

Diet of the Australian Hobby *Falco longipennis* breeding in Canberra, Australian Capital Territory, in 2002–2004 and 2005–2008

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Abstract. The diet of the Australian Hobby *Falco longipennis* was studied in Canberra (ACT), in the summers of 2002–2003 to 2004–2005 and 2005–2006 to 2008–2009 by analysis of prey remains and pellets (28 and 40 collections for a total of 229 and 132 prey items from six and four nests, respectively). The Hobbies' breeding diet in the first period consisted of 73% birds, 1% microbats and 26% insects by number, and 98% birds, <1% microbats and 1% insects by biomass, mainly parrots (Psittaculidae), Common Starlings *Sturnus vulgaris* and sparrows *Passer* sp. In the second period, it consisted of 94% birds, 3% mammals (mostly microbats), 2% lizards and <1% insects by number, and was more dominated by Starlings and other introduced birds, with the change perhaps reflecting a recent decline in local insect abundance. The Hobby's dietary metrics correspondingly shifted to a greater Geometric Mean Prey Weight and narrower food niche. The Hobby's diet overlapped moderately (42%) with that of the similarly sized Collared Sparrowhawk *Accipiter cirrocephalus* in the ACT over the same timeframe, although the two are separated by foraging habitats and methods.

Introduction

The diet of the Australian Hobby *Falco longipennis* has been studied or documented mainly in south-eastern Australia (Marchant & Higgins 1993; Olsen *et al.* 2008; Olsen 2014; Morley 2020), with fewer studies in the arid zone and tropics (Aumann 2001a; Aumann *et al.* 2016). The Hobby preys mainly on small birds <200 g in size taken in flight, and on flying insects and insectivorous bats. Hobbies often use freshly vacated corvid nests (e.g. Olsen 2014), which raises the risk of misattributing some apparent food items to the Hobbies rather than the prior nest occupants. There are virtually no prior comprehensive samples of Hobby pellet measurements, which might aid in diagnosing the origin of pellet samples. Similarly, there are few long-term data on breeding productivity of the Australian Hobby.

Despite the existence of breeding populations in urban areas of capital and other cities, the Hobby remains much less well known in Australia than the Peregrine Falcon *F. peregrinus*. Olsen *et al.* (2006a, 2008) compared the diets of the Hobby and Peregrine Falcon in Canberra, Australian Capital Territory (ACT), based on dietary samples from repeated measures of a single Hobby territory in 1991–1992 and 2002–2003. Here we describe the breeding diet of multiple pairs of Australian Hobbies in and around urban Canberra from summer 2002–2003 to summer 2008–2009, incorporating the 2002–2003 sample of Olsen *et al.* (2008). Preliminary appraisal of the data by year (see Methods, below) suggested a difference in dietary proportions, possibly related to a change in the availability of insects, in the second phase of the sampling period, so we here analyse the data in two time periods: summer 2002–2003 to summer 2004–2005, compared with summer 2005–2006 to 2008–2009. We also compare Hobby dietary parameters with those of the sympatrically

breeding, similarly sized (though more sexually size-dimorphic), bird-specialist Collared Sparrowhawk *Accipiter cirrocephalus* in urban Canberra (Hobby and Sparrowhawk average weight, sexes combined, = 250 and 183 g, respectively, cf. Olsen *et al.* 2006a, 2018).

Study areas and methods

The general study area in and around Canberra, ACT, has been described in previous related papers, including the Hobby site of Aranda Bushland and the dietary samples therefrom (e.g. Olsen *et al.* 2006a, 2008, 2018). The Hobby breeding cycle in the area occupies the spring and summer months, with fledging extending into early in the new year (Olsen 2014).

The additional Hobby sites and dietary sample characteristics are provided below. The mean number of prey individuals (MNI) in each sample was calculated as previously described (Olsen *et al.* 2006a, 2008, 2018). Pellets and prey remains (orts) were analysed by the late A.B. Rose (Associate, Australian Museum), and we follow his assumptions on MNI per sample. Items were collected, at varying intervals from a few days to ≥ 1 month, from the ground below the active Hobby nests unless otherwise stated (e.g. beneath roost-sites of dependent fledglings). The number of pellets and orts and their measurements, where given, reflect Rose's notes.

The Pinnacle, Coulter Drive (35°16'S, 149°03'E), urban-edge Nature Reserve bordering rural land.

Summer 2002–2003: >73 pellets and 11 orts collected 15 December–8 February (under roost as well as nest on 2 February). Nestling phase 15 and 29 December, three young fledged by 29 January. Three pellet subsamples measured (a) 19×12–40×15 mm (*n* not given);

(b) 21×12–36×28 mm ($n = 5$); (c) 14×11–40×20 mm ($n = 7$).

Summer 2003–2004, same Hobby nest: 4 December–13 January (21 pellets) and 4 March (two pellets under roost). Two young fledged by 13 January.

Summer 2005–2006: 20 pellets and nine orts, 1 January–8 February. Two young 'branching' on 1 January.

Summer 2006–2007, 22 pellets and 11 orts, 29 October–28 December. One young fledged.

Lanyon, Tuggeranong (35°29'S, 149°05'E), peri-urban rural land dotted with paddock trees and copses.

Summer 2002–2003: 26 December–18 February, 32 pellets and four orts under nest and two roosts (one pellet subsample 14–18×18–28 mm, $n = 14$). Incubating 26 December, two young fledged by 31 January.

Summer 2003–2004: three pellets and one ort, 15 November 2003. No young fledged; a pair of Peregrine Falcons usurped the nest in 2003, causing the Hobbies' breeding attempt to fail (Olsen *et al.* 2006b).

Mugga Farms, Jerrabomberra (35°22'S, 149°09'E), peri-urban rural woodland.

Summer 2002–2003: four pellets and two orts, 20 January and 7 February.

Summer 2004–2005: 15 orts and three pellets, 12 November–25 December. Nestling phase 14 and 25 December; two young subsequently fledged.

Lower Molonglo Valley (35°15'S, 148°59'E), rural landscape dotted with paddock trees and copses.

Summer 2002–2003: five pellets averaging 35 × 20 mm, 16 January (advanced nestlings); two young subsequently fledged.

Calvary Hospital, Bruce (35°15'S, 149°05'E), urban area and adjoining urban bushland (Nature Reserve).

Summer 2003–2004: eight pellets and five orts, 23 December–18 January. Two young fledged.

Summer 2007–2008, different nest: 38 pellets and 15+ orts, 4 December–17 February. Three young 'branched' on 22 January and fledged by 26 January.

Kambah (35°23'S, 149°04'E), urban area with playing fields, scattered trees and copses and a lake.

Summer 2005–2006: 11 pellets and 12 orts, 15 November–19 December. Two nestlings 19 December, subsequently fledged.

Forrest (35°15'S, 149°01'E), well-treed urban area with playing fields and wooded park, near urban bushland (Nature Reserve). The Hobbies usurped an active Little Raven *Corvus mellori* nest (B. & S. Walcott pers. comm.). Summer 2007–2008: 54 pellets and 4+ orts, 16 January–17 February. Three young fledged on 15 January.

Summer 2008–2009: 28 pellets and seven orts, 13 January–6 February. Four juveniles newly fledged on 30 January.

Analyses from the various sites were pooled for each time period. Incorporating the 2002–2003 Aranda sample (Olsen *et al.* 2008), there were approximately twice as many items represented in the first time period as in the second. Justification for pooling the samples in the two time periods is as follows, based on the major difference in insect occurrence in samples. In 2002–2003 to 2004–2005, there were 5–86 individual prey items found per Hobby nest, of which insects (2–19 per sample, respectively) consistently made up >20% of items. In 2004–2005 to 2008–2009,

there were 15–52 prey items found per nest, with one insect recorded in one sample (the largest sample, i.e. of 52 items), despite large prey collections at several sites well into the post-fledging period when juveniles normally forage on insects (e.g. Debus *et al.* 1991). We have no relevant data on insect abundance, but an index of bird abundance appears in the Canberra Ornithologists Group (COG) annual bird reports published in *Canberra Bird Notes* (www.canberrabirds.org.au/publications/canberra-bird-notes/), and we consulted those for trends in relevant bird species over the study period.

We made several assumptions about the samples, based on prior knowledge (ours and published) of the Hobby's confirmed prey spectrum and breeding behaviour (e.g. references cited above):

- (i) 29 beetles (mostly Christmas Beetles *Anoplognathus porosus*) under the Lanyon nest during the Hobbies' incubation period in December 2002 are here referred to the prior nest occupants (ravens *Corvus* sp.), on the grounds that male Hobbies bring birds to incubating females (our pers. obs.; Morley 2020), whereas insects mostly appear in Hobby pellets rather than as orts, because they are caught and eaten in flight rather than brought to nests.
- (ii) Galah *Eolophus roseicapilla* (including adult), Pied Currawong *Strepera graculina* and Australian Magpie *Gymnorhina tibicen* random (moulted?) feather(s) or carcass or part thereof, and juvenile European Rabbit *Oryctolagus cuniculus* skull or fur, under Hobby nests or roosts are assumed not referable to the Hobbies, as being too large for a Hobby to capture and most likely referable to the prior nest occupants (e.g. road-kill scavenged by ravens) or other predators, e.g. Red Fox *Vulpes vulpes*, as often suggested in Rose's notes.
- (iii) As per Rose's notes, insect and ant remains in two pellets from The Pinnacle in December 2003, and insect fragments in a pellet from December 2006, are assumed to be the gut contents of avian prey in the same pellets (unidentified small bird; six other insectivorous or potentially insectivorous birds represented in that sample of 18 pellets), and of a microbat in the other pellet, respectively. Similarly, insect remains in two pellets from Calvary Hospital in summer 2007–2008 are assumed to be the gut contents of a Common Starling *Sturnus vulgaris* and a small skink (Scincidae) in the same pellets, respectively (the latter including ants).
- (iv) Seeds in a pellet from Kambah are assumed to have been in the gut of a granivorous bird represented in the same pellet, as are sorghum *Sorghum* sp. and millet (Panicoideae) seeds in a pellet of feathers from The Pinnacle and seeds in a pellet of House Sparrow *Passer domesticus* feathers from Calvary Hospital.

For the two time periods (summer 2002–2003 to 2004–2005 versus 2005–2006 to 2008–2009), the Hobby dietary metrics—geometric mean prey weight (GMPW), Shannon Diversity Index, Standardised Food Niche Breadth (SFNB), and Pianka Index for dietary overlap with the Collared Sparrowhawk—were calculated as in previous papers in

this series (Olsen *et al.* 2006a, 2008, 2018). The Shannon Diversity Index (ranging upwards from 1 = lowest diversity) reflects prey species richness, SFNB values (between 0 and 1) reflect little (0) to high dietary evenness (1), and the Pianka Index values (between 0 and 1) reflect no overlap (0) to complete overlap (1). Prey weights were taken from Olsen *et al.* (2008) in the first instance, for consistency across Hobby studies, otherwise from Olsen *et al.* (2018) and Tsang *et al.* (2017) for additional prey species. One Sparrowhawk nest was 300 m from a Hobby nest (Calvary Hospital), so both species foraged over the same general area.

Results

Diet

A combined sample of 85 pellets from the later collections at The Pinnacle, Lanyon, Mugga Farms, Calvary Hospital and Kambah measured 14–53 × 11–30 mm (mean 28 × 17 mm). One pellet (32×26 mm) from the Calvary Hospital nest in early January, consisting of vegetation with a trace of feather and insect, suggested nibbling of foliage by a fledgling Hobby.

The Hobbies' breeding diet in the first time period (summer 2002–2003 to 2004–2005) consisted mostly of birds, some insects and a few microbats by number, and almost entirely birds by biomass. Predominant avian prey were parrots, Common Starlings and sparrows *Passer* sp., with introduced birds contributing about one-third of prey biomass (Table 1, Appendix 1).

In the second period (summer 2005–2006 to 2008–2009), a smaller sample from some different and more urbanised sites, although still influenced by data from The Pinnacle, again consisted mostly of birds, a few mammals (microbats and a rodent) and lizards. Almost no insects were detected, although insects would be expected to be consumed if available (>20% by number in the first time period and in other comparable studies, cf. Table 1 and Appendix 1; also Debus *et al.* 1991; Olsen *et al.* 2008).

Table 1. Some dietary parameters of the Australian Hobby breeding during two time periods in and around urban Canberra, summer 2002–2003 to summer 2008–2009; *n* = number.

Dietary category	2002–2003 to 2004–2005		2005–2006 to 2008–2009	
	% <i>n</i>	% biomass	% <i>n</i>	% biomass
Total birds	73	98	95	97
Parrots	17	36	14	20
Starlings	15	27	30	34
Sparrows	9	6	24	9
Introduced birds	25	35	58	52
Mammals	1 ^a	<1	3 ^b	3
Lizards	–	–	2	<1
Insects	26	1	<1	<1

^aMicrobats

^bMicrobats and a rodent

Otherwise, the avian prey profile was rather similar to the first time period, though more dominated by Starlings and other introduced birds (including the Common Myna *Acridotheres tristis*). Introduced birds contributed over half by number and biomass (Table 1, Appendix 1). The contrast in insect occurrence (or lack thereof) in pellets over time was despite the conservative approach regarding insect remains under a Hobby nest during the incubation period in summer 2002–2003. There were also some unusual food items in the second period (rodent, small lizards), possibly robbed from e.g. a Nankeen Kestrel *Falco cenchroides* (cf. Tsang *et al.* 2017), as Hobbies sometimes rob Kestrels of rodents (SD pers. obs.).

In both time periods, adults and juveniles of both rosella *Platycercus* species, Starlings and Mynas were taken. The Budgerigars *Melopsittacus undulatus* taken were most likely aviary escapes, on the basis of feathers from domestic colour varieties. The Australian Ringneck *Barnardius zonarius* was also probably an aviary escape, the ACT being outside the species' normal range.

The main avian prey species in both time periods (rosellas, Starlings, Mynas, sparrows) always ranked among the top 10 most frequently recorded species of appropriate body weight (i.e. <200 g) over the respective years in Canberra, as reported in the Canberra Ornithologists Group (COG) annual bird reports. Crimson Rosellas *Platycercus elegans*, Starlings and House Sparrows always ranked in the top five or six species of appropriate weight in the applicable years.

The Hobbies' geometric mean prey weight (GMPW) in the first time period was less than half that in the second, and the Shannon Diversity Index and Standardised Food Niche Breadth (SFNB) (particularly) were lower in the second time period (Table 2). All these values reflect the lack of insects in the diet in the second time period, and also the smaller sample size from more urbanised areas and consequently fewer incidental 'bush' birds, and hence greater representation of introduced birds, taken in the second period.

The Pianka Index for dietary overlap between the Hobby over the entire sampling period (data in Appendix 2) and sympatric Collared Sparrowhawk over the same period was 0.42 (i.e. 42% overlap) (Table 2).

Table 2. Dietary metrics of the Australian Hobby and Collared Sparrowhawk breeding sympatrically in and around urban Canberra, from summer 2002–2003 to summer 2008–2009 (Hobby) or 2010 (Sparrowhawk). GMPW = geometric mean prey weight, SFNB = standard food niche breadth (see Methods). The Hobby consumed many insects only in the first half of the sampling period (2002–2003 to 2004–2005).

Species	GMPW	SFNB	Shannon Index
Hobby overall	28	0.18	2.95
Hobby 2002–2003 to 2004–2005	20	0.31	2.93
Hobby 2005–2006 to 2008–2009	51	0.19	2.39
Sparrowhawk overall	7	0.35	3.08
Pianka Index overall = 0.42			

Fledgling productivity

For eight territories for which the nesting outcome was known for 2–5 breeding events over almost a decade (15 pair-years), including that for the Aranda pair in 2002–2003 (Olsen *et al.* 2008) and 2003–2004 (no dietary data collected), 1–4 young fledged per successful nest (mean brood size = 2.4) and an average of 2.2 young fledged per pair per year (see Figure 1).

Discussion

Overall, the Hobbies' diet in the present study was similar to that reported by Olsen *et al.* (2008) for two time periods, 1991–1992 versus 2002–2003, including a change in the contribution of Starlings over time. However, Hobbies took Common Myna(s) in summer 2004–2005 (a fledgling) and particularly from summer 2005–2006 onwards, in contrast with the prior study (Olsen *et al.* 2008) when no Mynas were recorded as prey. What is most noteworthy is the lack of insects in the diet from 2005–2006 to 2008–2009, possibly related to a suspected decline of insect numbers in Australia in the last decade or so (e.g. see Braby 2019 and Saunders *et al.* 2020). For instance, we have noticed a lack of Christmas beetle *Anoplognathus* spp. outbreaks in the last few summers on the New South Wales/ACT tablelands, mirroring anecdotal evidence of such declines in these beetles and some other insect groups in eastern Australia (e.g. Braby 2019; Pickrell 2019). The greater dietary predominance of Starlings and other introduced birds in the second time period (2005–06 to 2008–09) may be partly explained by the smaller dietary sample size across fewer and more urbanised sites, and possibly the use of insecticides and their effect on insect prey, in urban areas as well as the effect of dry years and habitat loss on Christmas beetles (e.g. Pickrell 2019). The Hobby prey-sampling periods followed the Millennium Drought and a series of dry years in the ACT through the 2000s (COG annual bird reports).

It might be thought that the Hobbies switched to increasing populations of more profitable avian prey in the second time period. However, the COG annual bird reports (ACT Garden Bird Survey indices) show that, of the Hobby's major prey species, parrots either increased slightly through the first period then peaked or stabilised (rosellas, especially Crimson) or remained rather stable in both periods; Starlings declined across both periods; Mynas peaked in 2003–2004 to 2005–2006 then declined greatly under a control program; and House Sparrows declined through the second period. Thus, the predominance of introduced birds (and lack of insects) in the diet in the second period cannot be attributed to increasing populations of introduced birds. Unusual prey in the second period (rodent, lizards) suggests a shortage of normal prey. Furthermore, large, swarming or emerging aerial insects can be energetically valuable for hobbies in summer (Eurasian Hobby *Falco subbuteo*: Clarke *et al.* 1996), and our findings suggest that there were fewer insects close (i.e. energetically efficient) to the ACT Hobby nests in the second time period. Olsen (2014) discussed the energetic trade-off between hunting small prey (e.g. insects) near the nest versus large prey (vertebrates) away from the nest.



Figure 1. A brood of two dependent juvenile Australian Hobbies, Australian Capital Territory, 31 January 2007. Photo: Julian Robinson

The Hobbies' dietary profile in Canberra is generally similar to that elsewhere in south-eastern Australia, notably that in peri-urban/rural Armidale on the Northern Tablelands (cf. Debus *et al.* 1991). It is also similar to that in urban and parkland Geelong (Victoria), though in such areas dominated by exotic vegetation introduced birds feature even more than in Canberra (cf. Morley 2020). The Hobbies' diet in Canberra contrasts somewhat with the lack of introduced prey in central Australia and the tropics (where relevant introduced birds do not occur), and the greater importance of insects in the tropics (cf. Aumann 2001a; Aumann *et al.* 2016).

The Hobbies' dietary profile around Canberra post-2002 continued to differ substantially from that of the Peregrine Falcon as reported by Olsen *et al.* (2006a, 2008). Later studies in the ACT continued to report some large and dangerous birds in the diet of the Peregrine Falcon, among an array of species taken that typically average larger than those taken by the Hobby (cf. Olsen *et al.* 2006b, 2011). Direct comparison is possible for one Hobby territory. The Lanyon nest was occupied by breeding Hobbies in summer 2002–2003, during which dietary analysis (included in Appendix 1) identified 19 birds ranging from European Goldfinch *Carduelis carduelis* to parrot in size (mostly small parrots and passerines <100 g), and 12 insects. Breeding Peregrine Falcons usurped the nest in 2003–2004 and 2004–2005, and in the latter summer took 31 birds ranging from Budgerigar to Australian Wood Duck *Chenonetta jubata* and Sulphur-crested Cockatoo *Cacatua galerita* in size (mostly Rock Doves *Columba livia* and Galahs, though with some overlap for rosellas and passerines ≥ 75 g) (see Table 1 of Olsen *et al.* 2006b).

The Hobbies' dietary profile around Canberra overall, 2002–2003 to 2008–2009 (Appendix 2), is rather similar in

some respects to that for the Collared Sparrowhawk in the same area and time period, as reflected in the Pianka Index indicating moderate overlap (cf. Olsen *et al.* 2018) and the respective Shannon Indices (Table 2). However, GMPW and SFNB values were somewhat different. The similarity is greater for the Hobby in 2002–2003 to 2004–2005 when it was taking many insects (Table 2). The two species differ in hunting habitat and methods, the (on average) somewhat heavier Hobby being an aerial pursuer in open habitats whereas the Sparrowhawk is an ambush hunter in wooded habitats (e.g. Olsen *et al.* 2006a, 2018; Olsen 2014). Following the decline of insects, the Hobby's dietary metrics might also have been influenced by robbery of atypical food items (rat, lizards) from other raptor species.

For the Sparrowhawk, a similar decline in insects in the diet also occurred over time. Raw data for Appendix 1 of Olsen *et al.* (2018) reveal that the Sparrowhawk took various insects, including many Christmas beetles *Anolognathus* spp. and cicadas *Psaltoda* spp., before 2004–2005 but (like the Hobby) only Black Prince Cicadas *P. plaga* after that summer. This difference may reflect a general decline in insects, the peak emergence years of *Psaltoda* species being out of phase, and/or the Sparrowhawk being adept at taking *Psaltoda* cicadas off perches (Barnes & Debus 2014). The Black Prince Cicada is a more reluctant flier than the Red-eye Cicada *P. moerens* (SD pers. obs.), and perhaps less susceptible to being taken by Hobbies.

Breeding productivity of the Hobby in Canberra in 2002–2008 was within values previously reported for inland and southern Australia (cf. Marchant & Higgins 1993; Aumann 2001b; Olsen 2014; Morley 2020), although the brood of four fledglings appears to be a record (cf. Marchant & Higgins 1993). We note that in the general area of the Molonglo Hobby nest, after a new suburb was developed that replaced the wooded rural landscape, that Hobby pair and many of the other nesting woodland raptors in the Lower Molonglo Valley (Little Eagles *Hieraaetus morphnoides*, Brown Falcons *Falco berigora*, some Kestrels) disappeared, although Wedge-tailed Eagles *Aquila audax* and Peregrine Falcons breeding in the river gorge remained (J. Olsen pers. obs.). With the Australian Hobby being an urban breeder in corvid nests, there is obvious scope for further study of its ecology in other capital, regional and rural cities in other parts of Australia, notably in the south-west and tropics/subtropics.

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Appendix 1. Prey of breeding Australian Hobbies in Canberra, ACT, during two time periods: summer 2002–2003 to season 2004–2005 (six territories) and summer 2005–2006 to season 2008–2009 (four territories, including two from the previous time period). Wt = weight, *n* = number.

Prey species	Wt (g)	2002–2003 to 2004–2005				2005–2006 to 2008–2009			
		n	% n	Biomass (g)	% biomass	n	% n	Biomass (g)	% biomass
Birds									
Stubble Quail <i>Coturnix pectoralis</i>	104	2	0.9	208	2.2				
Crested Pigeon <i>Ocyphaps lophotes</i>	205					3	2.3	615	7.1
Sacred Kingfisher <i>Todiramphus sanctus</i>	40	2	0.9	80	0.8				
Red-rumped Parrot <i>Psephotus haematonotus</i>	61	4	1.7	244	2.6	3	2.3	183	2.1
Crimson Rosella <i>Platycercus elegans</i>	135	4	1.7	540	5.6	6	4.5	810	9.3
Eastern Rosella <i>Platycercus eximius</i>	106	18	7.9	1908	19.9	4	3.0	424	4.9
Australian Ringneck <i>Barnardius zonarius</i>	157	1	0.4	157	1.6				
Little Lorikeet <i>Glossopsitta pusilla</i>	50					1	0.8	50	0.6
Budgerigar <i>Melopsittacus undulatus</i>	28	9	3.9	252	2.6	4	3.0	112	1.3
Superb Parrot <i>Polytelis swainsonii</i>	150					1	0.8	150	1.7
Parrot sp. (Psittaculidae)	90	4	1.7	360	3.8				
Eastern Spinebill <i>Acanthorhynchus tenuirostris</i>	11	1	0.4	11	0.1				
White-fronted Chat <i>Epthianura albifrons</i>	12					1	0.8	12	0.1
Red Wattlebird <i>Anthochaera carunculata</i>	108					5	3.8	540	6.2
Yellow-faced Honeyeater <i>Caligavis chrysops</i>	17	1	0.4	17	0.2				
Noisy Miner <i>Manorina melanocephala</i>	68	8	3.5	544	5.7	1	0.8	68	0.8
Spotted Pardalote <i>Pardalotus punctatus</i>	9	5	2.2	45	0.5	1	0.8	9	0.1
Striated Pardalote <i>Pardalotus striatus</i>	12	4	1.7	48	0.5	1	0.8	12	0.1
White-browed Scrubwren <i>Sericornis frontalis</i>	15					1	0.8	15	0.2
Thornbill <i>Acanthiza</i> sp.	9					1	0.8	9	0.1
White-browed Woodswallow <i>Artamus superciliosus</i>	35	5	2.2	175	1.8				
Dusky Woodswallow <i>Artamus cyanopterus</i>	39	2	0.9	78	0.8				
Woodswallow <i>Artamus</i> sp.	37	2	0.9	74	0.8				
Magpie-lark <i>Grallina cyanoleuca</i>	90	1	0.4	90	0.9	7	5.3	630	7.2

Appendix 1 continued

Prey species	Wt (g)	2002–2003 to 2004–2005				2005–2006 to 2008–2009			
		n	% n	Biomass (g)	% biomass	n	% n	Biomass (g)	% biomass
Australian Reed-Warbler <i>Acrocephalus australis</i>	18	1	0.4	18	<0.2				
Brown Songlark <i>Cincloramphus cruralis</i>	54	3	1.3	162	1.7	1	0.8	54	0.6
Tree Martin <i>Petrochelidon nigricans</i>	14	2	0.9	28	0.3				
Welcome Swallow <i>Hirundo neoxena</i>	15	1	0.4	15	0.2				
Silvereeye <i>Zosterops lateralis</i>	10	2	0.9	20	0.2	1	0.8	10	0.1
Common Starling <i>Sturnus vulgaris</i>	75	34	14.8	2550	26.7	39	29.5	2925	33.5
Common Myna <i>Acridotheres tristis</i>	116	1	0.4	116	1.2	7	5.3	812	9.3
Common Blackbird <i>Turdus merula</i>	95	1	0.4	95	1.0				
Double-barred Finch <i>Taeniopygia bichenovii</i>	10					1	0.8	10	0.1
Finch sp. (Estrildidae)	11	1	0.4	11	0.1				
House Sparrow <i>Passer domesticus</i>	27	12	5.2	324	3.4	22	16.7	594	6.8
Sparrow <i>Passer</i> sp.	25	9	3.9	225	2.4	9	6.8	225	2.6
Australasian Pipit <i>Anthus novaeseelandiae</i>	23					1	0.8	23	0.3
European Goldfinch <i>Carduelis carduelis</i>	18	1	0.4	18	0.2				
Unidentified small birds	30	16	7.0	480	5.0	2	1.5	60	0.7
Unidentified birds	57	9	3.9	513	5.4	2	1.5	114	1.3
Total birds		166	72.5	9406	98.3	125	94.7	8466	97.1
Mammals									
Gould's Wattled Bat <i>Chalinolobus gouldii</i>	14	3	1.3	42	0.4	1	0.8	14	0.2
Microbat (Microchiroptera)	14					2	1.5	28	0.3
Black Rat <i>Rattus rattus</i>	180					1	0.8	180	2.1
Total mammals		3	1.3	42	0.4	4	3.0	222	2.5
Reptiles									
Small lizard/skink (Scincidae)	15					2	1.5	30	0.3
Total reptiles						2	1.5	30	0.3
Insects									
Cockroach (Blattoidea)	2	2	0.9	4	<0.1				
Mantis (Mantidae)	2	1	0.4	2	<0.1				
Yellow-winged Locust <i>Gastrimargus musicus</i>	2	1	0.4	2	<0.1				
Cicada <i>Cicadetta</i> sp.	2	1	0.4	2	<0.1				

Appendix 1 continued

Prey species	Wt (g)	2002–2003 to 2004–2005				2005–2006 to 2008–2009			
		n	% n	Biomass (g)	% biomass	n	% n	Biomass (g)	% biomass
Red-eye Cicada <i>Psaltoda moerens</i>	2	20	8.7	40	0.4				
Black Prince Cicada <i>Psaltoda plaga</i>	2					1	0.8	2	<0.1
Christmas beetle <i>Anoplognathus porosus</i>	2	1	0.4	2	<0.1				
Christmas beetle <i>Anoplognathus</i> sp.	2	15	6.7	30	0.3				
Longicorn beetle <i>Phoracantha</i> sp.	2	2	0.9	4	<0.1				
Stag beetle <i>Lamprima latreillii</i>	2	2	0.9	4	<0.1				
Black Beetle <i>Heteronychus arator</i>	2	2	0.9	4	<0.1				
Scarab <i>Diaphonia dorsalis</i>	2	2	0.9	4	<0.1				
Beetle (Coleoptera)	2	10	4.4	20	0.2				
Unidentified insect	2	1	0.4	2	<0.1				
Total insects		60	26.2	120	1.3	1	0.8	2	<0.1
Grand total		229	100	9568	100	132	100	8720	100

Appendix 2. Total prey of breeding Australian Hobbies, Canberra (ACT), summer 2002–2003 to summer 2008–2009 (total eight territories), for comparison with Appendix 1 of Olsen *et al.* (2018). Wt = weight, *n* = number.

<i>Prey species</i>	<i>Wt (g)</i>	<i>Total n</i>	<i>% total n</i>	<i>Total biomass</i>	<i>% total biomass</i>
Birds					
Stubble Quail <i>Coturnix pectoralis</i>	104	2	0.6	208	1.1
Crested Pigeon <i>Ocyphaps lophotes</i>	205	3	0.8	615	3.4
Sacred Kingfisher <i>Todiramphus sanctus</i>	40	2	0.6	80	0.4
Red-rumped Parrot <i>Psephotus haematonotus</i>	61	7	1.9	427	2.3
Crimson Rosella <i>Platycercus elegans</i>	135	10	2.8	1350	7.4
Eastern Rosella <i>Platycercus eximius</i>	106	22	6.1	2332	12.8
Australian Ringneck <i>Barnardius zonarius</i>	157	1	0.3	157	0.9
Little Lorikeet <i>Glossopsitta pusilla</i>	50	1	0.3	50	0.3
Budgerigar <i>Melopsittacus undulatus</i>	28	13	3.6	364	2.0
Superb Parrot <i>Polytelis swainsonii</i>	150	1	0.3	150	0.8
Parrot sp. (Psittaculidae)	90	4	1.1	360	2.0
Eastern Spinebill <i>Acanthorhynchus tenuirostris</i>	11	1	0.3	11	<0.1
White-fronted Chat <i>Epthianura albifrons</i>	12	1	0.3	12	<0.1
Red Wattlebird <i>Anthochaera carunculata</i>	108	5	1.4	540	3.0
Yellow-faced Honeyeater <i>Caligavis chrysops</i>	17	1	0.3	17	0.1
Noisy Miner <i>Manorina melanocephala</i>	68	9	2.5	612	3.3
Spotted Pardalote <i>Pardalotus punctatus</i>	9	6	1.7	54	0.3
Striated Pardalote <i>Pardalotus striatus</i>	12	5	1.4	60	0.3
White-browed Scrubwren <i>Sericornis frontalis</i>	15	1	0.3	15	0.1
Thornbill <i>Acanthiza</i> sp.	9	1	0.3	9	<0.1
White-browed Woodswallow <i>Artamus superciliosus</i>	35	5	1.4	175	1.0
Dusky Woodswallow <i>Artamus cyanopterus</i>	39	2	0.6	78	0.4
Woodswallow <i>Artamus</i> sp.	37	2	0.6	74	0.4
Magpie-lark <i>Grallina cyanoleuca</i>	90	8	2.2	720	3.9
Australian Reed-Warbler <i>Acrocephalus australis</i>	18	1	0.3	18	0.1
Brown Songlark <i>Cincloramphus cruralis</i>	54	4	1.1	216	1.2
Tree Martin <i>Petrochelidon nigricans</i>	14	2	0.6	28	0.2
Welcome Swallow <i>Hirundo neoxena</i>	15	1	0.3	15	0.1
Silvereye <i>Zosterops lateralis</i>	10	3	0.8	30	0.2
Common Starling <i>Sturnus vulgaris</i>	75	73	20.2	5475	29.9
Common Myna <i>Acridotheres tristis</i>	116	8	2.2	928	5.1
Common Blackbird <i>Turdus merula</i>	95	1	0.3	95	0.5
Double-barred Finch <i>Taeniopygia bichenovii</i>	10	1	0.3	10	0.1
Finch sp. (Estrildidae)	11	1	0.3	11	0.1
House Sparrow <i>Passer domesticus</i>	27	34	9.4	918	5.2
Sparrow <i>Passer</i> sp.	25	18	5.0	450	2.5
Australasian Pipit <i>Anthus novaeseelandiae</i>	23	1	0.3	23	0.1
European Goldfinch <i>Carduelis carduelis</i>	18	1	0.3	18	0.1
Unidentified small birds	30	18	5.0	540	3.0
Unidentified birds	57	11	3.0	627	3.4
Total birds		291	80.6	17872	97.7
Mammals					
Gould's Wattled Bat <i>Chalinolobus gouldii</i>	14	4	1.1	56	0.3
Microbat (Microchiroptera)	14	2	0.6	28	0.2
Black Rat <i>Rattus rattus</i>	180	1	0.3	180	1.0
Total mammals		7	1.9	264	1.4

Appendix 2 continued

<i>Prey species</i>	<i>Wt (g)</i>	<i>Total n</i>	<i>% total n</i>	<i>Total biomass</i>	<i>% total biomass</i>
Reptiles					
Small lizard/skink (Scincidae)	15	2	0.6	30	0.2
Total reptiles		2	0.6	30	0.2
Insects					
Cockroach (Blattoidea)	2	2	0.6	4	<0.1
Mantis (Mantidae)	2	1	0.3	2	<0.1
Yellow-winged Locust <i>Gastrimargus musicus</i>	2	1	0.3	2	<0.1
Cicada <i>Cicadetta</i> sp.	2	1	0.6	2	<0.1
Red-eye Cicada <i>Psaltoda moerens</i>	2	20	5.5	40	0.2
Black Prince Cicada <i>Psaltoda plaga</i>	2	1	0.3	2	<0.1
Christmas beetle <i>Anoplognathus porosus</i>	2	1	0.3	2	<0.1
Christmas beetle <i>Anoplognathus</i> sp.	2	15	4.2	30	0.2
Longicorn beetle <i>Phoracantha</i> sp.	2	2	0.6	4	<0.1
Stag beetle <i>Lamprima latreillii</i>	2	2	0.6	4	<0.1
Black Beetle <i>Heteronychus arator</i>	2	2	0.6	4	<0.1
Scarab <i>Diaphonia dorsalis</i>	2	2	0.6	4	<0.1
Beetle (Coleoptera)	2	10	2.8	20	0.1
Unidentified insect	2	1	0.3	2	<0.1
Total insects		61	16.9	122	1.0
Grand total		361	100	18288	100