

Project Hurunui Wind



Interim Preconstruction Avifauna Monitoring Report
Prepared for Meridian Energy Limited

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Executive Summary

Meridian Energy Limited (Meridian) proposes to construct and operate a 33 turbine wind farm on privately owned farmland to the south of Greta Village in North Canterbury. In August 2009 Meridian engaged Boffa Miskell Limited (BML) to undertake an ecological assessment of their Hurunui Wind Farm proposal including an assessment of the effects of the proposal on avifauna.

The Assessment of Effects on Avifauna Report (Avifauna Assessment Report) (BML 2010b), that was attached to the original resource consent application, provided the results of a Level 1 avifauna study, an eight week Level 2 study undertaken between 19 November 2009 and 14 January 2010 and a desktop assessment of the risks to migratory shorebirds. This report also recommended that a full year's Level 2 pre-construction monitoring should be completed.

Since lodging the consent application, nine months of the recommended full year's Level 2 surveys (following the same methodology used in the Level 2 study (BML 2010b) but with four visits every season, i.e. 16 visits/year rather than weekly visits) have been completed. These surveys included point count samples, five-minute counts at forest sites, roaming counts and monitoring mast surveys.

This report provides the updated interim results of all the Level 2 surveys undertaken to date and based on this survey data, re-assesses the risk to the bird species recorded over the wind farm site.

The results obtained to date provide a representative sample of the diversity and behaviour of the birds across the site and the methodology has produced a comprehensive set of data that allows detailed analysis of the many variables likely to be associated with risk to avifauna.

The majority of the birds (in terms of numbers) within the wind farm site are introduced species reflecting the typically open, modified pastoral environment. Of the 34 bird species recorded within the site, half (17) were indigenous. Two of these are threatened; black-fronted tern and New Zealand falcon and two are classified as At Risk; New Zealand pipit and black shag.

Six indigenous species were recorded at blade height; black-backed gull, Australasian harrier, silvereye, welcome swallow, New Zealand pipit and paradise shelduck. With the exception of New Zealand pipit, all of these species are locally common and widespread.

There is a collision risk to black-fronted tern but this risk is considered to be low. However, given the conservation status of this species, collision fatalities could have a significant impact at the local and national population level. If blade strike monitoring demonstrates an adverse effect on black-fronted terns, appropriate mitigation will be required to address this effect.

There is a moderate collision risk to New Zealand pipit, which may have an impact on the local population, but adverse effects at the national population level are unlikely.

Only one black shag was recorded. The risk to this species is likely to be very low.

The risk to New Zealand falcon is reported on separately (Golder Associates 2010a, 2010b, 2010c).

In summary, a number of factors mean that many bird species are unlikely to be impacted by the proposed wind farm. These include a low diversity of indigenous birds in the study area, the location of turbines on high ridgelines and plateaus typically in pasture or silver tussockland, away from streams and wetlands, and with a large separation from forest remnants. Of the indigenous species that do frequent the wind farm footprint, only a small subset is active at heights that put them at risk of collision. With the exception of black-fronted tern, New Zealand falcon, New Zealand pipit and black shag, these species are widespread and abundant.

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1.0 Introduction

Meridian proposes to construct and operate a 33 turbine wind farm (Hurunui Wind) on privately owned farmland to the south of Greta Village in North Canterbury.

In August 2009 Meridian engaged BML to undertake an ecological assessment of their Hurunui Wind Farm proposal including an avifauna assessment. Detailed information on the wind farm site's existing ecological values and the project description are provided in the Ecological Values and Assessment of Effects Report (BML 2010a).

In addition to the avifauna assessment undertaken by BML, Meridian commissioned Golder Associates to carry out a falcon habitat suitability assessment. Early in the project, New Zealand (eastern) falcons were recorded on-site and an additional, comprehensive Level 3 study was developed for falcon. This work is reported on separately (Golder Associates 2010a, 2010b, 2010c).

As part of the avifauna assessment BML undertook a preliminary avifauna investigation (Level 1 study). This initial assessment identified it was possible that there were threatened bird species, which may be sensitive to wind farms, resident at the site or moving across the site. Recommendations were then made to Meridian for a more detailed (Level 2) avifauna assessment and a draft methodology was developed in October 2009.

The Assessment of Effects on Avifauna Report (Avifauna Assessment Report) (BML 2010b), that was attached to the original resource consent application, provided the results of this Level 1 avifauna study, an eight week Level 2 study undertaken between 19 November 2009 and 14 January 2010 and a desktop assessment of the risk to migratory shorebirds. This report also recommended that a full year's pre-construction monitoring (following the same methodology used in the Level 2 study (BML 2010b) but with four visits every season, i.e. 16 visits/year) should be completed¹ to:

- a) Establish seasonal variations in bird activity within the wind farm site;
- b) Determine whether any additional species, not recorded to date, utilise the site;
- c) Obtain a robust data set for comparison with post-construction monitoring, and;
- d) More accurately determine the collision risk to black-fronted tern.

Since lodging the consent application BML has been able to complete nine months of the recommended full year's Level 2 preconstruction avifauna monitoring surveys (between November 2010 and July 2011). Surveys could not be undertaken in August, September or October of 2011 to complete the full years pre-construction monitoring because the bird survey team were not able to access the site during the lambing period. However, completion of a full year's pre-construction monitoring prior to the construction of the wind farm is a requirement of consent conditions proposed by Meridian and these surveys will be undertaken as soon as access to the site is possible during this period.

The Hurunui Wind project application was referred directly to Environment Court and primary evidence relating to avifauna was prepared by Scott Hooson (BML) on behalf of Meridian. This evidence provided a summary of the findings of all the Level 2 survey data including the nine months of surveys between November 2010 and July 2011. However, more detailed information incorporating the results of the additional Level 2 surveys is required for the Hurunui District Council

¹ The Avifauna Assessment Report identified that access to the wind farm site may not be possible during the months of August, September and October when lambing occurs.

and section 274 (opposition) parties to consider the findings and evaluate the potential effects of the proposed wind farm on birds.

The purpose of this report is to provide that detailed information incorporating the results of the additional Level 2 surveys. The updated interim results of all the Level 2 survey data (i.e. the eight week study (19 November 2009 to 14 January 2010) and the subsequent Level 2 surveys (8 November 2010 and 29 July 2011)) is provided, and the risk assessment for the birds recorded at the wind farm site² is updated. A final report will be completed following the completion of the full years pre-construction monitoring (i.e. when Level 2 surveys have been completed for the months of August, September and October).

2.0 Methodology

The Level 1 study and migratory shorebird desktop assessment methodologies are provided in the Avifauna Assessment Report that was attached to the original resource consent application. The Level 2 study objectives and methodology are the same as that outlined in that report, but for ease of reference they are also provided below.

2.1 Objectives

The Level 2 study sought to determine the distribution and abundance of all avifauna within and immediately adjacent to the proposed project footprint, and to describe their behaviour and susceptibility to turbine interactions.

The study focus is on species that are nationally 'Threatened', 'At Risk' (Miskelly *et al.* 2008) or locally or regionally rare; however, the potential effects to species that are not threatened are also considered.

The methodology requires that if populations of key indigenous bird species are located and found to be breeding, then Level 2 studies will be supplemented with more detailed Level 3 studies.

The objectives of this Level 2 study were:

- To provide a comprehensive list of the bird species present, and document their distribution across the site, their habitat use, patterns of movement and behaviour.
- To establish a baseline to contextualise potential post construction effects³.
- To provide sufficient data to develop a risk profile for "sensitive" indigenous species.
- To provide sufficient information to inform the design of risk mitigation measures, if necessary.

² New Zealand falcon and migratory shorebirds are not covered in this report. Golder Associates were commissioned by Meridian to assess the risk the proposed wind farm presents to falcon and this work is reported on separately. The results of the migratory shorebird assessment is provided in the Avifauna Assessment Report that was attached to the original resource consent application.

³ If post-construction monitoring is deemed necessary.

2.2 Project Team

The project team consisted of:

Scott Hooson (Boffa Miskell Ltd)	-	Project Manager Avifauna
Dr Katrina Hale	-	Field Team Leader
Niall Mугan	-	Field Team

2.3 Field Methods

The initial 8 week period of weekly Level 2 surveys commenced on 19 November 2009 and was completed on 14 January 2010. Further Level 2 surveys were undertaken four times per season (i.e. four times per three month period) between 8 November 2010 and 29 July 2011. However, the full year's pre-construction monitoring could not be completed. Surveys could not be undertaken in August, September or October of 2011 because the bird survey team were not able to access the site during the lambing period.

2.3.1 Fixed point – fixed period bird utilisation surveys at point count stations

The core component of this study consisted of a bird utilisation survey based upon fixed point, fixed period counts. This is a standard technique for bird utilisation surveys at wind farm sites based upon guidelines developed in Canada (Bird Studies Canada 2003, CANWEA 2006) and Australia (AUSWEA 2005) and is the most commonly used method for generating quantitative data on bird use of a potential wind farm site (AUSWEA 2005). It has been used several times in New Zealand, for example at Titiokura and Te Waka (Hawkes Bay), West Wind (Wellington), Taharoa (Waikato), Central Wind (Waiouru), and Poutu (Northland). It has been modified slightly to take account of our local conditions (weather, terrain) and the habitat preferences and behaviours of our wildlife.

Thirteen point count stations were located at proposed turbine locations across the proposed Hurunui Wind Farm site. These sites represent over a third of the proposed wind turbine locations, which is consistent with standard international methodology (National Wind Coordinating Committee 1999)⁴. Wherever possible, count sites corresponded to every third turbine, working inward from the last turbine of each turbine chain. The last turbine in the chain is chosen as research suggests these particular turbines can have a disproportionate risk of bird collision (Smallwood and Thelander 2004 cited in Powesland 2009a). In addition, five count stations⁵ were established in locations that are a minimum of 500 metres from the nearest turbines. They are spread across the site and represent the turbine sites as closely as possible in terms of habitat and landscape setting and provide 'controls' for post-construction comparisons with and without turbines.

⁴ For large wind farms (>10 turbines) 30% coverage is considered appropriate (NWCC 1999). CANWEA similarly suggests that for larger wind farms (>11 turbines) a sub-sample of turbine locations should be chosen which should include at least one example (preferably more) of turbines from different habitat types. AUSWEA only requires that the location of point count sites should be representative of site conditions and the basis for site choice reported.

⁵ CANWEA suggests that a matched pairs design is not normally required but an appropriate number of reference (control) sites should be located in habitat similar to that of the wind farm site. AUSWEA similarly suggests a suitable number of reference sites should be counted with the same survey effort, they should be between 500m and 1500m from the nearest wind turbine site, and located in similar habitats and landscape settings to the "impact" sites. On the basis of these recommendations, and taking into account the limited variability of the site, five reference sites are considered to be appropriate.

Prior to the commencement of the additional Level 2 surveys in November 2010, three point count sites (including one control site) were relocated. During the original survey turbines A12 and D15 were selected as count sites, because at the time of designing the survey, they were the last turbine on each turbine chain. Turbines A12 and D15 were subsequently removed from the wind farm proposal. To ensure that the point count sites represented actual proposed turbine locations, new sites were established at turbine locations A11 and D14 which are now the last turbines in their respective chains. Control site 5 was also moved further downhill to the southeast (and re-named Control Site 5a), to ensure that it was further than 500 metres from turbine A2. The new and original point count locations are shown on Maps 1 and 2 respectively in Appendix 2).

Generally, the turbine sites at Project Hurunui Wind are on improved pasture or pasture and silver tussock; however, some of the sites selected also have rocky outcrops, adjacent shrublands and stock ponds. The locations of the point count stations are provided in Table 1 and are shown in Map 1 (Appendix 2) and habitat descriptions for each of the point count stations are provided in Table A1.1 (Appendix 1). Sufficient locations were sampled to provide a representative picture of the project area.

Table 1: Locations of point count bird survey stations

Turbine	Grid Reference (NZMG)	
	Easting	Northing
A1	2504602	5798706
A4	2505412	5800260
A9	2506799	5802065
A11	2507855	5802621
A12	2507832	5802891
B1	2504211	5799166
C1	2505563	5801469
D1	2502238	5798968
D12	2505999	5802357
D14	2506707	5802828
D15	2507388	5803281
D4	2503400	5799814
D7	2504261	5801142
E1	2504396	5800561
G1	2504899	5802195
Control Sites		
R1	2508428	5803014
R2	2505955	5803015
R3	2502909	5800333
R4	2506080	5800072
R5	2505538	5799136
R5a	2505154	5798414

During the initial period of weekly Level 2 surveys (19 November 2009 to 14 January 2010) each point count station was visited weekly for eight weeks. During the subsequent Level 2 surveys between 8 November 2010 and 29 July 2011 each point count station was visited four times in every season (i.e. four times in every three month period). The first 8 week period of monitoring was more intensive than the latter surveys, which were undertaken to record bird utilisation across the site over a much longer period. The counts involved two people stationed at a point, one

observing, and the other recording. All bird observations within a zone of 180°⁶ and a 100 m radius⁷ from the fixed survey point were recorded for a period of 30 minutes⁸.

Bird observation began after a five minute stand down period to allow for any disturbance by sampler arrival to settle. During the stand-down period a range of information was recorded including weather conditions: wind direction and approximate speed; temperature; percent cloud cover; precipitation; and visibility (refer to the point count survey data sheet, Appendix 3).

Once bird observations commenced, all indigenous and introduced birds that were observed within the fixed-point study area were recorded. For each bird or group of birds seen, the species, number of birds, distance and direction from observer, direction of movement, minimum and maximum height⁹, relative height in relation to the rotor swept height (RSH) and behaviour was recorded. This information was recorded on standardised record forms (Appendix 3).

Information on bird utilisation was classified by the type of activity: traverse, depart, arrive, feeding (ground, air, and canopy), short flight and breeding. Bird breeding was similarly recorded with a notation including nest with eggs, newly hatched, newly fledged, adult distraction display, display flight, male song posting, and adult with nest material or food.

The 180° x 100m survey zone was measured during project setup, with distances to obvious landmarks (vegetation boundaries, gates, roads, trees) identified to assist in determining the distance to the birds and their height. Staff were also trained to estimate height using known height references (i.e. power poles, monitoring masts). The rotor swept area for the proposed turbines at Hurunui Wind is between 29.5 and 130.5 m. Acknowledging the difficulties associated with estimating bird heights, a conservative height range relative to the proposed RSH was assessed as follows: below observer, less than 25 m (below); 25 to 135 m (at) and greater than 135 m (above).

2.3.1.1 Accounting for variation

The distribution, behaviour, and habitat needs of birds vary seasonally, for example kereru may visit the wind farm site to feed when particular trees are fruiting and bellbirds may traverse the site more often when kowhai are flowering. Ideally, to account for seasonal variation, bird activity would have been assessed over the following periods:

- 1) 1 September – 30 November (spring)
- 2) 1 December – 28/29 February (summer)
- 3) 1 March – 31 May (autumn)

⁶ Some methodologies require sampling over a full 360°, others a 180° semicircle. This was trialled by BML and it was concluded that there were practical difficulties observing accurately over 360° particularly when dealing with sites like Hurunui Wind which contain large numbers of small passerines.

⁷ AUSWEA recommends a search radius of 100m for small passerines and up to 800m for large raptors and large waterfowl. CANWEA recommends a search radius of 50m for small passerines and unlimited for larger species. The great majority of bird activity at Central Wind was of small passerines and so it was decided that a 100m radius was appropriate. This has been trialled at other sites and in our view provides a good balance of site coverage and accurate identification. Roaming counts, discussed below, are intended to provide detail on larger and less abundant birds.

⁸ AUSWEA recommends between 15 and 45 minutes count duration. CANWEA suggests 5 to 10 minutes for small passerines and 30-60 minutes for larger species. In 2005, BML trialled a range of sampling durations, from 15 minutes to 1 hour, at the Titiokura Wind farm site. It was our conclusion that in 30 minutes of observation all species likely to use the site were normally recorded. Beyond 30 minutes there were diminishing returns in terms of data collected versus effort.

⁹ The minimum and maximum heights recorded are heights above the ground. The steep nature of the wind farm site, which has numerous deep gullies, has implications for how this height information is interpreted. For example, a minimum and maximum height of 10 and 150 m may indicate that a bird flew across the top of a ridge at 10 m above the ground and then maintained its original height but flew over a 140 m deep gully.

4) 1 June – 31 August (winter)

The initial counts were undertaken over an eight week period between November 2009 and January (spring/summer) and the additional Level 2 surveys were undertaken between November 2010 and July 2011 (part spring, summer, autumn and part winter). Surveys could not be undertaken in August, September or October of 2011, to complete the full year's pre-construction monitoring, because the bird survey team were not able to access the site during the lambing period. Completion of a full year's pre-construction monitoring is important and was recommended in the Avifauna Assessment Report. Completion of these surveys is a requirement of the consent conditions proposed by Meridian which will ensure that four seasons of bird monitoring will be completed prior to the construction of the wind farm.

To account for daily variation in bird activity, the schedule for point surveys was staggered so that the survey points were visited at different times of day. Daily variation of bird activity was assessed over four periods:

- 1) Early morning (no earlier than 30 minutes after sunrise up until 10:30)
- 2) Late morning (10:30 to 12:00)
- 3) Early afternoon (12:00 to 14:30)
- 4) Late afternoon (14:30 up until no later than 30 minutes before sunset).

These periods are not fixed due to changing day length within the season and daylight saving. A schedule of counts was developed as per Table 2 to ensure an even spread of observation times for each site.

Table 2: Example of a schedule of surveys developed for point counts

Count Station	Survey Schedule			
	Early morning	Late morning	Early afternoon	Late afternoon
A1				
A2				
etc.				

In order to reduce the effects of weather on bird detection, surveys were not carried out during persistent precipitation, or when visibility was less than 200 m.

To date, a total of 358 point counts or 179 hours of survey time have been completed.

2.3.2 Roaming counts

Roaming counts (or incidental observations) consist of any notable observations made outside of the formally defined methods of data collection. For instance, birds were recorded while walking/driving between observation points and during point counts where notable species were seen at a distance but did not enter the sample site. Roaming count observations were recorded on standardised data sheets, an example of which is attached in Appendix 3. The data provides additional anecdotal information on the presence, absence, distribution and behaviour of bird species within the site and supplements the point count data to provide a complete species list for each observation period.

The focus of roaming counts was:

- 1) Indigenous water birds;
- 2) Uncommon sea or shorebirds;

- 3) Any other unusual or infrequently seen indigenous species.

Other behaviours that were recorded included unusually large numbers of common or introduced species, or unusual and noteworthy behaviour encountered. Records focused on birds utilising and traversing the site, however any observations made within 1-2 km of the property boundary were also noted. Roaming counts included information on all environmental variables at the time of observation as per the point counts. Observers also noted the habitat type in which the bird was seen and the distance to the nearest proposed turbine location, along with the bird's height range¹⁰, behaviour, and direction of movement.

2.3.3 Monitoring mast searches

The base of the monitoring mast was searched during each survey period to locate any dead birds which may have encountered the mast or its guys. A distance of 50m around the base of the tower was searched for any evidence of dead birds (e.g. carcasses, feathers, bones). Search times were between 20 to 30 minutes. An example of a field data sheet for mortality searching is attached in Appendix 3.

2.3.4 Five minute bird counts

Five minute bird counts in scrub and forest habitats were added to the methodology because none of the point count sites are located near forest habitats and therefore do not record bird activity within areas of forest. Forested areas within the wind farm site are restricted to the bottoms and SE facing sides of a few of the deeper gullies and none of the proposed turbine sites are situated close to forest margins. However, five minute bird counts were considered necessary to describe which bird species are present within scrub or forest habitats and could, therefore, potentially be at risk of collision with turbines, when travelling between scrub or forest areas, or be otherwise affected by the wind farm.

Five minute bird counts are a standard sampling method used to assess relative bird abundances in New Zealand (Dawson and Bull 1975). Counts were undertaken in scrubby or forested gullies within the wind farm site. Eight bird count locations were originally established on the margins of scrub and forest habitats (Map 1, Appendix 2) and were at least 200m apart. Counts were conducted according to the methodology of Dawson and Bull (1975) and Spur and Powesland (2000) (also, refer to the attached five minute bird count data sheet, Appendix 3).

Prior to the commencement of the additional Level 2 surveys (i.e. before 8 November 2010) five minute bird count sites 3 and 4 were re-located to more appropriate locations (see Map 1, Appendix 2). Site 3 was moved to a forested gully south of its original location and site 4 was moved into an area of kowhai forest in the bottom of the gully in the upper Motunau River catchment. In this report, the new sites are labelled as sites 9 and 10. The results of the five minute bird counts are presented as the average number of birds recorded/five minute bird count and the number of five-minute bird counts undertaken at each site is provided in the third row of Table 12 (Section 3.3).

To date, a total of 145 five minute bird counts or 725 minutes of survey time have been completed.

¹⁰ As for the minimum and maximum heights recorded during the point counts, these are the heights above the ground. The steep nature of the wind farm site, which has numerous deep gullies, has implications for how this height information is interpreted. For example, a minimum and maximum height of 10 and 150 m may indicate that a bird flew across the top of a ridge at 10 m above the ground and then maintained its original height but flew over a 140 m deep gully.

2.4 Quality Control

Quality control measures were implemented at all stages of the Level 2 studies, including field data collection, data entry, data analysis, and report preparation. At the end of each survey day, the field staff reviewed the data forms for completeness, accuracy, and legibility. These forms were also reviewed in the office for completeness, accuracy, and legibility and any issues were reported back to the field staff.

A Microsoft Access database was established to store, retrieve, and organize field observations. All field data forms and electronic data files have been retained for ready reference.

Once the data had been entered into the Microsoft Access database it was compared to the completed data sheets to detect any errors. Any irregular codes that were detected or any unclear or ambiguous data was discussed with the observer.

3.0 Updated Interim Results

This section presents the updated interim results of the Level 2 pre-construction avifauna monitoring undertaken at the proposed Hurunui Wind Farm. The results incorporate the data collected between 19 November 2009 to 14 January 2010 and 8 November 2010 and 29 July 2011.

The results of the Level 1 study and the migratory shorebird desktop assessment are provided in the Avifauna Assessment Report that was attached to the original resource consent application. The following section only presents the updated results of the Level 2 study.

An updated list of the species recorded within the ecological district (DOC 2000), wider area (Robertson *et al.* 2007) and by BML within the wind farm site is provided in Table A1.2 in Appendix 1. Three new species including two indigenous (black shag and New Zealand pipit) and one introduced species (little owl) were recorded onsite during the Level 2 studies that were not recorded during the earlier Level 1 study or the initial eight week Level 2 study. In total 34 species have been recorded within the wind farm site, of which half (17) are indigenous.

3.1 Point Count Station Results

3.1.1 Species presence and abundance

Table 3 shows the total number of birds observed at the point count stations and the contribution of each species to the total number of observed birds.

The table is read as follows: there were 1040 observations of greenfinches at point count stations throughout the wind farm and this species represents approximately 27% of all the bird observations made during point counts.

Table 3: Total number and proportion of each species recorded in point count bird surveys (listed from highest to lowest).

Species ¹¹	All bird observations	% of all observations by species	50%	75%	90%	95%
Greenfinch*	1040	27.46%				
Goldfinch*	466	12.30%				
Yellowhammer*	411	10.85%				
Chaffinch*	355	9.37%				
Starling*	272	7.18%				
Redpoll*	243	6.41%				
Silvereye	177	4.67%				
Skylark*	177	4.67%				
Australian magpie*	135	3.56%				
Rock pigeon*	74	1.95%				
Paradise shelduck	72	1.90%				
Australasian harrier	59	1.56%				
Dunnock*	56	1.48%				
Welcome swallow	54	1.43%				
New Zealand pipit	52	1.37%				
Black-backed gull	50	1.32%				
Grey warbler	22	0.58%				
Spur-winged plover	22	0.58%				
Blackbird*	16	0.42%				
Unknown	12	0.32%				
Song thrush*	11	0.29%				
Mallard*	3	0.08%				
Finch sp. *	3	0.08%				
New Zealand (eastern) falcon	2	0.05%				
White-faced heron	2	0.05%				
South Island fantail	1	0.03%				
House sparrow*	1	0.03%				
Total observations	3788	100.00%				

In total 26 species were recorded during point counts of which 11 are indigenous. In terms of relative abundance, the results indicate that the great majority (86%) of all of the birds counted during point counts at the proposed turbine sites are introduced. Three species, greenfinch, goldfinch and yellowhammer contributed over 50% of all bird observations and 11 species, nine of which are introduced, contributed 90% of all bird observations. The most common indigenous species recorded during point counts were silvereye (4.7% of observations), paradise shelduck (1.9%), Australasian harrier (1.6%), welcome swallow (1.4%), New Zealand pipit (1.4%) and black-backed gull (1.3%). The remaining indigenous species contribute less than one percent of the total bird activity recorded during point counts on the site.

3.1.2 Species distribution

Table 4 shows the distribution of indigenous species across the various point count sites. Table A1.3 in Appendix 1 provides detail on all bird observations at point count sites including those of introduced species.

¹¹ Throughout the tables in this report an asterisk (*) is used to denote introduced bird species. Those without an asterisk are indigenous species.

The results indicate that as expected, there is some variation in indigenous bird distribution between different point count stations (refer to Table A1.1, Appendix 1 and Map 1, Appendix 2, respectively, for descriptions of the habitats present at each point count station and the locations of the point count stations). Based on our knowledge of the site, this can be attributed to factors such as the presence or lack of appropriate habitat, or the location of a count station in relation to obvious corridors of bird movement. For instance, the control sites are located at a lower elevation than the proposed turbine sites and are near regenerating grey shrubland and scrub where frequent movement of indigenous bird species (particularly silvereyes) was observed. In comparison, site C1 is located on the central high point of the site and is surrounded by improved pasture. Generally, where count stations were located close to grey shrubland and scrub margins more indigenous species were recorded. For example, 92 of the 177 observations of silvereyes were at control sites 2 - 5 (where turbines will not be located) which are at lower elevations than the proposed turbine sites and are located in close proximity to grey shrubland and scrub. The one South Island fantail recorded was at control site 4, also in close proximity to grey shrubland and scrub.

Table 4: The distribution of indigenous bird species across the site, in point count bird surveys.

Monitoring site	Australasian harrier	Black-backed gull	Grey warbler	New Zealand (eastern) falcon	New Zealand pipit	Paradise shelduck	Silvereye	South Island fantail	Spur-winged plover	Welcome swallow	White-faced heron	Total
A1	2	6	2		8		5					23
A4	3				1	2	19			2		27
A9	2	7			4	4	15		8	9		49
A11 ²			1		2		8		2			13
A12 ¹	2	2	1				1			6		12
B1	6	4	1		5		1		1			18
C1		1								3		4
D1	4	3			10	3	2			4	2	28
D4	2	3	1		2		1			1		10
D7	3	4		1	4	46						58
D12	6	7			2		6		1	3		25
D14 ²	5	4			1	2						12
D15 ¹		1				2			4	4		11
E1	3	4		1	1	2	7			1		19
G1	2	3	3				20					28
Control site 1	6					10				1		17
Control site 2	7	1	1		2	1	20			17		49
Control site 3	3		1		1		20					25
Control site 4	2		7				37	1	2	2		51
Control site 5 ¹			4				1			1		6
Control site 5a ²	1				9		14		4			28
Total	59	50	22	2	52	72	177	1	22	54	2	513
% of Indig spp.	12%	10%	4%	0%	10%	14%	35%	0%	4%	11%	0%	100%

¹ Surveys November 2009 to January 2010.

² Surveys November 2010 to July 2011.

Black-backed gulls and Australasian harriers were recorded throughout the wind farm site. Paradise shelduck were recorded frequently at count site D7. Forty-two of the 46 observations at this count station were repeat observations of a resident adult pair with ducklings that occupied a small stock pond within the survey zone during the November 2009 to January 2010 surveys. Only two white-faced herons were recorded during counts and they were seen flying together from count station D1. Two observations of single New Zealand falcon were made at count stations D7 and E1 during point counts.

3.1.3 Seasonal variation

Table 5 shows the number of indigenous species recorded per count station by month. Table A1.4 in Appendix 1 provides this information for all bird observations including those of introduced species.

New Zealand pipits were only recorded at point count stations between February and July 2011 and they were most frequently recorded between February and April 2011. Silvereyes were most frequently recorded between March and June in 2011 and the number recorded per point count survey was particularly high in April 2011 (2.32 birds/count station). Grey warbler and welcome swallow were recorded in higher numbers over the summer months, but little seasonal variation is apparent for the remaining indigenous species. Australasian harrier and silvereye were the only indigenous species recorded during point counts in every month surveyed.

Table 5: The average number of indigenous birds recorded/point count survey by month (listed in alphabetical order) (the number of point counts undertaken in each month is provided in the third row of the table).

Year	2009		2010			2011							
Month	Nov	Dec	Jan	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	
Counts/month	34	72	36	18	18	36	18	35	19	18	18	36	Avg
Australasian harrier	0.15	0.14	0.22	0.06	0.06	0.31	0.11	0.17	0.37	0.06	0.11	0.14	0.16
Black-backed gull	0.21	0.21	0.17		0.06	0.22		0.14				0.22	0.14
Grey warbler	0.06	0.03	0.19			0.03	0.22	0.11	0.05		0.06		0.06
NZ (eastern) falcon		0.01				0.03							0.01
NZ pipit							0.72	0.29	0.63	0.17	0.28	0.25	0.15
Paradise shelduck	0.09	0.51	0.11	0.11				0.43	0.11	0.11		0.19	0.20
Silvereye	0.35	0.22	0.53	0.39	0.39	0.03	0.33	0.71	2.32	0.67	0.61	0.47	0.49
S.l. fantail								0.03					<0.00
Spur-winged plover	0.03	0.01	0.06		0.22	0.06	0.11	0.11		0.11	0.22		0.06
Welcome swallow	0.15	0.19	0.25	0.06	0.33	0.42		0.03	0.05			0.06	0.15
White-faced heron	0.06												0.01
TOTAL	10.8	13.1	16.4	13.2	9.6	7.0	8.8	7.9	10.1	8.5	8.1	8.4	10.6

3.1.4 Identification of species at risk of collision

Table 6 summarises data on the height that indigenous birds were observed flying relative to the height of the proposed turbines and the RSH at each of the point count stations (including the five control sites). Table A1.5 and the graphs in Figure A1 in Appendix 1 present the same data for all bird species.

Table 6: The number of observations of each indigenous bird species (listed in alphabetical order) recorded at each height band relative to the proposed RSH during point count surveys.

Species Name	Heard, not seen	Below observer	Below blade <25 m	At blade height 25 - 135 m	Above blade height 135 m +	Total
Australasian harrier		15	12	9	23	59
Black-backed gull		6	5	8	31	50
Grey warbler	4	16	2			22
New Zealand (eastern) falcon		1	1			2
New Zealand pipit	9	21	6	11	5	52
Paradise shelduck		49	10	12	1	72
Silvereye	11	69	22	31	44	177
South Island fantail		1				1
Spur-winged plover		16	6			22
Welcome swallow	1	25	11	9	8	54
White-faced heron		2				2
TOTAL	25	221	75	80	112	513

The majority of species recorded were below the observers (i.e. below the base of the turbine site). This is because many of the turbine sites are located on raised knolls or ridges and birds traversed around the sides of them below the observers. Notable exceptions to this were black-backed gulls and Australasian harriers, which were more frequently observed flying above blade height. Although the highest proportions of silvereyes were recorded below the observers, a relatively high proportion was also recorded above blade height.

Two New Zealand falcons were observed during point counts. Both birds flew below the proposed turbine blade height. The risk the proposed wind farm presents to falcon at this site is discussed in more detail in separate reports (Golder Associates 2010a, 2010b, 2010c).

Table 7 considers the risk of bird strike by focusing on the subset of observations of indigenous birds at the height of the proposed turbine blades (25 to 135 m, within RSH). The table is read as follows; 31 silvereyes were observed at turbine blade height which equates to 17.5% of total silvereye observations and approximately 39% of all indigenous bird observations at turbine blade height. Table A1.6 in Appendix 1 presents data on all bird species observations at blade height.

Table 7: Percentage of observations of indigenous bird species (listed from highest to lowest) recorded at the proposed RSH during point count bird surveys

Species	All birds observed at blade height	At risk as % of species observations	% of all indigenous birds observed at blade height
Silvereye	31	17.5	38.8
Paradise shelduck	12	16.7	15.0
New Zealand pipit	11	21.2	13.8
Australasian harrier	9	15.3	11.3
Welcome swallow	9	16.7	11.3
Black-backed gull	8	16.0	10.0
Total	80		100

Of the eleven indigenous species recorded during point counts six were observed flying at blade height. These were: silvereye, paradise shelduck, New Zealand pipit, Australasian harrier, welcome swallow and black-backed gull. Twenty-one, 18, 17, 17, 16, and 15% of observations of New Zealand pipit, silvereye, paradise shelduck, welcome swallow, black-backed gull and Australasian harrier, respectively, were within the RSH. With the exception of New Zealand pipit, which is classified as 'At Risk' (Declining), these species are locally and nationally common.

3.2 Roaming Counts

Table 8 shows the numbers of bird species recorded during roaming counts. Observations of the two Threatened species; black-fronted terns and New Zealand falcon and the two At Risk species; New Zealand pipit and black shag are discussed in more detail below.

Four species were observed during roaming counts that were not recorded during point counts. They are black-fronted tern, California quail, house sparrow and mallard. Large flocks of starling (up to 250) and greenfinch (up to 200) were recorded during roaming counts in pastoral habitats within the site.

Black-fronted terns were recorded during roaming counts on four separate days. This included three observations of 6, 2 and 1 birds on 22 December 2009, a single bird on 14 January 2010, another single bird on 4 December 2010 and two observations of 5 and 3 birds on 9 January 2011 (Table 9). At times these birds were observed flying close to proposed turbine sites and at blade height.

Table 8: Birds recorded (listed from highest to lowest) during roaming count bird surveys (outside of formalized point count and five minute bird count periods)

Species	Count
Starling*	1129
Greenfinch*	278
Silvereeye	88
Paradise shelduck	85
Skylark*	70
Australasian harrier	69
Black-backed gull	58
Mallard*	57
Rock pigeon*	57
Australian magpie*	55
New Zealand pipit	33
Black-fronted tern	21
Spur-winged plover	20
Welcome swallow	16
Yellowhammer*	15
New Zealand (eastern) falcon	7
House sparrow*	6
Bellbird	5
Shining cuckoo	3
South Island fantail	2
White-faced heron	2
Black shag	1
Little owl*	1
California quail*	1

Table 9: Details of black-fronted tern observations recorded during roaming count bird surveys

Date	Time	Number of birds	Nearest turbine	Distance from nearest turbine (m)	Min height (m)	Max height (m)	Behaviour	Habitat
22/12/2009	0900	2	E1, D5	100	200	300	Traversing /flying	Grassland, gully
22/12/2009	0945	1	D5	300	0	30	Feeding (air)	Grassland, pond
22/12/2009	1000	6	Various	Various	100	300	Traversing /flying	Grassland, shrubland, gully
14/01/2010	1100	1	A6, A7	0-100	10	250	Traversing /flying	Grassland
4/12/2010	?	3	?	100	110	300	Traversing /flying	Grassland
9/01/2011	0900	5	D13	0	100	400	Traversing /flying	Grassland, shrubland
9/01/2011	0950	3	A9	200	30	250	Traversing /flying	Grassland, shrubland

The first observation on 22 December was of two birds traversing a pasture and scrub gully at between 200 and 300 m above the ground. They were recorded at 09:00 between turbine sites E1 and D5 and flew to within approximately 100 m of the proposed turbine sites. One was carrying a small food item in its mouth (now thought to have been a lizard). Forty-five minutes later (09:45) a single bird was seen, at five minute bird count site number 5, flying and feeding between ground height and 30 m above the pasture in the vicinity of a small stock pond. Two pairs (one bird carrying a small food item) were sighted from turbine site E1 15 minutes later (10:00) flying over pasture and shrubland gullies at various heights throughout the Stephenson and Turnbull properties. They were then joined by two more birds. A single black-fronted tern was observed at 11:00 on the 14 January 2010 within 100m of turbine sites A6 and A7. It was flying at heights ranging between 10 and 250 m above the ground over grassland and was recorded as carrying a fish (now thought be a lizard). On the 4 December 2010 three black-fronted terns were observed flying at between 110 and 300 m over grassland within 100 m from a turbine (turbine not recorded). At 09:00 on 9 January five birds were observed in the vicinity of turbine D13 flying at between 100 and 400 m in height over grassland and shrubland. 50 minutes later three birds were observed flying at between 30 and 250 m over similar habitat 200 m from turbine A9.

Black-fronted terns were also recorded incidentally on two days by the falcon monitoring team. Two birds were observed on the 4 November 2010 near turbine C1. They were exhibiting foraging behaviour and seemed to be concentrating their efforts over tussock (R. Seaton pers. comm. 2010). Three separate sightings of single black-fronted terns were made from a vantage point very close to Turbine E1 on 9 December 2010 at 07:26, 08:54 and an unrecorded time presumably after 08:54. The first observation was of a bird flying over the main ridge at a height of 40 - 70m, the second was of a bird flying over a ridge at 10 - 25 m and the third was of a bird on the main ridge flying at a height of 20 m.

Table 10: Details of New Zealand (eastern) falcon observations recorded during roaming count bird surveys

Date	Number of birds	Nearest turbine	Distance from nearest turbine (m)	Min height (m)	Max height (m)	Behaviour	Habitat
25/11/2009	1	A1, B1	100	100	400	Traversing /flying	Grassland, scrub
18/12/2009	1	F1	0-100?	1	50	Breeding? carrying food	Gully with matagouri and cabbage trees
13/02/2011	2	D4	400	?	?	Heard not seen	Shrubland, scrub
26/03/2011	1	D12	500	50	120	Traversing /flying	Grassland, shrubland
27/03/2011	1	E1	?	?	?	Heard not seen	Grassland, shrubland
29/07/2011	1	?	?	?	?	Heard not seen	Gully

New Zealand falcons were recorded on six occasions during roaming counts. Five of these were of single birds and one observation was of two birds (Table 10). The first bird was seen flying down the gully over pasture and scrub on the 25 November 2009 in the vicinity of turbine sites B1 and A1 at a height of between 100 and 400m. The second observation was on 18 December 2009 of a falcon carrying a small bird. It flew up a gully and over the top of turbine site F1 at heights ranging between 1 and 50 m above the ground before disappearing over a small rise, presumably into the gully between F1 and G1. On 26 March 2011 a falcon was seen flying over

grassland and shrubland approximately 500 m from turbine D15 at a height of between 50 and 120 m. The remaining three records were of birds that were heard calling but were not seen. On 13 February 2011 two birds were heard calling approximately 400 m from turbine D4, on 27 March 2011 a falcon was heard calling in the distance from turbine E1 and on 29 June 2011 a falcon was heard calling in the distance from a gully.

New Zealand pipits were recorded during roaming counts on 16 occasions on 10 separate days between 13 February and 28 June 2011 (Table 11). Twelve records were of single birds and the remaining observations were of between 2 and 9 birds. Most observations during roaming counts were away from turbine locations (but pipits were also recorded during point counts). They were most often recorded near the ground in grassland, although four observations were of birds flying at between 60 and 100 m.

Table 11: Details of New Zealand pipit observations recorded during roaming count bird surveys

Date	Number of birds	Distance from nearest turbine (m)	Min height (m)	Max height (m)	Behaviour	Habitat
13/02/2011	1	200	0	0	Feeding on ground	Grassland
13/02/2011	2	200	100		Traversing /flying	Grassland
14/02/2011	1	150	2	0	Arriving	Grassland
14/02/2011	1	0	2	1	Traversing /flying	Grassland
4/03/2011	1	50	0	0	Feeding on ground	Grassland
4/03/2011	1	400	?	?	Heard not seen	Grassland
5/03/2011	1	100	50	0	Traversing /flying	Grassland
27/03/2011	9	0	70	0	Traversing /flying	Grassland
13/04/2011	1	200	?	?	Heard not seen	Grassland, shrubland
13/04/2011	1		?	?	Heard not seen	Grassland
14/04/2011	1	0	60	0	Departing	Grassland
14/04/2011	7	200	5	0	Feeding on ground	Grassland
3/06/2011	1	300	3	0	Traversing /flying	Grassland
16/07/2011	3	150	5	1	Traversing /flying	Grassland
16/07/2011	1	200	3	3	Traversing /flying	Grassland
28/07/2011	1	250	10	0	Departing	Grassland

A single black shag (At Risk - Naturally Uncommon) was recorded on 6 June 2011 flying low (4-5 m above the stream bed) in a gully system approximately 300 m from the nearest turbine.

3.3 Five Minute Bird Counts

Five minute bird counts were undertaken in scrubby or forested gullies within the wind farm site. They were undertaken to describe which bird species are present within scrub or forest habitats and could, therefore, potentially be at risk of collision with turbines when travelling between scrub or forest areas or be otherwise affected by the wind farm.

Table 12 summarises the five minute bird count data for each of the count stations. For ease of interpretation this data is also presented in Table A1.7 in Appendix 1 as the total number of each species recorded/five minute bird count site.

Table 12: The average number of birds recorded/ five minute bird count (listed from highest to lowest). The number of five-minute bird counts undertaken at each site is provided in the third row of the table.

	Five minute bird count site										Avg/ site
	1	2	3 ¹	4 ¹	5	6	7	8	9 ²	10 ²	
No. counts/station	15	15	7	7	20	19	19	19	12	12	
Silvereye	3.9	5.1	2.1	1.1	5.5	3.7	2.1	2.5	7.6	17.0	4.97
Greenfinch*	2.1	2.4	3.4	3.4	4.1	4.8	2.6	4.3	1.8	0.7	3.09
Chaffinch*	4.1	3.6	4.9	4.9	1.1	3.5	3.4	1.8	1.9	2.3	2.92
Yellowhammer*	2.1	3.6	2.9	2.0	2.5	2.9	2.6	2.2	1.0	0.8	2.33
Redpoll*	2.1	2.3	5.0	3.6	1.8	2.4	0.9	1.7	0.9	0.8	1.92
Dunnock*	1.0	1.2	1.0	1.1	1.3	1.1	1.2	1.5	2.0	1.7	1.30
Grey warbler	1.6	1.2	1.4	0.3	1.3	1.2	1.2	0.6	1.5	2.1	1.23
Blackbird*	0.9	0.7	0.3	0.7	0.5	1.3	0.9	0.3	2.2	1.6	0.92
Goldfinch*	0.3	2.2	4.6	0.4	0.3	0.8	0.6	0.2	0.5	0.2	0.81
Australian magpie*	0.3	0.5	0.4	0.3	0.3	1.4	1.6	0.8	0.9	0.6	0.79
Bellbird	0.2	1.7	2.3	0.9		0.5	0.1	0.3	0.2	1.9	0.63
South Island fantail	0.2	0.9	0.1	0.1		0.6	0.2		0.7	2.8	0.51
Starling*	0.2	0.5		1.1	0.4	0.3	0.6	1.6	0.1		0.50
Song thrush*	0.4	0.5	0.1	0.4	0.1	0.4	0.2	0.3	0.8	0.6	0.36
Australasian harrier		0.3	0.1	0.1	0.3	0.5	0.6	0.4	0.2	0.1	0.30
Skylark*	0.4	0.1		0.1	0.6	0.2	0.5	0.4	0.2	0.1	0.29
California quail*		0.1		0.1	0.3	0.2	0.1			0.3	0.10
New Zealand (eastern) falcon						0.1	0.2	0.1		0.1	0.05
New Zealand pipit					0.1			0.1	0.1	0.3	0.04
Black-backed gull		0.1				0.1	0.1	0.1			0.03
Paradise shelduck		0.1								0.3	0.03
Spur-winged plover								0.2	0.1		0.03
Sacred kingfisher									0.2	0.1	0.02
Welcome swallow								0.1	0.2		0.02
Black-fronted tern					0.1						0.01
Shining cuckoo			0.1	0.1							0.01
Cirl bunting*							0.1				0.01
House sparrow*						0.1					0.01

¹ Surveys November 2009 to January 2010.

² Surveys November 2010 to July 2011.

Silvereyes were the species most commonly recorded during five minute bird counts and they were notably more common than any of the other species recorded. After silvereye, the next most commonly recorded species were introduced passerines; greenfinch, chaffinch, yellow hammer, redpoll and dunnock.

Six species were recorded at the five minute count stations that were not recorded during point counts. These were bellbird, black-fronted tern, California quail, cirl bunting, sacred kingfisher and shining cuckoo.

As expected a broad comparison of the five minute bird count and point count bird survey data indicates that the native scrub and broadleaf/hardwood forest habitats within the gullies and lower slopes provides better habitat for some bird species, including the indigenous species silvereye, grey warbler, bellbird and South Island fantail. In total 14 indigenous species were recorded during the five minute forest counts. No new species (i.e. species that had not been

recorded by at least one of the other sampling methods) that are likely to be potentially at risk were identified during five minute bird counts.

Further information on the two black-fronted terns observed during a five minute bird count (count station number 5) on 22 December 2009, and the two falcons observed on 25 November and 18 December 2009 (count stations 7 and 8, respectively) is provided above in Section 3.2 (the detailed information relating to these observations was recorded on roaming count data sheets).

3.4 Monitoring Mast Searches

Prior to the commencement of the study one of the property owners recorded a dead pukeko below the monitoring mast. During searches around the wind monitoring mast between November 2009 and January 2010 one greenfinch carcass was found. We are unsure of the cause of death for these two birds, but it is possible that they died as a result of colliding with the mast or its guy wires. Subsequent searches between November 2010 and July 2011 did not find any other carcasses.

4.0 Discussion

Wind farms are generally considered to have four main effects on avifauna (Drewitt and Langston 2006):

- 1) Collision mortality;
- 2) Displacement due to disturbance;
- 3) Barrier effects (alteration of flight paths and migratory routes); and
- 4) Habitat loss or damage.

Each of these effects is discussed in relation to the Hurunui Wind Project in Section 4 of the Avifauna Assessment Report (BML 2010b), that was attached to the original resource consent application, based on the findings of the Level 1 study, the initial 8 week Level 2 study and the migratory shorebird desktop assessment. Collision mortality and displacement (generally), barrier effects and habitat loss or damage are discussed in Sections 4.1.1, 4.1.2 and 4.1.3 of the Avifauna Assessment Report respectively. With the exception of the potential effects of habitat loss or damage on New Zealand pipit, discussed in Section 4.1 below, the additional data collected during the subsequent nine months of Level 2 surveys has not changed the findings of these assessments and for this reason this information is not repeated here. Similarly, the additional data that has been collected has not changed any of the conclusions relating to the risk to migratory shorebirds. This is discussed in Section 4.2.3. of the Avifauna Assessment Report and again, is not repeated here. Section 4.2 of the Avifauna Assessment Report provides a detailed assessment of the bird species that are potentially at risk. It is necessary to re-assess the risk to these individual species based on the updated results of the Level 2 avifauna study and this assessment is provided in Sections 4.2 and 4.3 below.

4.1 Habitat Loss or Damage

The vegetation communities and habitats, and the effect of the proposed wind farm on these, are mapped and described in detail in the Ecological Values and Assessment of Effects Report (BML, 2010a). The majority of the vegetation within the design envelope is improved pasture and/or silver tussock grassland (BML 2010a). The Avifauna Assessment Report (BML 2010b) stated that:

"relative to other habitat types this does not provide good habitat for native birds (with the exception of New Zealand pipit, which have not been recorded onsite, to date)."

New Zealand pipits were recorded onsite during the subsequent Level 2 surveys between February and July 2010. The grasslands comprised of indigenous silver tussock are those that provide the best habitat for New Zealand pipits. In terms of the effect of the wind farm proposal, c. 6.4 ha, (or 1.8% of the c. 360 ha within the wind farm site) of these silver tussock grassland habitats would be removed. The effect of the clearance of these grasslands on New Zealand pipit is minor within the context of the wind farm site.

4.2 Species Recorded At Blade Height

Four indigenous species were recorded at blade height during the initial 8 week period of point counts between November 2009 and January 2010; black-backed gulls, Australasian harrier, silvereve and welcome swallow. Two additional indigenous species were recorded at blade height during point counts during the further nine months of Level 2 surveys. They were paradise shelduck and New Zealand pipit. With the exception of New Zealand pipit, which has a threat classification of At Risk (Declining) (Miskelly *et al.* 2008) all of these species are not threatened, locally common and widespread. The impact of potential collision fatalities is discussed for each of these species below.

Silvereve

Thirty-one silvereves were recorded at blade height during point counts, which represented 18% of the observations. They were the species most commonly recorded flying at blade height during point counts. Silvereve are widely distributed and one of the most abundant New Zealand birds. Powlesland (2009b) states that their abundance, widespread distribution and high fecundity mean that collision fatalities would be unlikely to have an impact at the population level locally or nationally.

Paradise shelduck

Paradise shelduck were observed utilising farm ponds and wet pasture within the study area and moving across the site. Forty-six of the 72 observations of this species were at turbine D7, and 42 of these (i.e. 58% of the total number of observations) were repeat observations of a resident adult pair with ducklings that occupied a small stock pond within the survey zone at this count station during the November 2009 to January 2010 surveys. Despite this, paradise shelduck were recorded flying at blade height on 12 occasions during point counts, which represented 17% of all observations of this species. Powlesland (2009b) states that wind farms have resulted in collision fatalities and displacement of some species of northern hemisphere ducks and geese, including one shelduck (*Tadorna tadorna*). However, since the impact of wind farms on birds tends to be species-specific, and there is no information on paradise shelduck collisions at wind farms in New Zealand, it is unknown how they are likely to react to wind turbines. However, this species is common locally and nationally and collisions seem highly unlikely to affect local or national populations.

New Zealand pipit

This species was recorded throughout the site during point counts, 5 minute bird counts and roaming counts between February and July 2011. New Zealand pipits were not recorded at the site between November and January. Some birds, perhaps mainly juveniles, form loose, transient flocks in autumn and winter (Heather and Robertson 1996). It appears likely that the pipits recorded at the site are transient visitors over the autumn and winter period, rather than adult birds that occupy the wind farm site year round. The threat status of New Zealand pipits was revised in 2007 from Not Threatened to At Risk (Declining) (Miskelly *et al.* 2008). The main causes for deterioration in threat status are thought to be changes in land-use, particularly conversion of sheep farming to dairy farming (Miskelly *et al.* 2008). Of the pipits recorded during point counts 21%, or 11 of the 52 observations, were at blade height. A recent review of the potential impacts of wind farms on New Zealand birds (Powesland 2009b) found that because this species occasionally flies more than 40 m above ground level, when involved in courtship flights or long distance movements during the non-breeding season, pipits may be at moderate risk of collision with turbine blades. The wind farm is likely to represent a moderate collision risk for New Zealand pipit, which may have an impact at the local population level. However, because this species is widespread and locally common in open country in the eastern foothills of the Southern Alps and has a widespread distribution throughout the North and South Islands (Heather and Robertson 1996), the wind farm is unlikely to result in adverse effects at the national population level.

Australasian harrier

Raptors are considered to be most at risk from collision due to their feeding and flight behaviour and have been found to be disproportionately at risk of collision when relative to their abundance. Studies overseas indicate that the larger, less manoeuvrable raptors such as eagles are more prone to collision with wind turbines (Powesland 2009b). Recent observations of Australasian harriers flying in the rotor swept zone of the Te Apiti Wind Farm suggest that 1) they do not appear to be displaced by wind farms, and 2) they may show avoidance behaviour of turbine blades (Stirneemann and Kessels 2008). However, harriers fly mainly by soaring and gliding, and deaths as a result of collisions with turbines have occurred at other wind farm sites in New Zealand. This, in conjunction with the fact that harriers are common within the proposed wind farm site and 15% of observations of harriers during point counts were at blade height, suggests that harriers will be at a high risk of colliding with the proposed wind turbines at Hurunui Wind. Twelve harrier mortalities have been recorded during two years post-construction monitoring at West Wind in Wellington (the majority of these have been juveniles). This collision rate is likely to be having an impact at the local population level (L. Bull *pers. comm.* 2012). Although mortalities as a result of collisions with wind turbines are also likely to have an impact at the local population level at Hurunui Wind, harriers are widespread and common throughout New Zealand and therefore are not expected to be affected at the national population level.

Welcome swallow

Welcome swallows were recorded flying at blade height on nine occasions during point counts, which represented 17% of all observations of this species. Due to their excellent flight manoeuvrability, Powesland (2009b) states that welcome swallows may be able to avoid collisions with wind farm structures. Also given the species abundance and high reproductive output, any mortality that occurs as a result of infrequent collisions with wind farms would be unlikely to have any impact at the population level.

Black-backed gull

With the exception of three sites in Belgium, gulls have suffered low rates of collision mortality at wind farms in other countries (Powesland 2009b). However, the occasional dead gull (species not indicated) has been found at wind farms in New Zealand (Rodgers 2006 *in* Powesland 2009b, S. Fuller *pers. comm.* 2009). Black-backed gulls were the only gull species recorded during surveys at Hurunui Wind. This was expected given the location of the proposed wind farm on inland hill-

country farmland. Black-backed gulls were recorded flying at blade height on eight occasions during point counts, which represented 16% of all observations of this species. Thus it seems that black-backed gulls will be at risk of collision fatalities at this site. However, this species has benefitted greatly from human settlement in New Zealand and is widespread and abundant. Where high collision rates have been recorded for gulls (i.e. in Belgium) the wind farm has been located near a breeding colony or an area with a very high density of birds (Powlesland 2009b). Such high densities have not been recorded at the Hurunui Wind farm site. Powlesland (2009b) is of the opinion that a few deaths as a result of collision fatalities away from nesting colonies (as is the situation at the Hurunui Wind Farm site) will have no impact on this species at the population level.

4.3 Other Bird Species Potentially At Risk

This section assesses the risk of the proposed wind farm to all the remaining indigenous species that were not recorded at blade height during the point counts but were recorded within the wind farm site.

Black-fronted tern

During the eight week Level 2 surveys between November 2009 and January 2010, the results of which were presented in the Avifauna Assessment Report, a total of 10 black-fronted terns were recorded during roaming counts (and one of the five minute bird count) on four separate occasions on two days. Further Level 2 surveys undertaken over the nine months between November 2010 and July 2011 recorded a further 11 black-fronted terns on three separate occasions on two days during roaming counts. All observations of black-fronted terns by BML survey staff over the nine months in which monitoring has occurred (November to July) have been in December and January¹². This suggests that black-fronted terns are a seasonal visitor to the site but further pre-construction monitoring during August, September and October is required to determine whether black-fronted terns utilise the wind farm site during these months.

The observation of black-fronted terns at the wind farm site was unexpected given the habitat types and the distance from the nearest known breeding colonies. The flight behaviour that was observed indicated that these birds were utilising the site for foraging. They did not exhibit a direct flight path indicative of a migratory movement. Observations of these birds suggest that black-fronted terns are foraging over the grassland and shrublands for lizards as has been documented in the Eglington Valley in Fiordland (O'Donnell and Hoare 2009). On several occasions, birds were observed carrying a small food item, most likely lizards.

The origins of the black-fronted terns observed over the site cannot be determined with any confidence. However, the birds observed over the site are most likely to be from the Hurunui River, or possibly non-breeding populations along the coast. The nearest black-fronted tern breeding colonies are on the Hurunui River (Table 13). Survey data is available for black-fronted terns on the Hurunui River for the years 1978, 2006, 2007, 2008, 2009 and 2010 (DOC unpubl. data). Surveys were not undertaken in 2011 (Andrew Grant *pers. com.* 2012) Most of the colonies are located on the lower 60 km of the river which varies from c. 24 to 35 km from the boundary of the wind farm site. The nearest colonies were c. 12.5 and 20 km from the boundary of the wind farm site in 2009 and 2010, respectively (DOC unpubl. data). Since 2006 at least 23 colonies have established between the coast and the Mandamus River and colony size has varied from 2 to 265 birds (DOC unpubl. data). The average number of terns on this section of the river is 397 (range 261 – 568) (DOC unpubl. data, Hughey 2009). Based on this average, this equates to 4.0% of the national population. The next closest breeding populations are on the upper Waiiau, Ashley,

¹² The falcon monitoring team observed two black-fronted terns over the wind farm site on a single occasion in November 2010.

Lottery and lower Waimakariri Rivers (O'Donnell and Hoare 2011) which are approximately 33, 38, 44 and 50 kilometres from the wind farm, respectively (Table 13).

The abundance and locations of non-breeding birds are less well known. The Hurunui and Waipara River mouths (which are 29 and 20 km from the centre of the wind farm site, respectively) support flocks of up to a few hundred non-breeding black-fronted tern. Flocks also occur at other river mouths further from the site (particularly in autumn and winter) such as the Ashley and Waiau Rivers (Heather and Robertson 1996, *pers. obs.*). Black-fronted terns roost at other locations along the coast and feed out to sea in Pegusus Bay, but no population estimates are available.

Table 13: *Black-fronted tern population count data from rivers within 50 km of the Hurunui Wind Farm site and proximity of the site to these rivers (data sourced from Appendix 1 of O'Donnell and Hoare (2011)).*

River	Approx distance from wind farm (km)	Number of counts	Year of first count	Year of last count	Earliest tern count	Most recent tern count
Hurunui	11	4	1978	2008	338	336
Upper Waiau	33	2	1975	2008	217	264
Ashley	38	9	1981	2008	194	81
Lottery	44	1	1988	1988	6	6
Lower Waimakariri	50	4	1980	2008	74	423

At times during roaming counts black-fronted terns were observed flying at blade height, (although the maximum heights recorded often indicate that birds were flying over deep gullies). These observations suggest that the proposed wind farm may present a collision risk to this species. The black-fronted tern has a threat ranking of Nationally Endangered (Miskelly *et al.* 2008) and an estimated total population likely to be in the order of 10,000 birds, with a predicted population decline of c.50% over the next 25 years if management is not instigated with some urgency (O'Donnell and Hoare 2011). Thus, collision fatalities, especially if they occur consistently, could impact on this species at the local and national population levels.

Internationally, terns have suffered low rates of mortality at wind farms (Powersland 2009b), with the exception of three sites in Belgium. At one of these sites the turbines were sited close to nesting colonies (Everaert and Stienen 2007). There are no records of black-fronted terns colliding with wind turbines in the literature, however we are not aware of any observations of black-fronted terns at an operational wind farm site. Powersland (2009b) states that it is likely that the black-fronted tern population would only be compromised if wind turbines were erected within or adjacent to nesting colonies or where terns congregate to forage. That is not the situation here. The wind farm site does not offer suitable breeding habitat for this species and the Hurunui River, the nearest known river on which black-fronted terns breed is approximately 11 km away.

While the survey data shows that black-fronted terns visit the wind farm site from time to time, the potential effect of collision fatalities with wind turbines at the proposed wind farm on the black-fronted tern population is likely to be low. In addition to the reasons discussed above, this assessment is based on:

- The fact that black-fronted terns are not resident at the site, but appear to be infrequent, seasonal visitors;
- The low number (21) of birds recorded over the site over 11 months of monitoring;
- The fact that they were not recorded during 179 hours of formal point count surveys;

- No birds were observed during a six month period of surveys between February and July;
- The majority of the observations during roaming counts were away from proposed turbine locations; and
- The fact that terns generally have excellent flight manoeuvrability.

New Zealand falcon

The New Zealand falcon has a threat ranking of Threatened (Nationally Vulnerable) (Miskelly *et al.* 2008). Falcons were recorded during point counts, roaming counts and five minute bird counts. Golder Associates were commissioned by MEL to assess the risk the proposed wind farm presents to falcon at this site and their studies have confirmed that a pair of falcon are resident, and breed within the wind farm site. The risk to falcons has been assessed separately (Golder Associates 2010a, 2010b, 2010c).

Black shag

Black shags have a threat classification of At Risk (Naturally Uncommon) (Miskelly *et al.* 2008). A single black shag was recorded flying down a stream in the bottom of a gully system within the wind farm site. Given that only one bird was recorded and that it was some distance from the design envelope, the risk of this species colliding with turbines is likely to be very low.

Other water birds

The other water birds that were recorded within the site (pukeko, spur-winged plover and white-faced heron) utilise farm ponds and wet pasture and move across the site. Even though they were not recorded flying at blade height during point counts they all seem likely to be at risk from collision mortality, and possibly also displacement because of turbine avoidance. However, all of these species are common locally and nationally and collisions seem highly unlikely to affect local populations.

Smaller forest passerines

None of the smaller forest passerines that have not already been discussed above (i.e. bellbird, grey warbler and South Island fantail) are considered to be at risk. None of these species were recorded flying at blade height and with the exception of grey warbler and one South Island fantail, which was recorded at one of the lower elevation control sites, they were only recorded at a considerable distance from the proposed turbine sites, most often in the scrub or forest habitats in the gullies. There is a high degree of confidence that these species will not be adversely affected by the operation of wind turbines in the area due to a combination of a low risk of collision and the fact that there will not be any loss or fragmentation of their core habitat.

Sacred kingfishers

Sacred kingfishers were only recorded at two five minute bird count stations located in forested gullies in lower elevation areas of the wind farm. These count sites, and other suitable kingfisher habitats are some distance from the proposed turbine locations. At least one sacred kingfisher has been a collision fatality at a New Zealand wind farm (Clutha District Council 2007 *cited in* Powesland 2009b). However, collision fatalities and displacement are considered unlikely to occur at the Hurunui Wind Farm site because kingfishers were not recorded at or near proposed turbine sites and the proposed wind farm will not result in the loss of fragmentation of kingfisher habitat. Kingfishers are abundant nationally and occasional mortality is unlikely to affect local populations of this species.

Shining cuckoo

The only other indigenous species recorded during surveys was shining cuckoo which were recorded infrequently during roaming counts (3 birds) and five minute bird counts (2 birds). Shining cuckoo are a migratory forest species. Nothing is currently known about their migration

routes once they reach New Zealand (Williams *et al.* 2006) or the altitudes at which they fly. However, because they fly at night they are thought to be potentially vulnerable to flying into wind turbines, particularly those situated within forest, or near to forest margins (Powesland 2009b). Because none of the proposed turbine sites are near forest margins and because the proposed wind farm is not anticipated to result in significant habitat loss or the displacement of their host species (grey warbler), it is considered unlikely that the proposed wind farm will affect shining cuckoo. This species is not threatened and is widely distributed throughout New Zealand.

4.4 Monitoring

The following monitoring is recommended:

- 1) Completion of the full year's pre-construction monitoring (i.e. Level 2 surveys during the months of August, September and October). Consent conditions are proposed by Meridian to ensure this monitoring is carried out.
- 2) Development and implementation of a robust, comprehensive blade-strike monitoring programme to monitor the potential impact of the wind farm on birds. Blade strike monitoring should be undertaken for at least two years and the timing of monitoring should take into account the occurrence of black-fronted tern observations during pre-construction monitoring. Consent conditions are also proposed by Meridian to ensure this monitoring is carried out.

Unless the results of the Level 2 surveys in the months of August, September and October indicate otherwise, other than blade strike monitoring, there is no need for post construction surveys (i.e. point counts and five minute bird counts). This is because species of concern have been recorded too infrequently to be able to detect any significant differences post-construction.

4.5 Recommended Measures to Avoid, Remedy or Mitigate Adverse Effects

If significant adverse effects on bird populations are identified during the remaining pre construction monitoring or the post-construction mortality monitoring that warrant remedial action, such actions may include, but are not limited to, the enhancement of bird corridors, protection and enhancement of habitat, on-site or off-site breeding programmes, nest protection and pest control. If implemented, these measures would need to be of such a nature and scale as is necessary to compensate for any adverse effects of the wind farm on avifauna.

If, during post-construction monitoring, any black-fronted terns are recorded as injured or killed by wind turbines, Meridian will be required to determine a reasonable course of action to remedy or mitigate those effects. Conditions proposed by Meridian provide the appropriate adaptive mechanism to address this effect. Decisions around the requirement for mitigation for black-fronted terns should be based on the results of the blade strike monitoring and the level of mitigation required should be determined based on an appropriate period of blade strike monitoring from which patterns of mortality can be more accurately determined. One potential mitigation action could include contributing funding to existing black-fronted tern conservation programmes which may include predator control. If predator control is used to offset the loss of mature individuals, consideration of the relative importance of nest and fledgling survival versus adult survival will be necessary.

The wind farm is likely to represent a moderate collision risk for New Zealand pipit, which may have an impact at the local population level. However, the wind farm is unlikely to result in adverse effects at the national population level. There are unlikely to be any effective mitigation measures available to mitigate adverse effects on this species.

5.0 Summary and Recommendations

- The methodology used to survey birds at this site is based on international best practice guidelines. It has been refined by BML through application at several other wind farms and accepted to be appropriate by the Environment Court.
- A total of 358 30 minute point counts have been undertaken (179 hours) and a further 145 five minute bird counts (725 minutes) have been completed over a total of 11 months encompassing nine months of the year (November to July). In addition, roaming counts were made by survey staff while working on the site over this period.
- The turbine layout avoids all indigenous habitats other than silver tussock grassland and very small areas of grey shrubland and rock habitat. Therefore, any direct effects on indigenous avifauna due to habitat loss are anticipated to be minor.
- Thirty four species were recorded within the wind farm site of which 17 are indigenous. Two of these are threatened; black-fronted tern (Nationally Endangered) and New Zealand falcon (Nationally Vulnerable) and two are classified as At Risk; New Zealand pipit (Declining) and black shag (Naturally Uncommon). The remaining species are widespread and locally common.
- With the exception of one South Island fantail, forest birds recorded during five minute counts in forest habitats such as bellbird, shining cuckoo and South Island fantail were not recorded within the wind farm footprint.
- Six indigenous species were recorded at blade height; black-backed gull, Australasian harrier, silvereye, welcome swallow, New Zealand pipit and paradise shelduck. With the exception of New Zealand pipit, all of these species are locally common and widespread.
- Neither falcon nor black-fronted terns were recorded over the footprint at turbine blade height during point counts, although observations during roaming counts of both black-fronted terns and falcon suggest they do fly over the site at blade height.
- There is a collision risk to black-fronted tern but this risk is low. However, given the conservation status of this species collision fatalities could have a significant impact at the local and national population level. It is recommended that if blade strike monitoring demonstrates an adverse effect on black-fronted terns, Meridian, through the proposed conditions, will determine a reasonable course of action to remedy or mitigate those effects.
- Falcons have been confirmed to be breeding at the site and were the subject of a separate more comprehensive Level 3 study that assessed the risk that the proposed wind farm poses to this species.
- There is a moderate collision risk to New Zealand pipit which may have an impact on the local population, but adverse effects at the national population level are unlikely.
- One black shag was recorded and it was not within the design envelope. The risk of this species colliding with turbines is very low.
- In summary, the low diversity of indigenous birds in the study area, the wind farm location on high ridgelines and plateaus, typically in pasture or silver tussockland, away from streams and wetlands, and separated from native forest remnants, means that the majority of bird observations during bird surveys were of introduced species. Of the indigenous species that do frequent the wind farm footprint, only a small subset is active

at heights that put them at risk of collision. With the exception of black-fronted tern, New Zealand falcon and New Zealand pipit, all of these are not threatened, and are widespread and abundant.

- With regard to monitoring, completion of Level 2 surveys during the months of August, September and October is required to account for seasonal variation in bird activity and to determine whether black-fronted tern utilise the site over these months. In addition, completion of at least two years blade strike monitoring is recommended and this should include specific, intensive searches during the period that black-fronted tern occur at the site. Conditions have been proposed by Meridian to ensure that this monitoring is undertaken.

6.0 References

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Appendices

Appendix 1: Supplementary Tables and Figures

Table A1.1: Habitat descriptions for each of the turbine sites selected for point counts

Site	Habitat
Turbine sites	
A1	Pasture, scattered shrubland in pasture (95m), scrub margin in head of gully (120m)
A4	Pasture, two small farm ponds (50m), scrub margin in head of gully (250m)
A9	Pasture, rocky outcrop (80m), head of gully (90m), broadleaf forest in gully bottom (360m)
A11	Pasture, rocky outcrop (15m), small area pine forest (35 m)
A12	Pasture, shrubland margin (80m)
B1	Pasture, scattered rocky outcrops (115m), shrubland margin (75m)
C1	Pasture, rocky outcrops (220m), shrublands in head of gully (230m)
D1	Pasture, shrubland margin (150m), head of gully (215m)
D4	Pasture and silver tussock, shrubland margin (110m)
D7	Pasture, small farm pond (120m), head of gully and shrubland margin (210m)
D12	Pasture and silver tussock, scattered shrubland (80m)
D14	Pasture, silver tussock and shrubland margin (80m), scrub in gully (180 m)
D15	Pasture, shrubland margin (50m)
E1	Pasture and silver tussock, rocky outcrops (30m), small farm pond (120m), shrubland margin (250m)
G1	Pasture, silver tussock, scattered shrubs, shrubland margin (80m), broadleaf forest in gully (240m)
Reference sites	
Site 1	Pasture, shrubland margin (80m), pine forest margin (95m)
Site 2	Pasture, shrubland margin (20m)
Site 3	Pasture, shrubland margin (50m)
Site 4	Pasture, shrubland margin (100m), broadleaf forest in gully bottom (190m)
Site 5	Pasture, shrubland margin (70m)
Site 5a	Pasture and silver tussock, scattered shrubland (50m), small area broadleaf forest (150m)

Table A1.2: Birds recorded from the ecological district (DOC 2000), the wider area (OSNZ 2007) and during all BML surveys (sorted by threat classification (Miskelly *et al.* 2008)).

Common name	Scientific name	National threat status Miskelly <i>et al.</i> (2008)	DOC (2000)	OSNZ (2007)	BML (all surveys)
Grey duck	<i>Anas superciliosa superciliosa</i>	Nationally Critical		✓	
Black-billed gull	<i>Larus bulleri</i>	Nationally Endangered	✓	✓	
Black-fronted tern	<i>Chlidonias albostratus</i>	Nationally Endangered	✓	✓	✓
New Zealand (eastern) falcon	<i>Falco novaeelandiae "eastern"</i>	Nationally Vulnerable			✓
Pied shag	<i>Phalacrocorax varius varius</i>	Nationally Vulnerable	✓		
Black shag	<i>Phalacrocorax carbo novaehollandiae</i>	Naturally Uncommon		✓	✓
Little shag	<i>Phalacrocorax melanoleucos brevirostris</i>	Naturally Uncommon		✓	
New Zealand pied oystercatcher	<i>Haematopus ostralegus finschi</i>	Declining		✓	
New Zealand pipit	<i>Anthus novaeseelandiae novaeseelandiae</i>	Declining	✓	✓	✓
Sooty shearwater	<i>Puffinus griseus</i>	Declining	✓		
Black-fronted dotterel	<i>Charadrius melanops</i>	Coloniser	✓		
Variable oystercatcher	<i>Haematopus unicolor</i>	Recovering	✓		
Fairy prion	<i>Pachyptila turtur</i>	Relict	✓		
Red-capped dotterel	<i>Charadrius ruficapillus</i>	Vagrant	✓		
Australasian harrier	<i>Circus approximans</i>	Not Threatened	✓	✓	✓
Australasian shoveler	<i>Anas rhynchos variegata</i>	Not Threatened		✓	
Bellbird	<i>Anthornis melanura melanura</i>	Not Threatened	✓	✓	✓
Brown creeper	<i>Mohoua novaeseelandiae</i>	Not Threatened	✓	✓	
Grey warbler	<i>Gerygone igata</i>	Not Threatened		✓	✓
Morepork	<i>Ninox novaeseelandiae</i>	Not Threatened	✓		
New Zealand pigeon	<i>Hemiphaga novaeseelandiae novaeseelandiae</i>	Not Threatened		✓	
New Zealand scaup	<i>Aythya novaeseelandiae</i>	Not Threatened		✓	
Paradise shelduck	<i>Tadorna variegata</i>	Not Threatened		✓	✓
Pied stilt	<i>Himantopus himantopus leucocephalus</i>	Not Threatened		✓	
Pukeko	<i>Porphyrio porphyrio melanotus</i>	Not Threatened		✓	✓
Sacred kingfisher	<i>Halcyon sancta vagans</i>	Not Threatened		✓	✓
Shining cuckoo	<i>Chrysococcyx lucidus lucidus</i>	Not Threatened		✓	✓
Silvereye	<i>Zosterops lateralis lateralis</i>	Not Threatened		✓	✓
South Island fantail	<i>Rhipidura fuliginosa fuliginosa</i>	Not Threatened		✓	✓
Southern black-backed gull	<i>Larus dominicanus dominicanus</i>	Not Threatened		✓	✓

Common name	Scientific name	National threat status Miskelly <i>et al.</i> (2008)	DOC (2000)	OSNZ (2007)	BML (all surveys)
Spur-winged plover	<i>Vanellus miles novaehollandiae</i>	Not Threatened		✓	✓
Welcome swallow	<i>Hirundo tahitica neoxena</i>	Not Threatened		✓	✓
White-faced heron	<i>Ardea novaehollandiae novaehollandiae</i>	Not Threatened	✓	✓	✓
Total indigenous		33	14	25	17
Australian magpie*	<i>Gymnorhina fibicen</i>	Introduced & Naturalised	✓	✓	✓
Blackbird*	<i>Turdus merula</i>	Introduced & Naturalised	✓	✓	✓
California quail*	<i>Callipepla californica brunnescens</i>	Introduced & Naturalised		✓	✓
Canada goose*	<i>Branta canadensis maxima</i>	Introduced & Naturalised	✓	✓	
Chaffinch*	<i>Fringilla coelebs</i>	Introduced & Naturalised	✓	✓	✓
Cirl bunting*	<i>Emberiza cirius</i>	Introduced & Naturalised			✓
Feral goose*	<i>Anser anser</i>	Introduced & Naturalised		✓	
Goldfinch*	<i>Carduelis carduelis</i>	Introduced & Naturalised	✓	✓	✓
Greenfinch*	<i>Carduelis chloris</i>	Introduced & Naturalised	✓	✓	✓
Hedge sparrow*	<i>Prunella modularis</i>	Introduced & Naturalised	✓	✓	✓
House sparrow*	<i>Passer domesticus</i>	Introduced & Naturalised	✓	✓	✓
Little owl*	<i>Athene noctua</i>	Introduced & Naturalised		✓	✓
Mallard*	<i>Anas platyrhynchos platyrhynchos</i>	Introduced & Naturalised	✓	✓	✓
Muscovy duck*	<i>Cairina moschata</i>	Introduced & Naturalised		✓	
Mute swan*	<i>Cygnus olor</i>	Introduced & Naturalised		✓	
Redpoll*	<i>Carduelis flammea</i>	Introduced & Naturalised	✓	✓	✓
Ring-necked pheasant*	<i>Phasianus colchicus</i>	Introduced & Naturalised		✓	
Rock pigeon*	<i>Columba livia</i>	Introduced & Naturalised	✓	✓	✓
Skylark*	<i>Alauda arvensis</i>	Introduced & Naturalised		✓	✓
Song thrush*	<i>Turdus philomelos</i>	Introduced & Naturalised		✓	✓
Starling*	<i>Sturnus vulgaris</i>	Introduced & Naturalised	✓	✓	✓
Wild turkey*	<i>Meleagris gallopavo</i>	Introduced & Naturalised	✓		
Yellowhammer*	<i>Emberiza citrinella</i>	Introduced & Naturalised	✓	✓	✓
Total introduced		23	14	19	17
TOTAL		56	28	46	34

Table A1.3: Bird distributions (all species, listed in alphabetical order) recorded at point count stations

Species	A1	A4	A9	A11 ²	A12 ¹	B1	C1	D1	D4	D7	D12	D14 ²	D15 ¹	E1	G1	Control 1	Control 2	Control 3	Control 4	Control 5 ¹	Control 5a ²	TOTAL
Australian magpie*	19	14	23		9	11	1	6	10	12	9		1	6		4	3	2	1	4		135
Australasian harrier	2	3	2		2	6		4	2	3	6	5		3	2	6	7	3	2	1		59
Black-backed gull	6		7		2	4	1	3	3	4	7	4	1	4	3		1					50
Blackbird*	2					3					1			1	1	1		1	4	2		16
Chaffinch*	11	7	47	41	15	11	1	33	4	2	12	1	9	6	40	19	18	23	40	9	6	355
Dunnock*					2			1		1				4	1	1	2	34	10			56
Finch sp. *			1			1												1				2
Goldfinch*	69	21	11	4	3	8		10 8	15	6	16	26	30	4	9	25	19	36	34	17	5	466
Greenfinch*	76	74	87	4	43	17	6	56	17	20	42	2	64	13	95	57	54	16 0	79	55	19	1040
Grey warbler	2			1	1	1			1						3		1	1	7	4		22
House sparrow*					1																	1
Mallard*																		3				3
New Zealand pipit	8	1	4	2		5		10	2	4	2	1		1			2	1		9		52
New Zealand (eastern) falcon										1				1								2
Paradise shelduck		2	4					3		46		2	2	2		10	1					72
Redpoll*	7	10	4		4		3	61	4		13	1	3		22	11	51	19	21	8	1	243
Rock pigeon*			4	16	2	4		9				2	13			20			2		2	74
Silvereye	5	19	15	8	1	1		2	1		6			7	20		20	20	37	1	14	177
Skylark*	8	21	3		17	4	14	31	26	3	22			12	2	7	2		2	2	1	177
Song thrush*	1							1		1	1		1					3	3			11
South Island fantail																			1			1
Spur-winged plover			8	2		1					1		4						2		4	22
Starling*	3	7	79	30	26	10	1	3	5	4	7	1	1	6	8	9	20	22	23		7	272
Unknown	1				1	1		1						1		1	5		1			12
Welcome swallow		2	9		6		3	4	1		3		4	1		1	17		2	1		54
White-faced heron								2														2
Yellowhammer*	16	12	34	16	34	22	5	22	21	8	18	4	8	25	30	18	27	30	29	21	11	411
TOTAL	236	193	342	124	169	110	35	360	112	115	166	49	141	97	236	190	250	359	300	120	84	3788

¹ Surveys November 2009 to January 2010.

² Surveys November 2010 to July 2011.

Table A1.4: The average number of birds recorded/point count survey by month (all species, listed in alphabetical order). The number of point counts undertaken in each month is provided in the third row of the table.

Year	2009		2010			2011							
Month	Nov	Dec	Jan	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	
Counts/month	34	72	36	18	18	36	18	35	19	18	18	36	Avg.
Australian magpie*	0.15	0.21	0.75	0.22	0.56	0.36	0.78	0.17	0.05	1.06	0.67	0.25	0.38
Australasian harrier	0.15	0.14	0.22	0.06	0.06	0.31	0.11	0.17	0.37	0.06	0.11	0.14	0.16
Black-backed gull	0.21	0.21	0.17		0.06	0.22		0.14				0.22	0.14
Blackbird*	0.06	0.07	0.11		0.11	0.03			0.05	0.06			0.04
Chaffinch*	0.91	1.33	0.47	1.56	1.17	0.31	0.56	0.49	1.21	0.78	0.67	2.08	0.99
Dunnock*	0.06	0.14	0.19	0.17	0.78	0.11	0.22	0.09	0.11	0.06	0.06	0.14	0.16
Finch sp. *					0.06	0.03		0.03					0.01
Goldfinch*	1.15	1.39	3.00	0.67	0.39	0.78	3.56	0.54	1.42	0.22	1.89	0.67	1.30
Greenfinch*	2.74	5.07	6.28	3.50	1.50	2.25	1.17	2.83	0.74	1.67	0.44	0.36	2.91
Grey warbler	0.06	0.03	0.19			0.03	0.22	0.11	0.05		0.06		0.06
House sparrow*					0.06								0.00
Mallard*										0.17			0.01
NZ (eastern) falcon		0.01				0.03							0.01
NZ pipit							0.72	0.29	0.63	0.17	0.28	0.25	0.15
Paradise shelduck	0.09	0.51	0.11	0.11				0.43	0.11	0.11		0.19	0.20
Redpoll*	1.26	0.67	0.72	1.06	1.22	0.67	0.11		0.89	0.06	0.61	0.83	0.68
Rock pigeon*	0.06	0.21	0.56			0.14	0.28	0.26			0.06	0.47	0.21
Silvereye	0.35	0.22	0.53	0.39	0.39	0.03	0.33	0.71	2.32	0.67	0.61	0.47	0.49
Skylark*	1.15	0.67	0.42	1.22	0.50	0.36	0.11	0.09	0.58	0.11		0.36	0.49
Song thrush*	0.15	0.03	0.06					0.03				0.03	0.03
S.I. fantail								0.03					
Spur-winged plover	0.03	0.01	0.06		0.22	0.06	0.11	0.11		0.11	0.22		0.06
Starling*	1.21	0.60	1.28	0.61	1.06	0.17	0.06	0.34	0.05	2.39	0.17	1.28	0.76
Unknown	0.12	0.03	0.03						0.26				0.03
Welcome swallow	0.15	0.19	0.25	0.06	0.33	0.42		0.03	0.05			0.06	0.15
White-faced heron	0.06												0.01
Yellowhammer*	0.71	1.35	1.06	3.56	1.17	0.69	0.50	1.03	1.16	0.83	2.22	0.56	1.15
TOTAL	10.8	13.1	16.4	13.2	9.6	7.0	8.8	7.9	10.1	8.5	8.1	8.4	10.6

Table A1.5: Relative height of bird activity (all species, listed in alphabetical order) recorded at point count stations

Species	Heard, not seen	Below observer	Below blade	At blade height	Above blade height	Not recorded	Count
Australian magpie*		84	28	16	7		135
Australasian harrier		15	12	9	23		59
Black-backed gull		6	5	8	31		50
Blackbird*	2	13	1				16
Chaffinch*	9	244	62	32	8		355
Dunnock*		53	3				56
Finch sp. *		2	1				3
Goldfinch*	24	278	69	57	36	2	466
Greenfinch*	21	495	274	154	96		1040
Grey warbler	4	16	2				22
House sparrow*						1	1
Mallard*				3			3
Paradise shelduck		49	10	12	1		72
New Zealand pipit	9	21	6	11	5		52
New Zealand (eastern) falcon		1	1				2
Redpoll*	11	110	68	41	13		243
Rock pigeon*		33	13	20	8		74
Silvereye	11	69	22	29	44	2	177
Skylark*	3	73	30	24	47		177
Song thrush*		10		1			11
South Island fantail		1					1
Spur-winged plover		16	6				22
Starling*	1	170	51	47	3		272
Unknown		8	3		1		12
Welcome swallow	1	25	11	9	8		54
White-faced heron		2					2
Yellowhammer*	6	275	67	54	9		411
TOTAL	102	2064	745	527	345	5	3788

Table A1.6: Observations at blade height (all species, listed from highest to lowest)

Species	All birds observed at blade height	At risk as % of species observations	% of all observed at blade height
Greenfinch*	154	14.8	29.2
Goldfinch*	57	12.2	10.8
Yellowhammer*	54	13.1	10.2
Starling*	47	17.3	8.9
Redpoll*	41	16.9	7.8
Chaffinch*	32	9	6.1
Silvereve	29	16.4	5.5
Skylark*	24	13.6	4.6
Rock pigeon*	20	27	3.8
Australian magpie*	16	11.9	3
Paradise shelduck	12	16.7	2.3
New Zealand pipit	11	21.2	2.1
Australasian harrier	9	15.3	1.7
Welcome swallow	9	16.7	1.7
Black-backed gull	8	16	1.5
Mallard*	3	100	0.6
Song thrush*	1	9.1	0.2
Total	527		100

Figure A1: Relative height of bird activity (all species) recorded during point count surveys (axis = 0 to 100)

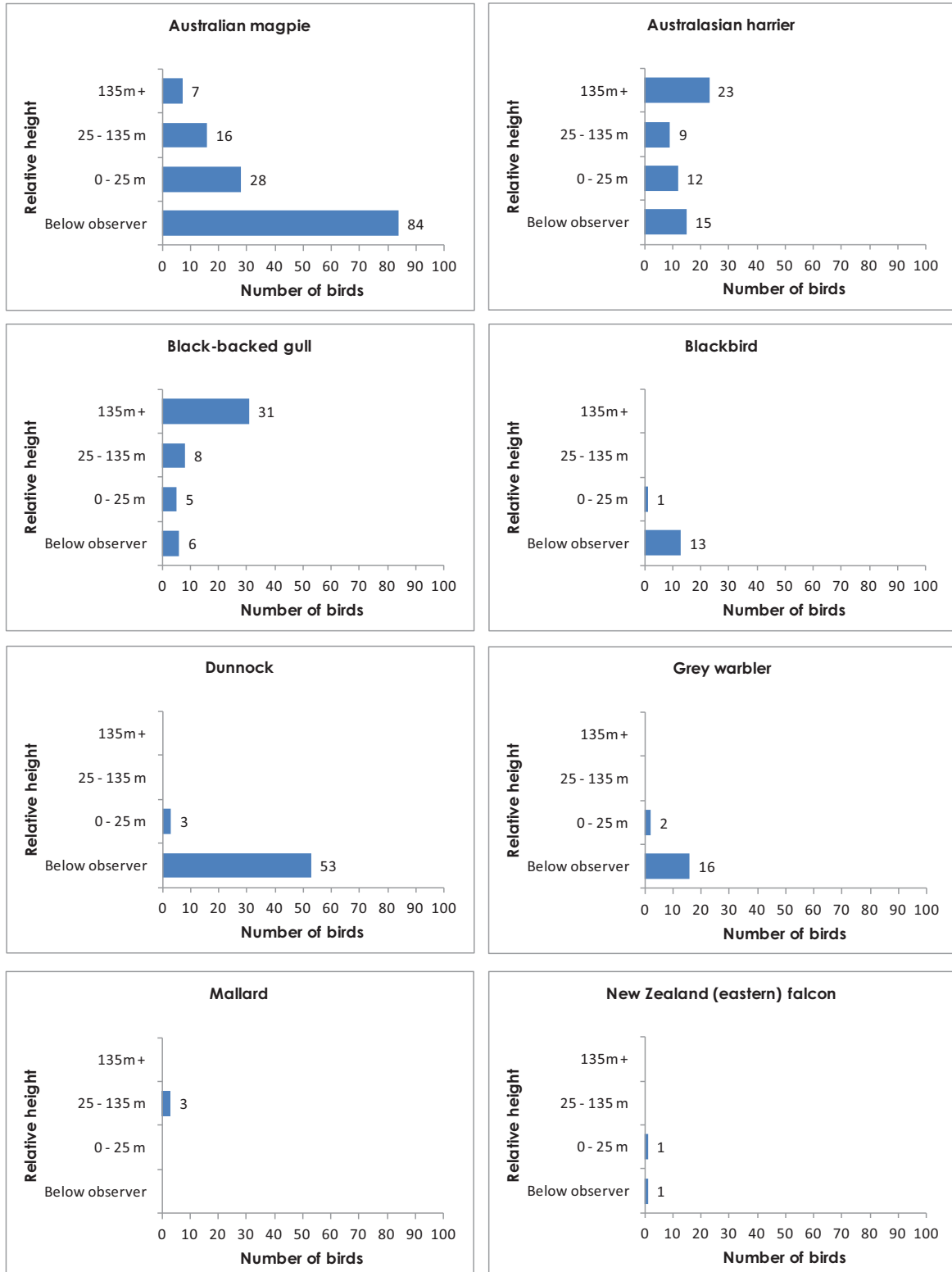


Figure A1: continued (x axis = 0 to 100)

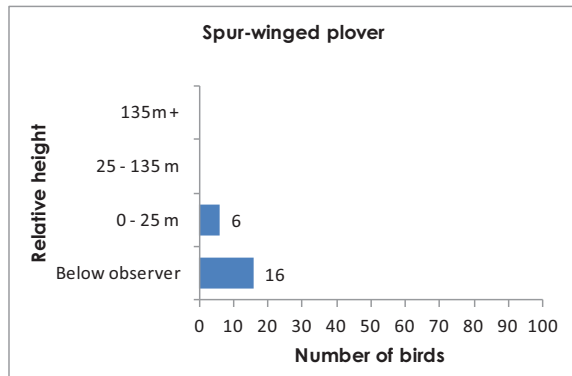
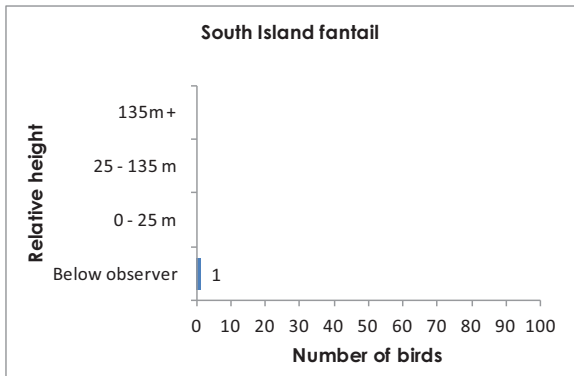
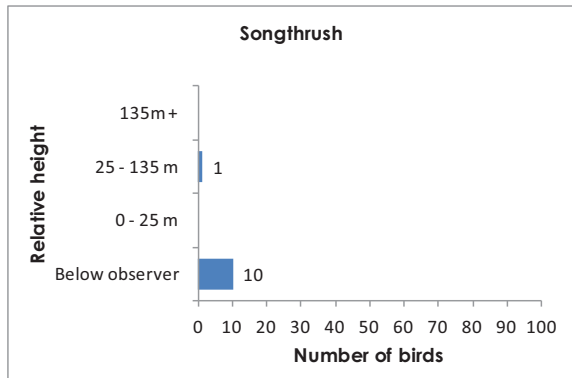
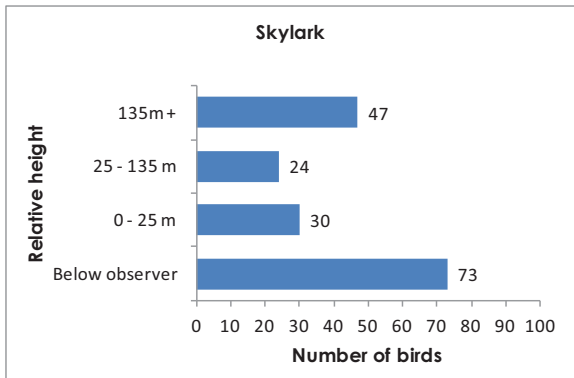
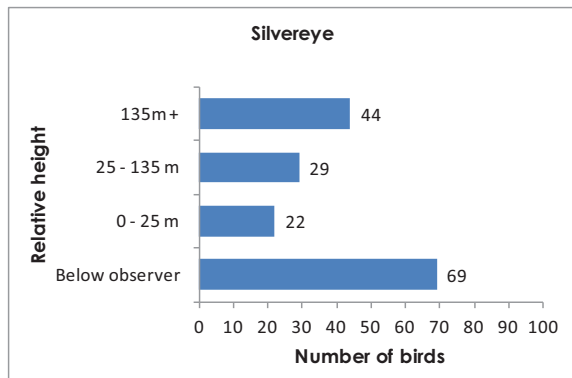
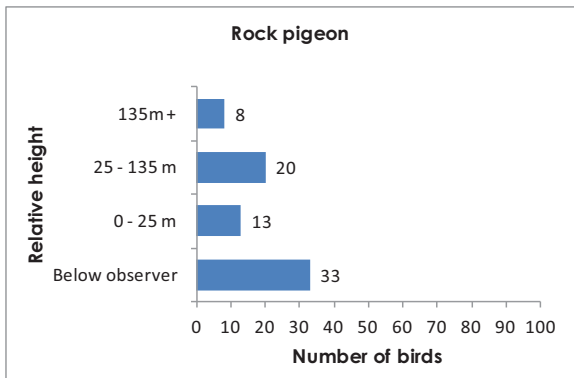
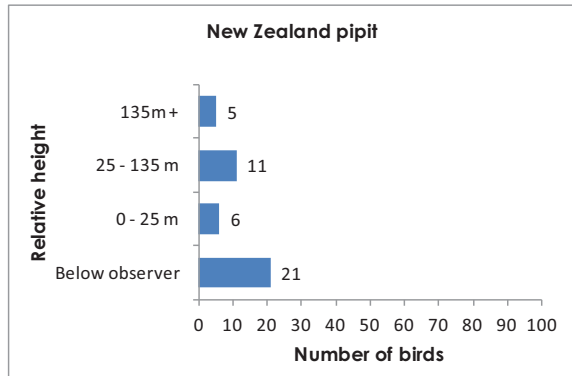
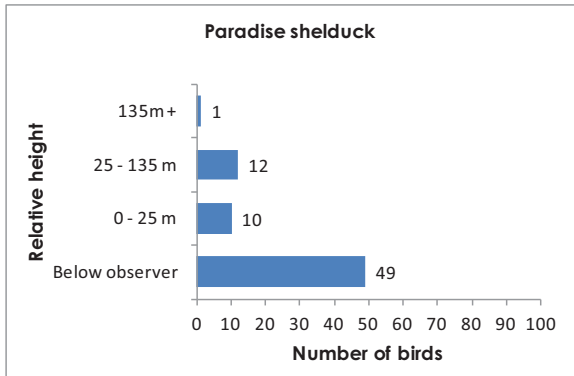


Figure A1: continued (x axis = 0 to 100)

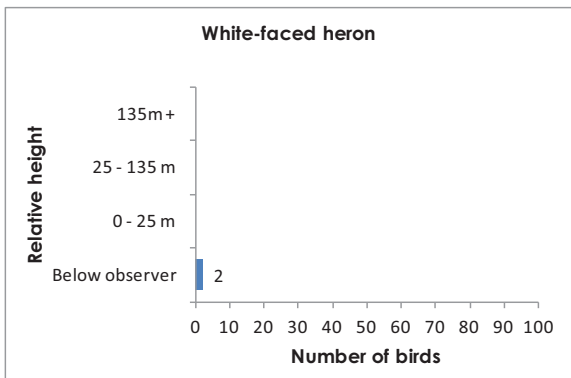
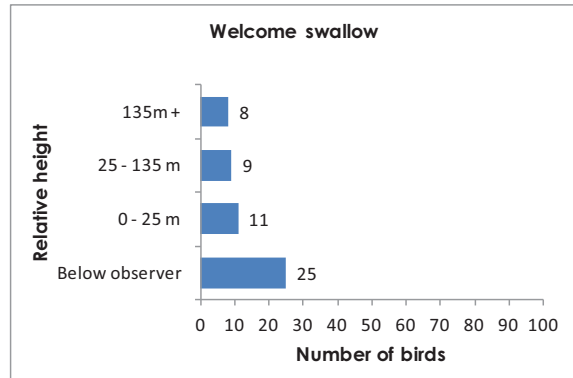
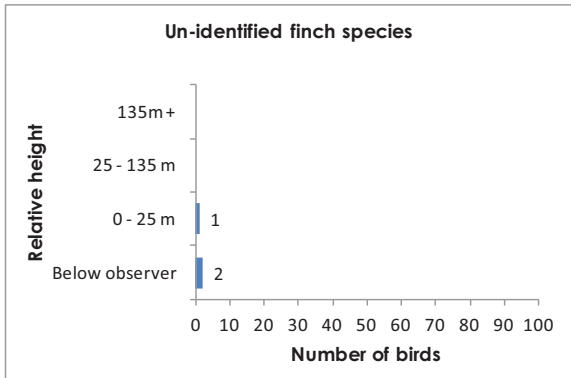


Figure A1: continued (x axis = 0 to 500)

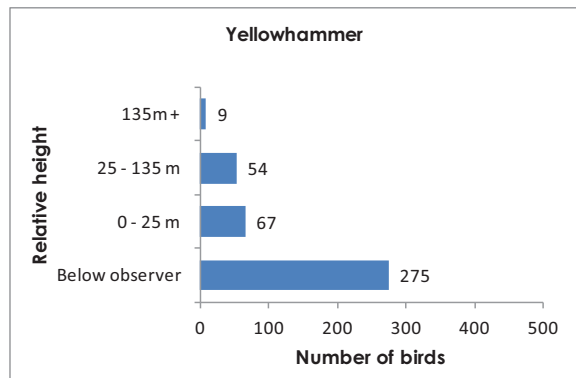
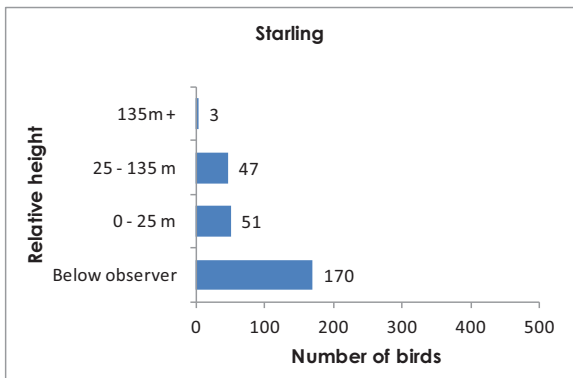
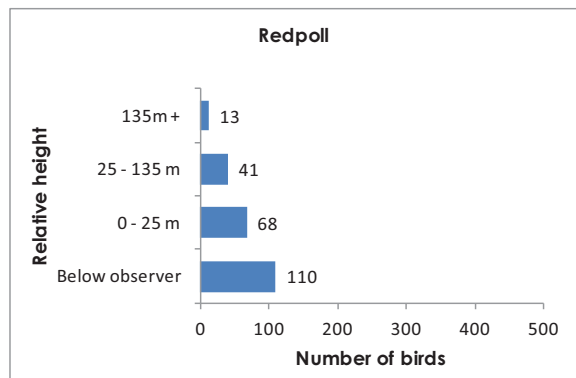
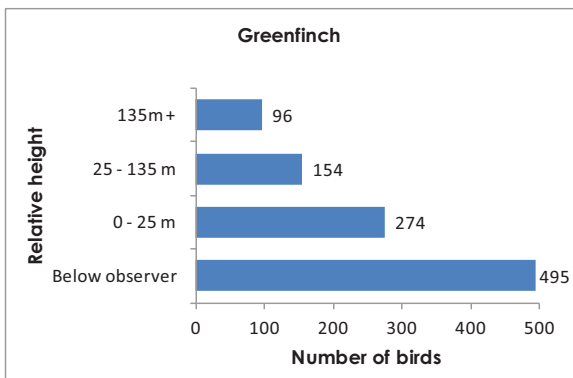
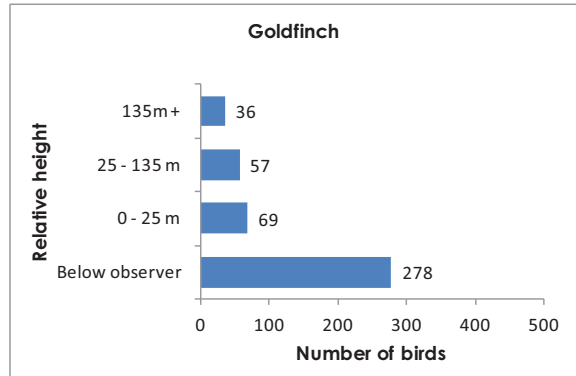
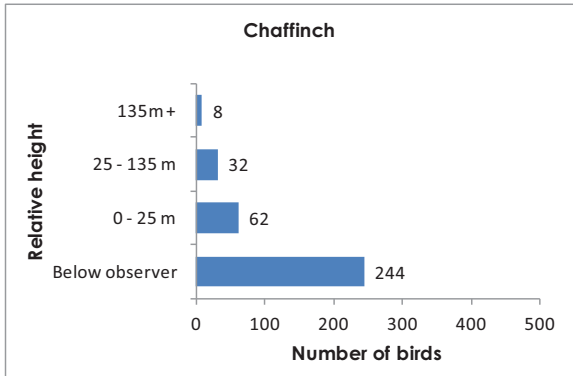
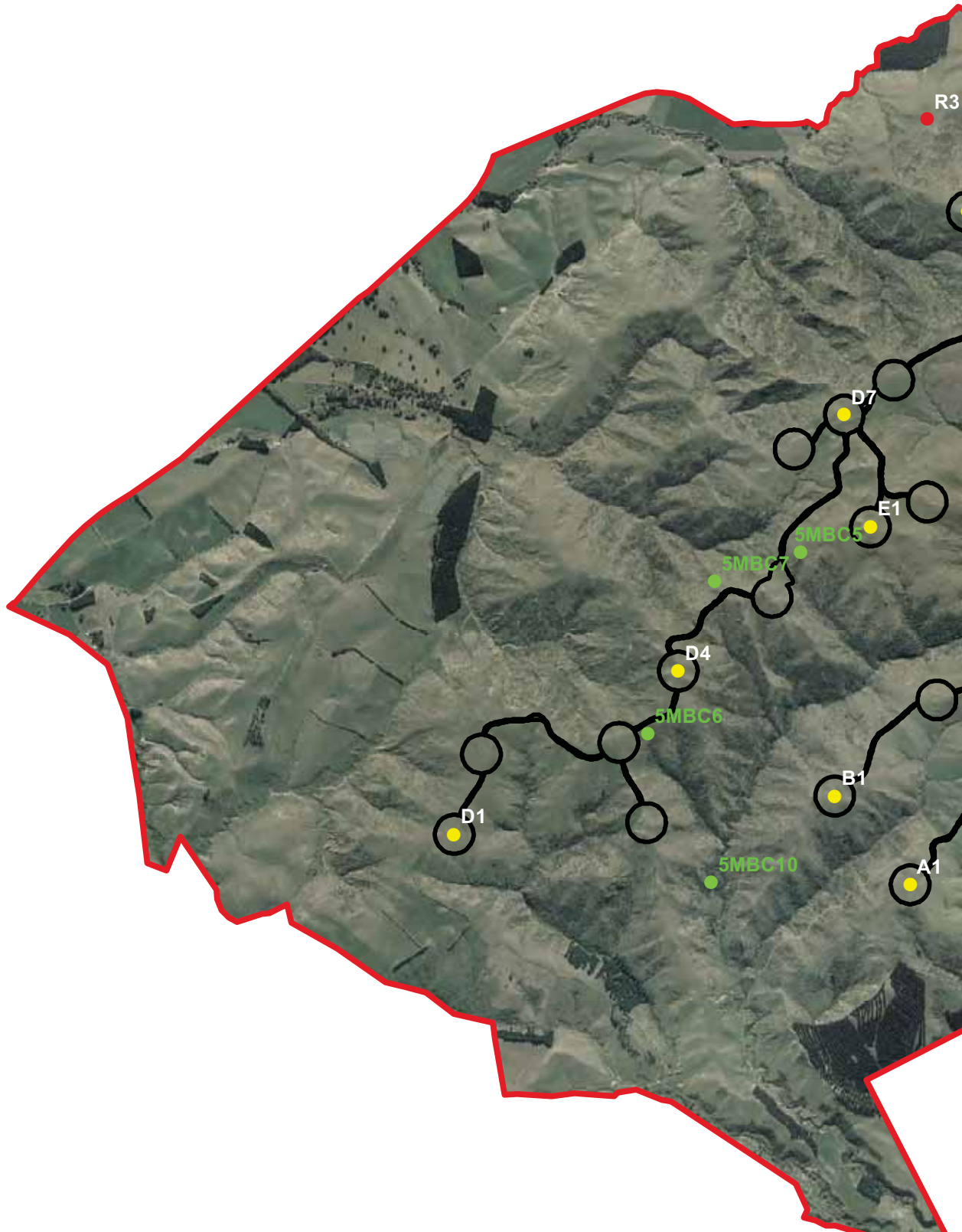
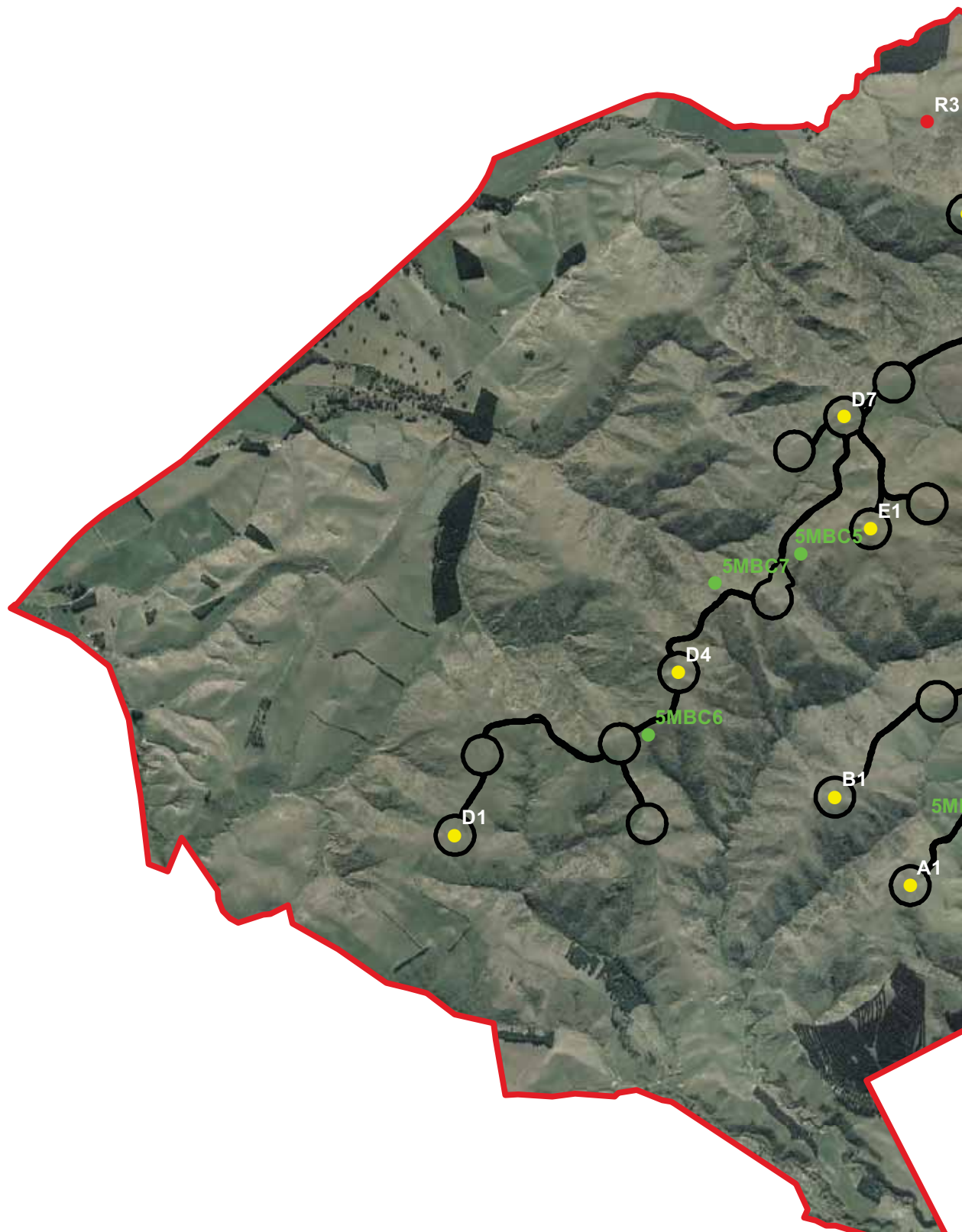


Table A1.7: The total number of each bird species recorded/five minute bird count site (listed from highest to lowest). The number of five-minute bird counts undertaken at each site is provided in the third row of the table.

	Five minute bird count site										Total
	1	2	3	4	5	6	7	8	9	10	
No. counts/station	15	15	7	7	20	19	19	19	12	12	
Silveryeye	58	77	15	8	110	70	40	48	91	204	721
Greenfinch*	31	36	24	24	81	92	49	81	22	8	448
Chaffinch*	61	54	34	34	22	67	65	35	23	28	423
Yellowhammer*	32	54	20	14	49	56	49	42	12	10	338
Redpoll*	32	35	35	25	35	46	17	32	11	10	278
Dunnock*	15	18	7	8	25	20	23	29	24	20	189
Grey warbler	24	18	10	2	25	23	22	11	18	25	178
Blackbird*	13	10	2	5	10	25	18	6	26	19	134
Goldfinch*	5	33	32	3	5	16	12	4	6	2	118
Australian magpie*	5	8	3	2	5	27	30	16	11	7	114
Bellbird	3	26	16	6		9	1	6	2	23	92
South Island fantail	3	13	1	1		11	3		8	34	74
Starling*	3	7		8	8	5	11	30	1		73
Song thrush*	6	8	1	3	2	7	3	6	9	7	52
Australasian harrier		4	1	1	6	10	11	7	2	1	43
Skylark*	6	1		1	11	3	9	8	2	1	42
California quail*		1		1	5	3	2			3	15
New Zealand (eastern) falcon						1	4	1		1	7
New Zealand pipit					1			1	1	3	6
Black-backed gull		1				2	1	1			5
Paradise shelduck		2								3	5
Spur-winged plover								3	1		4
Sacred kingfisher									2	1	3
Welcome swallow								1	2		3
Black-fronted tern					2						2
Shining cuckoo			1	1							2
Cirl bunting*							1				1
House sparrow*						1					1

Appendix 2: Maps





Legend

- Point
- Contr
- 5 min

Appendix 3: Example Data Sheets

POINT COUNTS

Observer:

Direction Faced:

Date:

Weather	Visibility		Cloud Cover (as % of sky)	Precipitation			Temperature			Wind
	0. Fine / sunny 1. Partly cloudy 2. Overcast	3. Heavy cloud 4. Mist / fog 5. Rain		0. None 1. Dripping foliage 2. Drizzle	3. Light 4. Moderate 5. Heavy	0. Freezing (<0°C) 1. Cold (0-5) 2. Cool (5-11)	3. Mild (11-16) 4. Warm (16-22) 5. Hot (>22°C)	0. 1. 2.		
Start	2		80	0			2			
Finish	2		70	0			2			

	Species	Number of birds	Distance from observer	Direction from observer	Direction of bird movement	Maximum Height	Minimum Height	Relative Height RSA (- 0 +)	Behaviour (see codes)	Breed (see codes)
1	Chaffinch	1	50	4	N-S	20	20	-	2	
2	Finch (unknown)	3	80	3	SE-NE	0	10	-	2	
3	Tui	1	100	4				-	7	
4	Chaffinch	6	80	3		0	0	-	4	
5	Songthrush	1	100	4				-	7	
6	Dunnock	1	60	3	E-W	15	25	-	2	
7	Chaffinch	1	90	3	E-W	5	1	-	1	
8	Yellowhammer	1	60	3	E-W	5	3	-	1	
9	Greywarbler	1	50	4				-	7	
10	Chaffinch	1	60	4	E-W	20	20	-	2	
11	Chaffinch	1	80	3	W-N	0	30	-	2	
12	Chaffinch	2	15	4	N-S	10	20	-	8	f
13	Chaffinch	1	90	4	N-S	0	40	0	2	
14	Chaffinch	2	80	3	NW-SE	0	0	-	4	
15	Chaffinch	1	50	4	W-E	0	15	-	3	
16	Chaffinch	1	60	3	W-E	5	15	-	2	
17	Silvereye	1	80	4	W-E	10	10	-	2	
18	Chaffinch	3	60	3	NW-NE	20	25	-	1	
19	Starling	12	80	3	NW-NE	15	5	-	2	
20										

Behaviour: 1 = Traverse 2 = Depart 3 = Arrive 4 = Feeding (ground) 5 = Feeding (air) 6 = Feeding (canopy) 7 = ...
Breeding: (a) = Nest with eggs (b) = Newly hatched (c) = Newly fledged (d) = Adult distraction display (e) = Display flight (f) = Male song posting (g) = ...

ROAMING COUNTS

Observer:

Date:.....

Start Time:

Weather	Visibility		Cloud Cover (as % of sky)	Precipitation			Temperature			Wind
	0. Fine / sunny 1. Partly cloudy 2. Overcast	3. Heavy cloud 4. Mist / fog 5. Rain		0. None 1. Dripping foliage 2. Drizzle	3. Light 4. Moderate 5. Heavy	0. Freezing (<0°C) 1. Cold (0-5) 2. Cool (5-11)	3. Mild (11-16) 4. Warm (16-22) 5. Hot (>22°C)	0. 1. 2.		
Start	2		80	0			2			
Finish	2		70	0			2			

	Species	Number of birds	Distance from nearest turbine	Behaviour (see codes)	Maximum Height	Minimum Height	Relative Height RSA (- 0 +)	Broad habitat description	Breed (see codes)	N
1	<i>New Zealand falcon</i>	1	2.5 km	1	10	5	1	Open Tussock	Unknown	S
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										

EXAMPLE

Behaviour: 1 = Traverse 2 = Depart 3 = Arrive 4 = Feeding (ground) 5 = Feeding (air) 6 = Feeding (canopy) 7 = ...
Breeding: (a) = Nest with eggs (b) = Newly hatched (c) = Newly fledged (d) = Adult distraction display (e) = Display flight (f) = Male song posting (g) = ...

MONITORING MAST COUNTS

Observer:

Date:

Sta

Dead bird evidence? (Y/N)			
Body (Yes / No)			
Feather spot Body (Yes / No)			
Time body found			
Species			
Number of dead			
Age (juv / adult)			
Sex			
Estimated time of death			
Location relative to mast			
Scavenged (Yes / No)			
Description			
Notes			

EXAMPLE

Age:

U = unknown **I** = Immature **A** = Adult

Sex:

U = unknown **F** = Female **M** = Male

Estimated time of death:

1 = Unknown (write description of flesh and feather in description)

3 = Actual time estimate (based on blood, other rationale, give in description)

2 = Fresh Kill (Sever

4 = Not applicable (i.

5-MINUTE COUNTS

Observer:

Direction Faced:

Date:

Weather	Visibility		Cloud Cover (as % of sky)	Precipitation			Temperature			Wind
	0. Fine / sunny	3. Heavy cloud		0. None	3. Light	0. Freezing (<0°C)	3. Mild (11-16)	0.		
	1. Partly cloudy	4. Mist / fog		1. Dripping foliage	4. Moderate	1. Cold (0-5)	4. Warm (16-22)	1.		
	2. Overcast	5. Rain		2. Drizzle	5. Heavy	2. Cool (5-11)	5. Hot (>22°C)	2.		
Start										

	Species	Heard	Seen	Notes
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

Heard and Seen. Birds that are first heard should be counted under Heard (even if they are later seen). Birds that are first seen should be entered under Seen. Adding H