	0.0612	0.5535	0.1765
2006-2007	0.0704	0.0259	0.0356	0.9134
2007-2008	0.0129	0.7986	0.1314	0.0951
3-year steps 2005-2008	0.8904	0.4810	0.0000	0.0285

Groups matched across Years on: Transec, Wind, Precip, Count

Good Estimate: Matched ttests of Year Differences - individual Counts within Transecs used

2-tail non-pair homoscedastic ttests	BELLBIRDTOTAL	GREY WARBLERTOTAL	FANTAILTOTAL	SILVEREYETOTAL
1-year steps 2005-2006	0.0039	0.0718	0.3604	0.0329
2006-2007	0.0496	0.0006	0.0386	0.9514
2007-2008	0.0060	0.7624	0.1124	0.4074
3-year steps 2005-2008	0.6073	0.3494	0.0000	0.3558

Raw Data: Average Change

Not Controlled for WIND or other factors

1 - (Yr_2_Avg - Yr_1_Avg)/Yr_1_Avg	BELLBIRDTOTAL	GREY WARBLERTOTAL	FANTAILTOTAL	SILVEREYETOTAL
1-year steps 2005-2006	-23%	35%	-41%	-25%
2006-2007	-23%	-20%	-39%	-1%
2007-2008	58%	0%	-55%	4%
3-year steps 2005-2008	-6%	8%	-84%	-23%

Ttests on raw data - not valid because not controlled for factors (Wind, Precip) or number of Transecs surveyed

Crude ttests of Year Differences

2-tail non-pair homoscedastic ttests	BELLBIRDTOTAL	GREY WARBLERTOTAL	FANTAILTOTAL	SILVEREYETOTAL
1-year steps 2005-2006	0.0005	0.0078	0.0084	0.1162
2006-2007	0.0039	0.0421	0.0769	0.9557
2007-2008	0.0000	1.0000	0.0506	0.8564
3-year steps 2005-2008	0.4169	0.5575	0.0000	0.1460
2-year steps 2005-2007	0.0000	0.5295	0.0000	0.1390
2-year steps 2006-2008	0.0131	0.0545	0.0003	0.8884

Best Estimate: Average Change		TotalsTOTAL		
1 - (Yr_2_Avg - Yr_1_Avg)/Yr_1_Avg		TotalsTOTAL INDIG	EXOTIC	TotalsTOTAL ALL
1-year steps	2005-2006	-6%	-16%	-12%
	2006-2007	-24%	-28%	-26%
	2007-2008	15%	23%	20%
3-year steps	2005-2008	-10%	-4%	-6%

Groups matched across Years on: Transec, Wind, Precip, Count

Best Estimate: Matched Grouped ttests of Year Differences - grouped by Averages of Counts withir

		TotalsTOTAL		
2-tail non-pair homoscedastic ttests		TotalsTOTAL INDIG	EXOTIC	TotalsTOTAL ALL
1-year steps	2005-2006	0.4353	0.0250	0.0186
	2006-2007	0.0010	0.0010	0.0000
	2007-2008	0.1694	0.0199	0.0062
3-year steps	2005-2008	0.0926	0.4576	0.0617

Groups matched across Years on: Transec, Wind, Precip, Count

Good Estimate: Matched ttests of Year Differences - individual Counts within Transecs used

		TotalsTOTAL		
2-tail non-pair homoscedastic ttests		TotalsTOTAL INDIG	EXOTIC	TotalsTOTAL ALL
1-year steps	2005-2006	0.0221	0.0456	0.0017
	2006-2007	0.0002	0.0002	0.0000
	2007-2008	0.0821	0.1132	0.0158
3-year steps	2005-2008	0.0934	0.1056	0.0094

Raw Data: Average Change

Not Controlled for WIND or other factors

		TotalsTOTAL		
1 - (Yr_2_Avg - Yr_1_Avg)/Yr_1_Avg		TotalsTOTAL INDIG	EXOTIC	TotalsTOTAL ALL
1-year steps	2005-2006	-13%	-12%	-12%
	2006-2007	-21%	-20%	-20%
	2007-2008	28%	40%	35%
3-year steps	2005-2008	-12%	-1%	-6%

Ttests on raw data - not valid because not controlled for factors (Wind, Precip) or number of Transe

Crude ttests of Year Differences

		TotalsTOTAL		
2-tail non-pair homoscedastic ttests		TotalsTOTAL INDIG	EXOTIC	TotalsTOTAL ALL
1-year steps	2005-2006	0.0081	0.0238	0.0003
	2006-2007	0.0001	0.0011	0.0000
	2007-2008	0.0001	0.0000	0.0000
3-year steps	2005-2008	0.0182	0.8325	0.0712
2-year steps	2005-2007	0.0000	0.0000	0.0000
2-year steps	2006-2008	0.8320	0.0435	0.0450

Best Estimate: Average Change

1 - (Yr_2_Avg - Yr_1_Avg)/Yr_1_Avg		TotalsINDIG SP	TotalsEXOTIC SP	TotalsALL SP
1-year steps	2005-2006	-3%	-12%	-9%
	2006-2007	-23%	-29%	-27%
	2007-2008	-1%	8%	5%
3-year steps	2005-2008	-15%	-16%	-15%

Groups matched across Years on: Transec, Wind, Precip, Count
Best Estimate: Matched Grouped ttests of Year Differences - grouped by Averages of Counts within T

2-tail non-pair homoscedastic ttests		TotalsINDIG SP	TotalsEXOTIC SP	TotalsALL SP
1-year steps	2005-2006	0.6309	0.0270	0.0411
	2006-2007	0.0001	0.0000	0.0000
	2007-2008	0.9366	0.3236	0.4213
3-year steps	2005-2008	0.0059	0.0000	0.0000

Groups matched across Years on: Transec, Wind, Precip, Count
Good Estimate: Matched ttests of Year Differences - individual Counts within Transecs used

2-tail non-pair homoscedastic ttests		TotalsINDIG SP	TotalsEXOTIC SP	TotalsALL SP
1-year steps	2005-2006	0.3576	0.0391	0.0263
	2006-2007	0.0000	0.0000	0.0000
	2007-2008	0.8466	0.8321	0.9227
3-year steps	2005-2008	0.0880	0.0000	0.0000

Raw Data: Average Change
Not Controlled for WIND or other factors

1 - (Yr_2_Avg - Yr_1_Avg)/Yr_1_Avg		TotalsINDIG SP	TotalsEXOTIC SP	TotalsALL SP
1-year steps	2005-2006	-5%	-11%	-9%
	2006-2007	-16%	-20%	-19%
	2007-2008	4%	22%	15%
3-year steps	2005-2008	-18%	-13%	-14%

Ttests on raw data - not valid because not controlled for factors (Wind, Precip) or number of Transec
Crude ttests of Year Differences

2-tail non-pair homoscedastic ttests		TotalsINDIG SP	TotalsEXOTIC SP	TotalsALL SP
1-year steps	2005-2006	0.2478	0.0086	0.0034
	2006-2007	0.0003	0.0000	0.0000
	2007-2008	0.5260	0.0002	0.0002
3-year steps	2005-2008	0.0001	0.0010	0.0000
2-year steps	2005-2007	0.0000	0.0000	0.0000
2-year steps	2006-2008	0.0015	0.6355	0.0411

3 Chi-squared tests on raw data

ChiSquared Tests on Raw Data

Sum of BELLBIRDTOTAL	ChiTest
2005-2006	**0.001369004**
2005-2007	**1.55254E-09**
2005-2008	**0.891380375**
2006-2007	**0.004135158**
2007-2008	**3.53317E-09**

Sum of GREY WARBLERTOTAL	ChiTest
2005-2006	**0.002483947**
2005-2007	**0.241128734**
2005-2008	**0.862829322**
2006-2007	**0.060568871**
2007-2008	**0.317310813**

Sum of FANTAILTOTAL	ChiTest
2005-2006	**0.000126337**
2005-2007	**0.000265707**
2005-2008	**3.47734E-08**
2006-2007	**0.827259347**
2007-2008	**0.01255492**

Sum of TotalsTOTAL INDIG	ChiTest
2005-2006	**7.26075E-32**
2005-2007	**1.82933E-16**
2005-2008	**0.00323121**
2006-2007	**0.000146882**
2007-2008	**8.04998E-08**

Sum of TotalsTOTAL EXOTIC	ChiTest
2005-2006	**1.35753E-45**
2005-2007	**2.12509E-21**
2005-2008	**0.001566145**
2006-2007	**5.65743E-07**
2007-2008	**1.45255E-10**

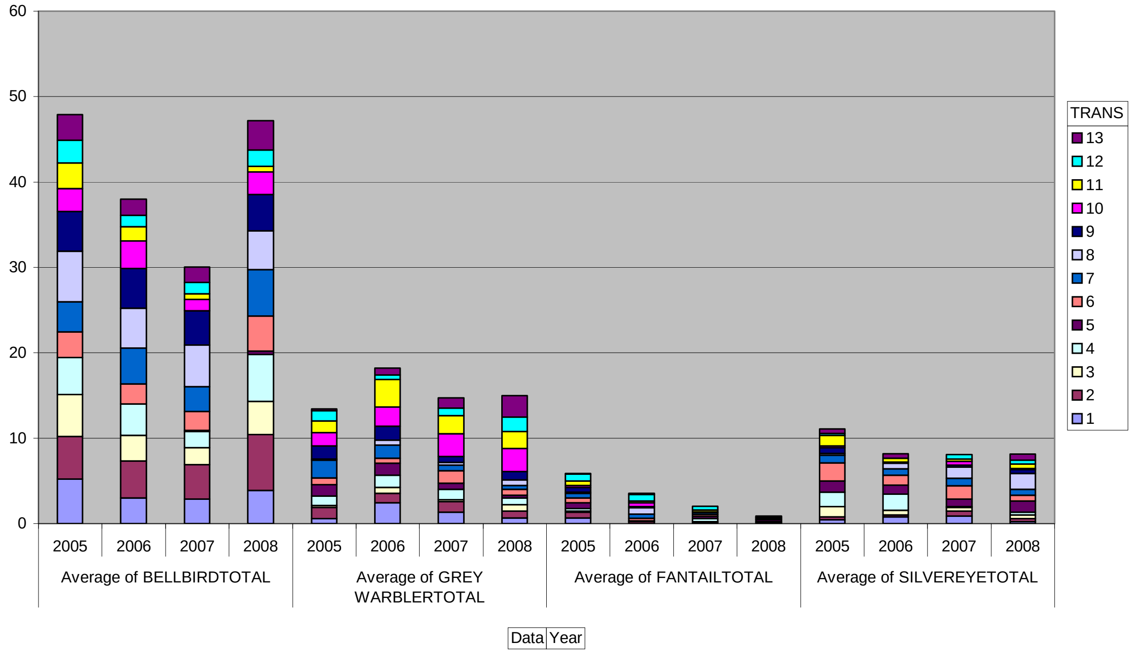
Sum of TotalsTOTAL ALL	ChiTest
2005-2006	**1.17019E-75**
2005-2007	**3.48617E-36**
2005-2008	**1.63701E-05**
2006-2007	**3.41096E-10**
2007-2008	**6.44898E-17**

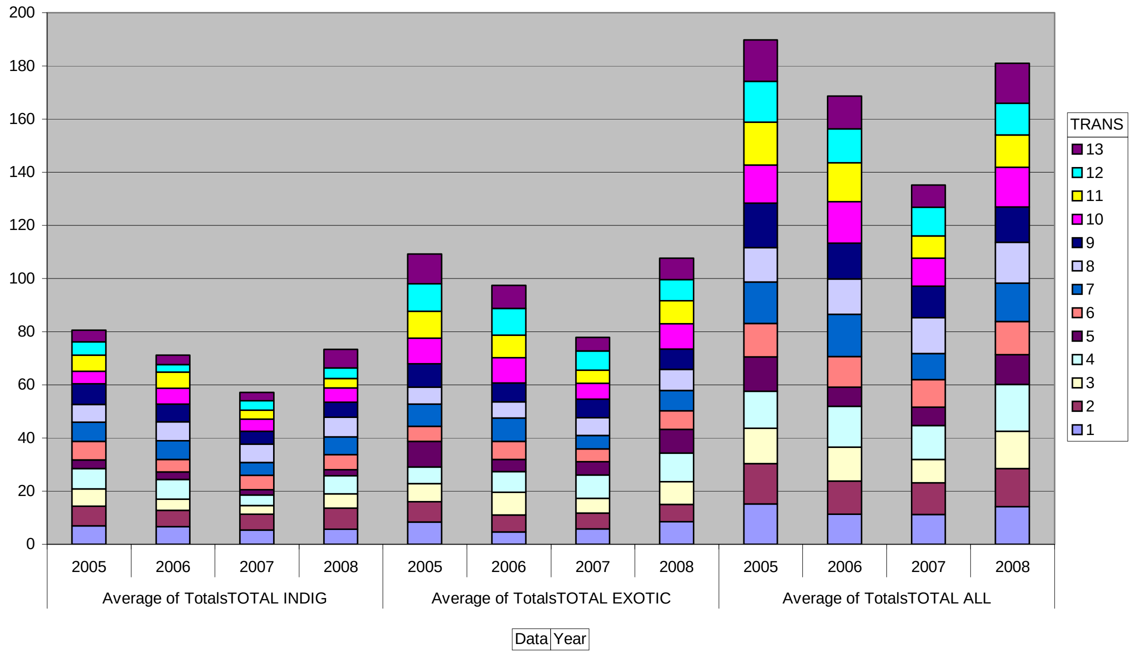
Sum of TotalsINDIG SP	ChiTest
2005-2006	**1.01657E-13**
2005-2007	**9.47003E-07**
2005-2008	**0.014756265**
2006-2007	**0.006832603**
2007-2008	**0.012222801**

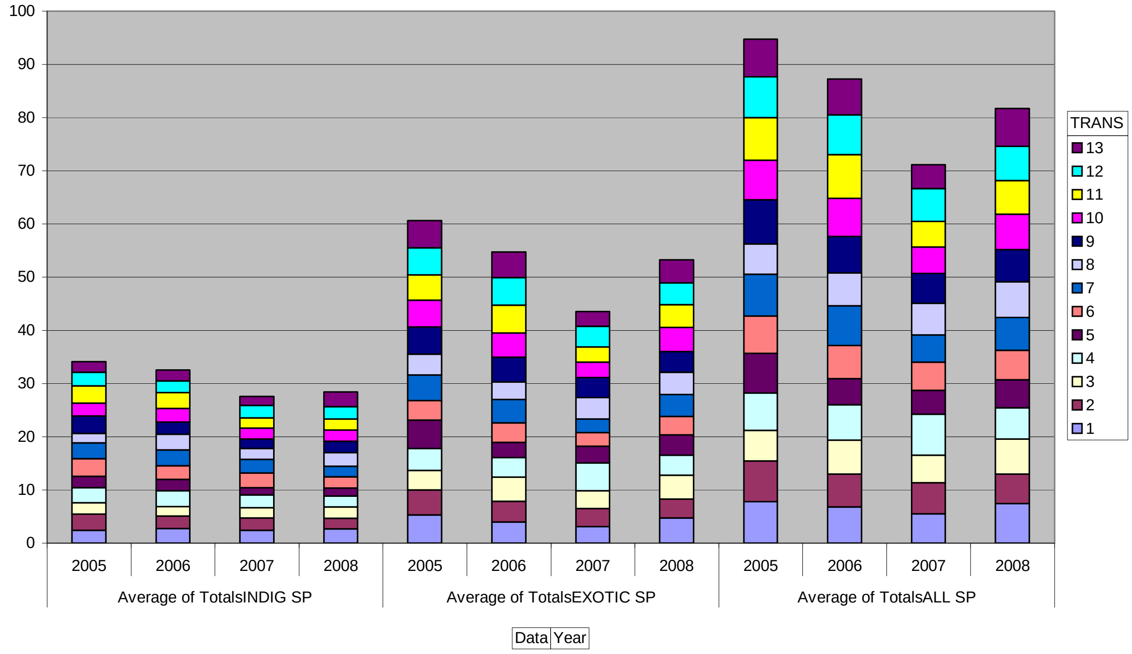
Sum of TotalsEXOTIC SP	ChiTest
2005-2006	**3.39397E-23**
2005-2007	**1.0958E-10**
2005-2008	**0.003340846**
2006-2007	**0.000238767**
2007-2008	**0.000361289**

Sum of TotalsALL SP	ChiTest
2005-2006	**2.70498E-35**
2005-2007	**5.43135E-16**
2005-2008	**0.000141264**
2006-2007	**5.07461E-06**
2007-2008	**1.30718E-05**

4 Yearly changes in average bird counts (stratified into transects)






100
90
80
70
60
50
40
30
20
10
0
2005
2006
2007
2008
Average of TotalsINDIG SP
Average of TotalsEXOTIC SP
Average of TotalsALL SP
TRANS
13
12
11
10
9
8
7
6
5
4
3
2
1
Data
Year