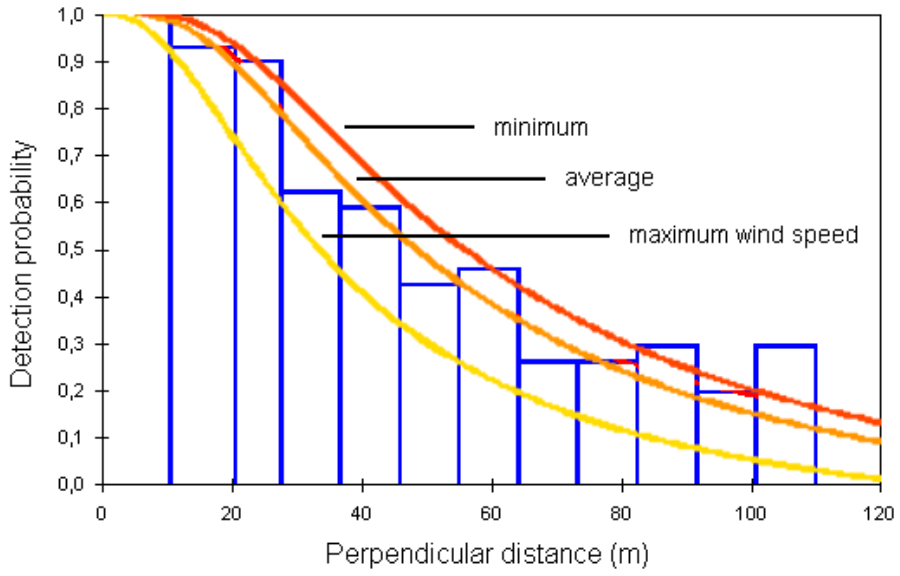
Appendix 1. Detection probability for skylark on Oamaru farms.

Figure A1. Example of a farm-level detection histogram and detection function curve for skylark (Farm 6 – Oamaru cluster). The *x*-axis shows detection distance (m) out to truncation distance, the *y*-axis shows detection probability. The histogram shows number of detections (not labelled) per distance interval. The detection function *g(x)* was fitted to the histogram and the *y*-axis then scaled to *g(0)* = 1. *g(x)* is shown for three example levels (maximum, average, minimum) of the continuous covariate 'wind speed'. The uppermost curve, resulting in the highest overall detection probability, corresponds to the lowest wind speed, showing that skylark detectability decreased in high winds on this farm.



Appendix 2. Estimation of covariate effects on detectability.

In multiple covariate distance sampling as implemented in program Distance (Marques & Buckland 2003), covariates enter the distance model through a scale factor (sigma), which is a function of the covariates z_i : $\sigma(z_i) = \exp(\beta_0+\beta_1 z_1+\beta_2 z_2+...)$, where β is a coefficient to be estimated (β_0 = intercept; in the case of a factor covariate, each level enters as an individual z_i). A larger scale factor causes the function to decline less steeply with increasing distance from the centre line, resulting in an increased average detection probability / effective strip width. A sigma calculated using a single level's coefficient denotes the relative strength of influence (change of shape of the detection function curve) of that covariate level. 'Sigma ratios' were calculated as the ratio between sigma at a given level of the covariate and at the lowest of these levels (for factor covariates: season, observer, habitat, heard/seen), or the ratio between sigma at the zero value of the covariate and sigma at the average value (for continuous covariates: wind, minutes since sunrise).

Table A1. Covariate scores (sum of Akaike weights of models containing the covariate) and sigma ratios (relative magnitude of scale factor driven by the covariate, normalised to lowest value among levels [factor covariates] or 0 [continuous covariates]) for covariates used in detection function modelling. For factor covariates (season, observer, habitat, heard/seen), sigma ratios describe the ratio between sigma at a covariate level and at the lowest of these levels (weight-averaged over the model set), allowing levels to be ordered by increasing positive influence on detectability. For continuous covariates (wind, minutes since sunrise) sigma ratios describe the ratio between sigma at the zero value (no wind, or at sunrise) and sigma at the average value, thus a value of 1 corresponds to no effect, <1 to a negative and >1 to a positive effect of the covariate on detectability.

Some values were capped: 98% of tabulated normalised sigmas for factor covariates were below 8; the remaining 2% had values between 20 and 10 000. Sigma will asymptotically approach infinity the ‘flatter’ the curve is, hence the estimate of sigma can become extremely large with little increase in the actual effect. As interest lay primarily in the direction of influence of a covariate level rather than in the magnitude, to enable the computation of averages, values > 8 were capped at 10 (13/675). Similarly, normalised sigmas for continuous covariate ‘wind’ were capped at 2 (2/48), and those for continuous covariate ‘minutes’ at 3 (5/48). Capped values are denoted with an asterisk *.

		Cumulative covariate scores							Weight-averaged sigma ratios												
									Season			Observer			Habitat			Heard / seen		Continuous	
Species	Farm	Season	Observer	Habitat	Heard/seen	Wind	Minutes	None	Breed	Post	Winter	Main	Other	Main+other	Veg	Open	Other	Seen	Heard	Wind	Minutes
Skylark	1	0.394	0.176	0.000	0.133	0.305	0.246	0.218	1.800	1.795	1.000	1.102	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.979	1.375
	2	0.119	0.382	0.000	0.111	0.048	0.172	0.288	1.060	1.408	1.000	1.194	1.000	1.000	1.000	1.000	1.000	1.000	1.240	1.000	1.164
	3	0.435	0.177	0.097	0.000	0.166	0.463	0.048	1.928	1.050	1.000	1.617	1.000	1.382	1.000	1.000	1.000	1.000	1.000	1.189	2.821
	4	0.759	0.491	0.333	0.000	0.000	0.087	0.044	1.172	1.000	1.291	1.000	1.196	6.553	1.000	3.980	10.000 *	1.000	1.000	1.000	1.187
	5	0.945	0.158	0.297	0.038	0.123	0.110	0.000	1.000	1.093	10.000 *	1.372	1.000	2.230	1.000	1.000	10.000 *	1.000	1.000	0.808	1.000
	6	0.016	0.149	0.205	0.590	0.565	0.391	0.043	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.143	5.534	1.000	1.017	1.530
	7	0.000	0.000	0.202	0.165	0.287	0.263	0.348	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2.626	1.000	10.000 *	1.307	1.000
	8	1.000	0.763	0.000	0.000	0.000	1.000	0.000	3.755	2.691	1.000	1.932	1.000	1.696	1.000	1.000	1.000	1.000	1.000	1.000	2.658
	9	0.000	0.000	0.000	0.318	0.000	0.000	0.682	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	10	0.038	0.096	0.111	0.000	0.472	0.189	0.283	1.000	1.000	1.000	1.058	1.000	1.000	1.000	1.000	1.530	1.000	1.000	0.631	1.078
	11	0.000	0.220	0.000	0.281	0.276	0.202	0.268	1.000	1.000	1.000	1.000	1.006	1.000	1.000	1.000	1.000	2.752	1.000	1.358	1.664
	12	0.169	0.000	0.179	0.000	0.000	1.000	0.000	2.152	1.000	1.452	1.000	1.000	1.000	1.000	1.000	4.968	1.000	1.000	1.000	3.000 *
Averages		0.323	0.218	0.119	0.136	0.187	0.344	0.185	1.489	1.253	1.812	1.190	1.017	1.655	1.000	1.248	3.022	1.524	1.770	1.024	1.623
Blackbird	1	0.113	0.063	0.092	0.501	0.064	0.062	0.415	1.221	1.000	1.000	1.083	1.000	1.000	1.000	1.000	1.000	1.000	1.459	1.061	1.000
	2	0.262	0.141	0.042	0.231	0.303	0.376	0.134	1.000	1.779	2.155	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2.004	0.686	3.000 *
	3	0.232	0.178	0.227	0.130	0.266	0.633	0.075	3.225	4.430	1.000	1.615	1.000	10.000 *	1.000	1.839	1.000	1.669	1.000	1.660	3.000 *
	4	0.047	0.340	0.000	0.084	0.341	1.000	0.000	1.000	1.000	1.000	1.801	3.408	1.000	1.000	1.000	1.000	1.000	1.000	1.193	0.369
	5	0.000	0.065	0.441	0.067	0.107	0.054	0.320	1.000	1.000	1.000	1.000	1.000	1.000	1.000	4.540	2.582	1.000	1.000	0.758	1.000
	6	1.000	0.000	0.000	0.000	0.000	1.000	0.000	1.885	1.000	10.000 *	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3.000 *
	7	1.000	0.399	1.000	0.000	0.601	0.000	0.000	2.393	1.000	7.312	1.000	1.755	1.616	1.000	1.098	10.000 *	1.000	1.000	2.000 *	1.000
	8	0.000	0.000	1.000	0.602	0.838	0.156	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2.291	2.653	1.000	1.743	1.598	1.000
	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10	0.117	0.290	0.000	0.108	0.113	0.406	0.266	1.089	1.393	1.000	1.522	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.101	3.000 *
	11	0.000	0.139	0.626	0.327	0.139	1.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.426	1.461	1.000	1.425	0.964	0.777
	12	0.000	0.277	1.000	0.262	0.590	0.145	0.000	1.000	1.000	1.000	1.000	1.231	1.000	1.000	2.023	1.016	1.000	1.268	1.247	0.851
Averages		0.252	0.172	0.403	0.210	0.306	0.439	0.110	1.438	1.418	2.497	1.184	1.308	1.874	1.000	1.656	2.156	1.061	1.264	1.206	1.636
Thrush	1	0.137	0.155	0.000	0.000	0.138	0.000	0.570	1.000	1.000	1.000	1.120	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.984	1.000
	2	0.000	1.000	0.182	0.000	0.187	0.000	0.000	1.000	1.000	1.000	3.770	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2.000 *	1.000
	3	0.000	0.000	0.127	0.127	0.128	0.127	0.491	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.986	1.000
	4	0.000	0.187	0.076	0.076	0.202	0.202	0.535	1.000	1.000	1.000	2.106	2.341	1.000	1.000	1.000	1.000	1.000	1.000	0.702	1.493
	5	0.000	1.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7	1.000	0.000	0.000	0.415	0.207	0.396	0.000	1.218	1.000	3.196	1.000	1.000	1.000	1.000	1.000	1.000	1.359	1.000	0.746	0.000
	8	0.060	0.074	0.330	0.080	0.154	0.424	0.234	1.000	1.000	1.000	1.000	1.000	1.000	2.408	1.000	3.467	1.118	1.000	1.073	0.436
	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	10	0.175	0.419	0.000	0.258	0.289	0.256	0.131	2.583	1.000	1.441	1.849	1.000	1.000	1.000	1.000	1.000	1.000	1.899	0.741	2.364
	11	0.032	0.281	0.093	0.263	0.453	0.035	0.198	1.000	1.000	1.000	1.000	1.279	1.000	1.000	1.000	1.000	1.092	1.000	1.327	1.000
	12	0.000	0.257	0.000	0.743	0.122	0.878	0.000	1.000	1.000	1.000	1.932	1.000	1.000	1.000	1.000	1.000	1.000	2.798	1.000	1.918
Averages		0.140	0.337	0.081	0.196	0.188	0.232	0.216	1.180	1.000	1.264	1.578	1.162	1.000	1.141	1.000	1.247	1.057	1.270	1.056	1.121
Magpie	1	0.031	1.000	0.306	0.307	0.185	0.234	0.000	1.000	1.000	1.000	2.266	1.000	1.000	1.446	1.000	1.000	1.000	1.950	1.214	1.293
	2	0.000	0.240	0.000	0.191	0.270	0.286	0.329	1.000	1.000	1.000	1.000	1.256	1.000	1.000	1.000	1.000	1.000	10.000 *	0.936	0.351
	3	0.000	0.000	0.000	0.844	0.152	0.168	0.156	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	10.000 *	0.971	0.809
	4	0.119	0.925	0.383	0.075	0.000	0.075	0.000	1.000	1.000	1.000	1.000	3.291	1.058	1.000	1.229	10.000 *	1.000	1.000	1.000	1.000
	5	0.270	0.182	0.196	0.104	0.183	0.273	0.185	1.489	7.190	1.000	3.497	2.447	1.000	3.967	2.383	1.000	1.000	1.000	0.395	2.238
	6	0.790	0.000	0.000	0.147	1.000	0.297	0.000	1.210	2.235	1.000	1.000	1.000	1.000	1.000	1.000	1.000	2.309	1.000	0.695	0.615
	7	0.090	0.107	0.256	0.052	0.301	0.230	0.332	1.000	1.000	1.000	2.748	1.000	1.190	7.886	1.000	10.000 *	1.000	1.000	0.677	2.243
	8	0.000	0.000	0.000	0.450	0.109	0.584	0.261	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	3.391	1.000	0.256
	9	0.313	0.000	1.000	0.072	0.392	0.473	0.000	1.000	1.028	3.611	1.000	1.000	1.000	2.094	1.000	10.000 *	1.000	1.000	0.813	0.524
	10	0.000	0.000	0.000	0.245	0.686	0.000	0.213	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	11	0.055	0.196	0.000	0.000	0.244	0.753	0.105	1.000	1.000	1.000	1.063	1.000	1.000	1.000	1.000	1.000	1.000	1.000	0.701	0.367
	12	0.089	0.162	0.097	0.000	0.183	0.640	0.208	1.000	1.805	1.165	1.168	1.000	1.000	1.067	1.000	10.000 *	1.000	1.000	1.030	1.858
Averages		0.146	0.234	0.186	0.207	0.309	0.334	0.149	1.058	1.688	1.231	1.479	1.333	1.021	1.955	1.134	4.000	1.109	2.778	0.869	1.046