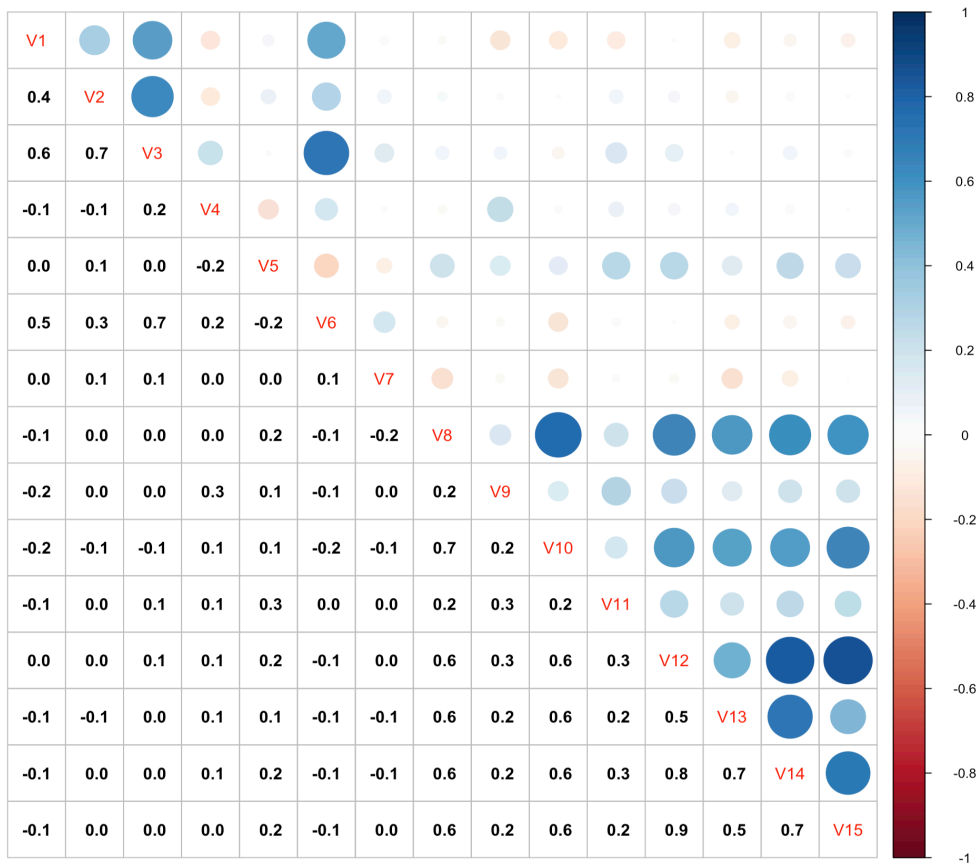


SUPPLEMENTARY MATERIAL

Figure S1. (A) Correlogram of the raw data in the initial variables tested, including (V1) uniqueness, (V2) mass, (V3) brain mass, (V4) brain mass residual, (V5) clutch size, (V6) generation length, (V7) island endemism, (V8) total feeding habitats, (V9) total feeding locations, (V10) total breeding habitats, (V11) total food types, (V12) feeding in agriculture, (V13) feeding in urban areas, (V14) feeding in modified landscapes, (V15) breeding in agriculture. Pearson's r values are displayed below diagonal and visual representation above diagonal. (B) VIF values of the selected variables with $-0.5 \leq \text{Pearson's } r \leq 0.5$. For details on the variables see Table S1.

a



b

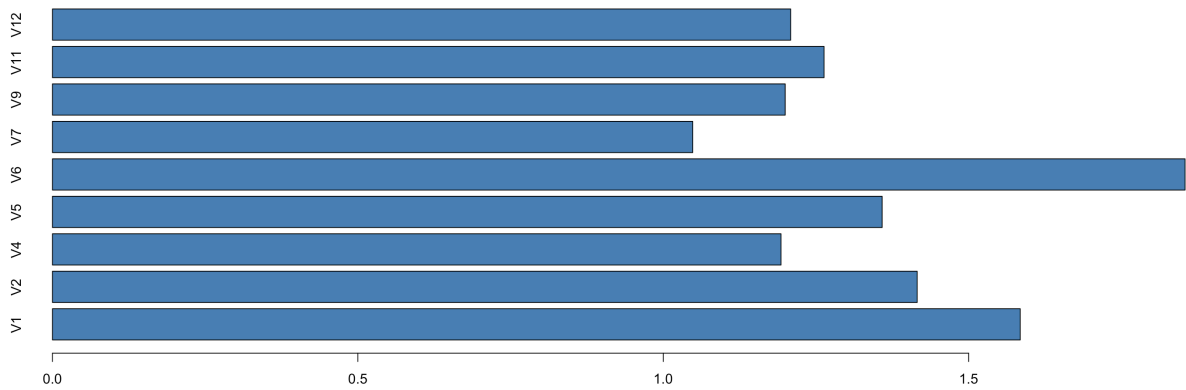


Table S1. Explanatory variables used in the statistical models predicting the likelihood of Australian bird taxa being threatened (VU/EN/CR). All data are sourced from Garnett *et al.* (2015).

Variable name	Definition	Values
Uniqueness	Measure of evolutionary distinctiveness of taxon calculated from the number of families in an order (a), number of genera in a family (b), number of species in a genus (c), and number of subspecies in a species (d), with the equation = $100 * (1 / (a * b * c * d))^{(1/4)}$.	numeric
Mass	Average body mass in grams. Natural logarithm of these values was used to normalise this variable.	gram
Brain mass residual	Brain mass controlling allometrically for body mass relative to a regression of brain mass on body mass.	numeric
Clutch size	Average number of eggs in a completed clutch. Natural logarithm of these values was used to normalise this variable.	numeric
Generation length	Average length of a generation. Natural logarithm of these values was used to normalise this variable.	year
Island endemism	Only occurs on islands (including Tasmania).	yes / no
Total feeding locations	Total number of feeding locations (out of six, including ground, shrub, canopy, aerial, deep water, and shallow water).	integer (0–6)
Total food types	Total number of food types (including fruit, nectar or pollen, seeds, foliage or herbs, corms or tubers, terrestrial invertebrates, terrestrial vertebrates, carrion, intertidal invertebrates, marine fish or invertebrates, and freshwater fish or invertebrates).	integer (0–11)
Feeding in agriculture	Agricultural landscapes provide a non-trivial proportion of the nutrient and energy intake of the taxon.	yes / no
Brain mass*	Weight of brain.	gram
Total feeding habitats*	Total number of feeding habitats.	integer
Total breeding habitats*	Total number of breeding habitats.	integer
Feeding in urban areas*	Urban landscapes provide a non-trivial proportion of the nutrient and energy intake of the taxon.	yes / no
Feeding in modified landscapes*	Modified landscapes provide a non-trivial proportion of the nutrient and energy intake of the taxon.	yes / no
Breeding in agriculture*	Agricultural land provides a non-trivial proportion of nest sites used by the taxon.	yes / no

* Excluded variables from the analyses.

Table S2. Predictor variables of the likelihood of Australian bird species being threatened (VU/EN/CR on the IUCN Red List). Results of the generalized linear mixed-effects models (GLMMs) are provided for each decade (1990–2020) with the number of ultrataxa tested (n), variance (V) of the random effects (taxonomic families) \pm SD, coefficient of determination (R^2_{pred}), estimates (B), z-score (Z), and chi-square *P* values (<0.05 are shown in bold). * Normalised by \log_e

Variable	1990			2000			2010			2020		
	n = 748; V = 0.14 \pm 0.37			n = 748; V = 0.23 \pm 0.48			n = 747; V = 0.14 \pm 0.37			n = 747; V < 0.01		
	$R^2_{\text{pred}} = 0.1$			$R^2_{\text{pred}} = 0.1$			$R^2_{\text{pred}} = 0.1$			$R^2_{\text{pred}} = 0.1$		
	B	Z	P	B	Z	P	B	Z	P	B	Z	P
Uniqueness	0.05	2.83	0.005	0.05	2.89	0.004	0.04	2.69	0.007	0.05	3.54	<0.001
Mass*	0.12	0.63	0.531	0.17	0.92	0.359	0.01	0.06	0.953	-0.14	-0.94	0.349
Brain mass residual	1.49	1.06	0.289	1.23	0.92	0.356	0.66	0.55	0.58	2.75	2.78	0.005
Clutch size*	0.32	0.78	0.438	0.43	1.07	0.286	0.59	1.59	0.112	0.34	1.06	0.289
Generation length*	<0.01	0.01	0.995	0.13	0.23	0.816	0.73	1.42	0.154	0.47	1.1	0.273
Island endemism	1.51	3.73	<0.001	1.45	3.59	<0.001	1.2	3.08	0.002	0.83	2.33	0.02
Total feeding locations	-0.01	-0.03	0.975	-0.16	-0.46	0.649	-0.3	-0.91	0.361	-0.52	-1.78	0.075
Total food types	-0.16	-0.74	0.462	-0.25	-1.15	0.249	-0.16	-0.83	0.405	-0.01	-0.07	0.941
Feeding in agriculture	-1.05	-2.37	0.018	-0.99	-2.33	0.02	-0.99	-2.45	0.014	-1.01	-2.92	0.004

Table S3. Predictor variables of the likelihood of Australian bird species and ultrataxa within (a) passerines (Passeriformes), (b) parrots (Psittaciformes), (c) shorebirds (Charadriiformes), and (d) seabirds (Sphenisciformes, Procellariiformes, and Suliformes) being threatened (VU/EN/CR on the IUCN Red List). Results of the generalized linear mixed-effects models (GLMM) over four decades are provided for the number of species and ultrataxon used (n) as the average variance (V) of the random effects (taxonomic families) \pm SD, coefficient of determination (R^2_{pred}), estimates (B), z-scores (Z), and chi-square P values (<0.05 are shown in bold). * Normalised by \log_e

(a) PASSERINES	1990 n = 341; V < 0.01 $R^2_{\text{pred}} = 0.27$			2000 n = 341; V < 0.01 $R^2_{\text{pred}} = 0.27$			2010 n = 340; V < 0.01 $R^2_{\text{pred}} = 0.27$			2020 n = 340; V = 0.51 ± 0.71 $R^2_{\text{pred}} = 0.27$		
Species	B	Z	P	B	Z	P	B	Z	P	B	Z	P
Uniqueness	0.35	3.58	<0.001	0.33	3.31	0.001	0.2	2.56	0.01	0.19	2.82	0.005
Mass*	0.14	0.24	0.809	0.15	0.25	0.804	-0.15	-0.29	0.774	-0.35	-0.73	0.465
Brain mass residual	-13.62	-2.08	0.038	-14.16	-2.09	0.037	-3.77	-0.7	0.482	6.07	1.46	0.145
Clutch size*	-0.39	-0.32	0.75	-0.33	-0.26	0.791	-0.03	-0.02	0.982	-0.81	-0.78	0.437
Generation length*	0.17	0.10	0.923	0.32	0.17	0.862	-0.13	-0.08	0.937	-0.64	-0.52	0.602
Island endemism	3.67	3.85	<0.001	3.72	3.87	<0.001	2.46	2.82	0.005	2.27	2.78	0.005
Total feeding locations	-0.12	-0.2	0.843	-0.31	-0.47	0.637	-0.68	-1.05	0.295	-1.09	-1.94	0.053
Total food types	0.4	0.85	0.394	0.35	0.71	0.477	0.23	0.54	0.586	0.05	0.14	0.888
Feeding in agriculture	-1.14	-1.21	0.225	-1.05	-1.11	0.266	-0.94	-1.07	0.284	-0.51	-0.74	0.461
Ultrataxa	n = 717; V = 0.7 ± 0.84 $R^2_{\text{pred}} = 0.15$			n = 715; V = 0.6 ± 0.78 $R^2_{\text{pred}} = 0.15$			n = 714; V = 0.59 ± 0.77 $R^2_{\text{pred}} = 0.15$			n = 714; V = 1.61 ± 1.27 $R^2_{\text{pred}} = 0.15$		
Variable	B	Z	P	B	Z	P	B	Z	P	B	Z	P
Uniqueness	0.11	2.28	0.023	0.11	2.18	0.029	0.09	1.86	0.063	0.13	2.65	0.008
Mass*	0.22	0.63	0.526	0.26	0.77	0.444	0.17	0.49	0.625	0.27	0.87	0.386
Brain mass residual	2.37	0.72	0.475	1.25	0.38	0.701	2.09	0.66	0.512	5.95	2.23	0.026
Clutch size*	-0.28	-0.36	0.722	-0.17	-0.23	0.821	-0.12	-0.16	0.876	-1.02	-1.46	0.146
Generation length*	-1.19	-1.33	0.184	-1.29	-1.45	0.146	-1.59	-1.83	0.068	-1.18	-1.64	0.1
Island endemism	1.33	2.95	0.003	1.26	2.87	0.004	0.9	2.06	0.039	1.89	5.66	<0.001
Total feeding locations	-0.22	-0.6	0.55	-0.31	-0.84	0.398	-0.31	-0.91	0.365	-0.47	-1.6	0.109
Total food types	0.08	0.26	0.792	0.09	0.33	0.743	0.17	0.64	0.524	0.06	0.24	0.809
Feeding in agriculture	-1.53	-2.74	0.006	-1.32	-2.54	0.011	-0.9	-1.92	0.054	-0.31	-0.89	0.373

(b) PARROTS	1990			2000			2010			2020		
Species	n = 56; V < 0.01 $R^2_{\text{pred}} = 0.25$			n = 56; V < 0.01 $R^2_{\text{pred}} = 0.25$			n = 56; V < 0.01 $R^2_{\text{pred}} = 0.25$			n = 56; V < 0.01 $R^2_{\text{pred}} = 0.25$		
Variable	B	Z	P	B	Z	P	B	Z	P	B	Z	P
Uniqueness	0.03	0.48	0.635	0.03	0.48	0.635	0.03	0.48	0.635	0.09	1.39	0.165
Mass*	-0.58	-0.42	0.676	-0.58	-0.42	0.676	-0.58	-0.42	0.676	-0.65	-0.51	0.612
Brain mass residual	7.01	0.82	0.412	7.01	0.82	0.412	7.01	0.82	0.412	4.01	0.55	0.58
Clutch size*	0.55	0.32	0.751	0.55	0.32	0.751	0.55	0.32	0.751	-0.85	-0.59	0.557
Generation length*	1.96	0.78	0.433	1.96	0.78	0.433	1.96	0.78	0.433	1.5	0.65	0.517
Island endemism	5.82	2.42	0.016	5.82	2.42	0.016	5.82	2.42	0.016	5.65	2.31	0.021
Total feeding locations	-0.4	-0.4	0.69	-0.4	-0.4	0.69	-0.4	-0.4	0.69	-0.64	-0.66	0.507
Total food types	-1.64	-1.29	0.196	-1.64	-1.29	0.196	-1.64	-1.29	0.196	-1.39	-1.18	0.237
Feeding in agriculture	-2.02	-1.31	0.192	-2.02	-1.31	0.192	-2.02	-1.31	0.192	-1.48	-1.14	0.255
Ultrataxa	n = 102; V < 0.01 $R^2_{\text{pred}} = 0.14$			n = 102; V < 0.01 $R^2_{\text{pred}} = 0.14$			n = 102; V < 0.01 $R^2_{\text{pred}} = 0.14$			n = 102; V < 0.01 $R^2_{\text{pred}} = 0.14$		
Variable	B	Z	P	B	Z	P	B	Z	P	B	Z	P
Uniqueness	0.08	1.87	0.062	0.09	1.92	0.055	0.08	1.84	0.066	0.08	2.02	0.043
Mass*	-0.07	-0.08	0.937	-0.46	-0.53	0.6	-0.4	-0.47	0.639	-0.05	-0.06	0.952
Brain mass residual	-1.82	-0.31	0.753	0.12	0.02	0.984	-1.24	-0.21	0.83	-4.67	-0.89	0.372
Clutch size*	-0.41	-0.44	0.662	-0.34	-0.36	0.719	-0.8	-0.87	0.384	-0.91	-1.1	0.272
Generation length*	0.61	0.47	0.639	0.9	0.68	0.495	0.91	0.69	0.491	0.67	0.58	0.56
Island endemism	2.55	2.87	0.004	2.65	2.92	0.003	2.58	2.85	0.004	2.54	2.98	0.003
Total feeding locations	-0.5	-1.12	0.261	-0.37	-0.81	0.42	-0.48	-1.08	0.281	-0.38	-0.99	0.323
Total food types	0.5	0.87	0.386	0.4	0.68	0.499	0.41	0.71	0.477	0.35	0.67	0.504
Feeding in agriculture	-0.94	-1.24	0.214	-1.13	-1.44	0.149	-0.82	-1.1	0.271	-0.68	-1.03	0.302

(c) SHOREBIRDS	1990			2000			2010			2020		
	n = 91; V < 0.01 $R^2_{\text{pred}} = 0.45$			n = 91; V < 0.01 $R^2_{\text{pred}} = 0.45$			n = 91; V < 0.01 $R^2_{\text{pred}} = 0.45$			n = 91; V < 0.01 $R^2_{\text{pred}} = 0.45$		
Species												
Variable	B	Z	P	B	Z	P	B	Z	P	B	Z	P
Uniqueness	0.32	0.78	0.434	0.12	1.61	0.106	0.08	1.71	0.087	0.09	1.83	0.067
Mass*	-2.45	-0.6	0.549	1.8	1.62	0.105	-0.36	-0.58	0.565	-0.44	-0.7	0.485
Brain mass residual	7.8	0.3	0.761	0.91	0.09	0.925	-1.24	-0.2	0.844	0.11	0.02	0.986
Clutch size*	-9.57	-1.28	0.199	0.83	0.42	0.677	0.69	0.55	0.58	0.47	0.38	0.706
Generation length*	-14.37	-1.36	0.175	-4.83	-1.85	0.064	0.5	0.32	0.745	0.49	0.31	0.757
Island endemism	-45.79	<0.01	1	-24.82	<0.01	1	-21.51	-0.01	0.988	-24.61	<0.01	1
Total feeding locations	-14.52	<0.01	0.999	-17.46	<0.01	0.998	-0.84	-0.69	0.492	-1.15	-0.94	0.347
Total food types	-3.6	-0.93	0.352	-0.21	-0.25	0.802	-0.17	-0.36	0.716	0.19	0.42	0.672
Feeding in agriculture	-37.1	<0.01	1	-0.86	-0.58	0.565	-0.26	-0.26	0.798	-0.38	-0.38	0.705
Ultrataxa	n = 107; V < 0.01 $R^2_{\text{pred}} = 0.36$			n = 107; V < 0.01 $R^2_{\text{pred}} = 0.36$			n = 107; V < 0.01 $R^2_{\text{pred}} = 0.36$			n = 107; V < 0.01 $R^2_{\text{pred}} = 0.36$		
Variable	B	Z	P	B	Z	P	B	Z	P	B	Z	P
Uniqueness	0.09	1.48	0.14	0.1	1.86	0.063	0.02	0.53	0.594	0.05	1.19	0.233
Mass*	-0.28	-0.35	0.725	0.45	0.67	0.505	-0.34	-0.77	0.441	-0.78	-1.8	0.072
Brain mass residual	-6.6	-0.79	0.432	-1.92	-0.28	0.782	-4.3	-0.84	0.399	1.35	0.26	0.793
Clutch size*	-0.25	-0.16	0.874	0.89	0.64	0.523	1.67	1.8	0.071	2.87	3.08	0.002
Generation length*	-1.37	-0.69	0.491	-1.78	-1.04	0.3	1.03	0.96	0.339	2.57	2.35	0.019
Island endemism	4.17	2.88	0.004	4.59	3.09	0.002	2.42	2.63	0.008	2.38	2.62	0.009
Total feeding locations	0.66	0.43	0.666	-0.7	-0.5	0.618	-0.37	-0.39	0.695	-1.1	-1.18	0.238
Total food types	-0.56	-0.8	0.426	-0.61	-0.97	0.334	-0.72	-1.85	0.065	-0.50	-1.42	0.156
Feeding in agriculture	-0.75	-0.53	0.598	0.34	0.29	0.769	0.2	0.23	0.818	0.04	0.05	0.963

(d) SEABIRDS	1990			2000			2010			2020		
Species	n = 89; V < 0.01 $R^2_{\text{pred}} = 0.08$			n = 89; V < 0.01 $R^2_{\text{pred}} = 0.08$			n = 89; V < 0.01 $R^2_{\text{pred}} = 0.08$			n = 89; V < 0.01 $R^2_{\text{pred}} = 0.08$		
Variable	B	Z	P	B	Z	P	B	Z	P	B	Z	P
Uniqueness	0.01	0.23	0.822	0.03	0.87	0.383	0.03	0.74	0.458	0.01	0.32	0.75
Mass*	0.24	0.66	0.512	0.21	0.55	0.58	0.19	0.54	0.591	0.26	0.72	0.469
Brain mass residual	-0.88	-0.21	0.831	1.5	0.36	0.717	0.6	0.15	0.881	-1.99	-0.51	0.611
Clutch size*	-1.18	-0.76	0.446	-0.8	-0.55	0.586	-0.72	-0.49	0.623	-0.41	-0.29	0.771
Generation length*	0.46	0.35	0.729	1	0.76	0.449	1.39	1.05	0.294	0.96	0.74	0.457
Island endemism	0.78	1.34	0.179	0.62	1.11	0.268	0.65	1.17	0.243	0.13	0.23	0.819
Total feeding locations	-17.36	0.00	0.998	-17.98	<0.01	0.998	-18.3	<0.01	0.998	-17.82	-0.05	0.956
Total food types	-0.39	-0.60	0.548	-0.87	-1.29	0.198	-0.71	-1.11	0.267	-0.46	-0.71	0.478
Feeding in agriculture	-33.12	<0.01	1	-36.27	<0.01	1	-3158	<0.01	1	-27.9	-0.03	0.978
Ultrataxa	n = 100; V < 0.01 $R^2_{\text{pred}} = 0.11$			n = 100; V < 0.01 $R^2_{\text{pred}} = 0.11$			n = 100; V < 0.01 $R^2_{\text{pred}} = 0.11$			n = 100; V < 0.01 $R^2_{\text{pred}} = 0.11$		
Variable	B	Z	P	B	Z	P	B	Z	P	B	Z	P
Uniqueness	<0.01	-0.01	0.994	0.02	0.53	0.593	0.03	0.99	0.322	0.01	0.18	0.856
Mass*	0.29	0.9	0.367	0.26	0.8	0.423	0.18	0.57	0.568	0.37	1.11	0.265
Brain mass residual	-1.28	-0.34	0.736	0.84	0.22	0.825	1.5	0.39	0.696	-1.79	-0.47	0.635
Clutch size*	-2.39	-1.61	0.108	-2.7	-1.78	0.075	-2.93	-1.85	0.064	-0.88	-0.68	0.499
Generation length*	-0.48	-0.43	0.666	-0.09	-0.08	0.936	0.43	0.39	0.695	0.56	0.48	0.632
Island endemism	1.15	2.23	0.026	0.92	1.82	0.068	1.16	2.23	0.026	0.55	1.09	0.276
Total feeding locations	-17.4	<0.01	0.998	-17	<0.01	0.997	-18.22	<0.01	0.998	-18.91	<0.01	0.999
Total food types	-0.28	-0.46	0.648	-0.64	-1.04	0.297	-0.75	-1.22	0.222	-0.82	-1.28	0.201
Feeding in agriculture	-23.85	<0.01	1	-412.11	<0.01	1	-18.31	<0.01	1	-25.79	<0.01	1

Table S4. Number of Australian bird species and ultrataxa by taxonomic orders and the 2020 IUCN and Australian Red List categories (LC = Least Concern, NT = Near Threatened, VU = Vulnerable, EN = Endangered, CR = Critically Endangered, and EX = Extinct). The scientific and English name of each species displayed on the phylogeny figures are given with the corresponding artists.

Order	Species				Ultrataxon				Illustrations in phylogeny tree		
	LC/NT	VU/EN/CR	EX	Total	LC/NT	VU/EN/CR	EX	Total	Scientific name	English name	Artist
Accipitriformes	17	1	0	18	19	3	0	22	<i>Erythrotriorchis radiatus</i>	Red Goshawk	Frank Knight
Anseriformes	21	0	0	21	22	1	0	23	<i>Spatula rhynchotis</i>	Australasian Shoveler	Mike Bamford
Caprimulgiformes	11	0	0	11	15	1	0	16	<i>Eurostopodus argus</i>	Spotted Nightjar	Ian Hance
Charadriiformes	80	11	0	91	76	31	0	107	<i>Turnix olivii</i>	Buff-breasted Button-quail	Ian Hance
Ciconiiformes	1	0	0	1	1	0	0	1	<i>Ephippiorhynchus asiaticus</i>	Black-necked Stork	Nan Lepinath
Columbiformes	25	0	0	25	39	3	2	44	<i>Ptilinopus superbus</i>	Superb Fruit-Dove	Ian Hance
Coraciiformes	12	0	0	12	22	1	0	23	<i>Merops ornatus</i>	Rainbow Bee-eater	Debbie Sullivan
Cuculiformes	13	0	0	13	19	0	0	19	<i>Chalcites basalus</i>	Horsfield's Bronze-Cuckoo	Belinda Brooker
Falconiformes	5	1	0	6	9	1	0	10	<i>Falco hypoleucos</i>	Grey Falcon	Bevly Hughes
Galliformes	5	1	0	6	11	1	0	12	<i>Leipoa ocellata</i>	Malleefowl	Susan Tingay
Gruiformes	16	2	1	19	20	2	3	25	<i>Hypotaenidia sylvestris</i>	Lord Howe Woodhen	Kelsey Bennett
Otidiformes	1	0	0	1	1	0	0	1	<i>Ardeotis australis</i>	Australian Bustard	Krystii Melanie

Passeriformes	317	23	3	343	634	80	17	731	<i>Anthochaera phrygia</i>	Regent Honeyeater	Nan Lepinath
Pelecaniformes	19	1	0	20	24	1	0	25	<i>Botaurus poiciloptilus</i>	Australasian Bittern	Nan Lepinath
Phaetontiformes	2	0	0	2	2	3	0	5	<i>Phaethon lepturus</i>	White-tailed Tropicbird	Augusto Ferrari
Podicipiformes	3	0	0	3	3	0	0	3	<i>Poliocephalus poliocephalus</i>	Hoary-headed Grebe	Mike Bamford
Procellariiformes	48	18	0	66	54	22	0	76	<i>Diomedea dabbenena</i>	Tristan Albatross	Andrew Silcocks
Psittaciformes	46	10	2	58	80	22	4	106	<i>Zanda baudinii</i>	Baudin's Black-Cockatoo	Ian Hance
Sphenisciformes	5	3	0	8	4	4	0	8	<i>Eudyptes pachyrhynchus</i>	Fiordland Penguin	Alex Croft
Strigiformes	11	1	0	12	17	5	1	23	<i>Ninox natalis</i>	Christmas Island Boobook	Jeff Davies
Struthioniformes	2	0	2	4	2	0	3	5	<i>Casuaris casuaris</i>	Southern Cassowary	Nan Lepinath
Suliformes	13	2	0	15	15	2	0	17	<i>Papasula abbotti</i>	Abbott's Booby	Donna Mitchell
Total	673	74	8	755	1089	183	30	1302			