

# A 20-year study investigating the diet of Peregrines, *Falco peregrinus*, at an urban site in south-west England (1997–2017)

Nick DIXON<sup>1</sup> & Edward J. A. DREWITT<sup>2\*</sup>

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**Abstract** Until relatively recently Peregrines have been regarded as a rural bird. As their populations have increased over the past 20 years, Peregrines have increasingly become urban birds. One of the earliest locations to be occupied by Peregrines in the UK was on a church in Exeter, in the county of Devon. Over the past 20 years we have studied their diet, collecting prey remains on a regular basis. The results reveal that Feral Pigeons *Columba livia* comprise one third of the diet by frequency and just over half of the diet when measured by mass. The remainder of the diet comprises a wealth of other species including wading birds, other doves and pigeons, ducks, gulls and terns, and rails. A selection of species eaten by the Peregrines reveal that they are hunting at night, taking certain wading birds, rails and grebes, that would be difficult to catch by day and are known to migrate at night. This study is the most comprehensive to date and reveals that while the Feral Pigeon is an important part of the diet, contrary to public opinion, it is by no means the only species that Peregrines eat. In fact, the remaining half of the diet, by mass, comprised 101 other species of bird and three species of mammal. Such dietary studies help dispel myths about peregrines feeding habits and ensure that their conservation and protection is based on evidence.

Keywords: prey, food, nocturnal, hunting, church

**Összefoglalás** A vándorsólymot egészen mostanáig egy városokon kívül élő fajnak tekintették. Az elmúlt 20 évben, ahogy a vándorsólymok állományok növekedtek, egyre inkább városi madárrá vált. Az Egyesült Királyságban az egyik első városi költőhely, amit vándorsólymok foglaltak el, a Devon megyei Exeterben, egy templomon volt. Az elmúlt 20 évben tanulmányoztuk a táplálkozásukat rendszeres táplálékmaradvány gyűjtéssel. Az eredmények azt mutatják, hogy táplálékuk egyharmadát parlagi galambok teszik ki, ha a tömegét tekintjük, akkor annak valamivel több, mint felét. A táplálék többi része különböző fajok nagy változatosságából áll, többek között partimadarakból, más galambokból és gerlékből, sirályokból és csérekéből, valamint guvatfélékből. A vándorsólymok által fogyasztott fajok egy része azt mutatja, hogy a vándorsólymok éjszaka is vadásznak, mivel olyan fajokat, pl. partimadarakat, guvatféléket és vöcsköket zsákmányolnak, amelyeket nappal nagyon nehéz lenne elfogniuk, és amelyek éjszaka vonulnak. Ez a tanulmány eddig a legátfogóbb, és kimutatja, hogy a parlagi galambok a sólymok táplálékának ugyan jelentős részét teszik ki, de a közhiedelemmel ellentétben messze nem az egyetlen táplálék, amit fogyasztanak. Valójában a táplálékuk másik részét 101 különböző madárfaj és három emlősfaj adja. Az ilyen táplálékvizsgálatok segíthetnek eloszlatni a vándorsólymok táplálékosztási szokásairól terjedő téveszméket és biztosítani, hogy védelmük és megőrzésük tényeken alapuljon.

Kulcsszavak: zsákmány, táplálék, éjszakai vadászat, templom

<sup>1</sup> Churchgate, Drewsteignton, Exeter, EX6 6QU, email: nick@urbanperegrines.co.uk

<sup>2</sup> School of Biological Sciences, University of Bristol, Bristol Life Sciences Building, 24 Tyndall Avenue, Bristol BS18 1TQ, email: ed.drewitt@bristol.ac.uk

\* corresponding author

## Introduction

In the late 1990s Peregrines, *Falco peregrinus*, were just beginning to appear in towns and cities in southern England. Two decades later, in 2014, 1,769 pairs were recorded across the UK. Out of these approximately 211 pairs now breed on man-made structures, with many currently populating city centres (Wilson *et al.* 2018, pers. com.). One of the earliest cities to be occupied was Exeter in Devon, where Peregrines tenanted St. Michael's Church, Mount Dinham. This is very close to the city centre and 6 km from where the River Exe begins to open out in the Exe Estuary.

Urban sites such as St. Michael's Church have had different Peregrines in residence over a 20-year period. During this time there has been a growing interest and commitment by individuals, groups and organisations to observe and share with the general public the comings and goings of Peregrines that may be nesting in their local city centre. The Exeter Peregrines have been watched by a worldwide audience, following the installation of a camera to watch the nest by the wildlife surveillance company, Eco-watch Ltd; this was in use between 2001 and 2007. They have also been part of the Royal Society for the Protection of Birds' (RSPB) 'Aren't Birds Brilliant' Campaign between 2005 and 2008.

Urban nesting Peregrines provide a unique chance to study different aspects of their lives and behaviour in close detail, and, in particular, their diet. When they bring prey back to buildings, fallen remains end up on the ground, on the roofs and in the gutters (Drewitt & Dixon 2008). This provides an opportunity – not generally available at traditional cliff nest sites – to regularly collect remains all year round with no disturbance to the Peregrines to determine prey selection and diet. Nick Dixon has been collecting prey remains since June 1997 at St. Michael's, and has been investigating the diet of the Peregrines, with the help of Ed Drewitt. This study covers the period 1997 to 2017, and is the largest single-site study of prey by Peregrines in the world.

The study of the diet of any animal gives researchers the potential to find out what that species is eating and what is important for their survival. While peregrines are mainly generalist avian feeders, there are patterns to their diet. Discovering what Peregrines eat, and how their diet changes throughout a year and over a longer period, is important for the species' conservation. It gives us a better understanding of how they fit into the ecology of our rural and urban landscapes. While the Peregrine has been increasing in urban areas across England, there have been declines across the UK, particularly in northern England and Scotland (Wilson *et al.* 2018). Therefore, knowing what Peregrines are feeding on is an important part of understanding what may be affecting population numbers in certain regions.

## A brief history of the peregrines at St. Michael's Church

Peregrines have been associated with St. Michael and All Angels Church at Mount Dinham in Exeter City Centre since July 1988, when a second summer male first took up residence. He was joined by an adult female in the spring of 1989 and the pair was regularly observed hunting over the city, feeding and perching on the many stone pinnacles on the church tower.

The Devon Bird Watching & Preservation Society (DBWPS) installed a nest box. However, the falcons were never observed entering it. The pair dispersed in late 1990, but other single Peregrines were occasionally recorded up until 1992. This behaviour is typical of Peregrines and how they colonise urban areas over time (the pattern of urbanisation) (Taranto 2009). No Peregrines were recorded at the church from 1993 until 1997.

A pair of Ravens *Corvus corax* had previously been nesting in tall cedar trees to the west of the church and, in 1997, built a stick nest on an 45cm wide east-facing ledge at the base of the spire, about 30m above ground level. It is not known if the Ravens used the nest. However, a new pair of Peregrines took up residence in early April, laid eggs and successfully reared three young, in what was the first record of urban nesting on a man-made structure in Devon.

During the following winter, the lightning conductor, upon which the Ravens had constructed their nest, had to be replaced. The stick nest was in poor condition, having been flattened by the three juvenile Peregrines during their development, and subsequently fell apart and was removed. During the works, DBWPS replaced it with a purpose-built shallow tray containing loose substrate, with sticks wired around the exterior to replicate the original nest. The falcons immediately took to the new nest tray, and in 1998 they again fledged three young and continued to use this site over the following years.

In 2001, the wildlife surveillance company Eco-Watch Ltd. designed and installed a camera to film the birds at the nest, enabling all to watch the developments via the Worldwide Web. The RSPB, Devon Wildlife Trust and Exeter City Council also ran guided watches for the public from a tall car park overlooking St. Michael's Church during many of the breeding seasons.

In 2008, the camera became obsolete when a new female arrived and opted to use the original nest box erected in 1989 on the southern face. This new site required the falcons to enter a wide stone trefoil, 2 m above the south-facing ledge, to access an internally mounted nest box set within the bell chamber.

A new web camera was installed prior to the breeding season in 2013 by Jason Fathers, of 'Wildlife Windows', a wildlife surveillance company. Jason has also ringed the juvenile peregrines in the south face nest since 2013.

The peregrines at St. Michael's Church have bred every year since 1997, rearing 57 young over the period, with all but two successfully fledging into the wild. In 1997, one juvenile came down to the ground prior to fledging and was taken into care by a rehabilitator and later reported as released into the wild. In 2008, a newly fledged female became entangled in anti-bird netting on a nearby roof, damaging its wing and many primary feathers. This bird was also taken into care and subsequently released into the wild after she had moulted into her adult plumage and been trained into peak fitness for hunting (Dixon 2017).

## Materials and methods

When feeding, Peregrines leave behind lots of evidence of what they have been eating. Feathers, wings, beaks, heads, legs, and whole or partially eaten corpses are dropped or left on and around the structures where Peregrines reside.

Over the past 20 years, prey remains have been collected at least once a week from the ground beneath St. Michael's Church by Nick Dixon. Collections have also been undertaken from Exeter Cathedral and another church within the city from 2006, with careful comparisons of dates and species caught, so that the same individual prey items remains are not counted twice. Sometimes prey may be plucked at one site and then taken to another site to be eaten.

Since 2009, local residents have been helping to collect feathers and, also in 2009, an MSc student from the University of Exeter, Lin Chen Yu, undertook daily collections for three months as part of a more detailed study (Chen Yu 2009). This close scrutiny retrieved dropped or discarded material, including whole or part carcasses, feathers, heads/skulls, wings, legs, rings and pellets (Oro & Tella 1995, López-López *et al.* 2009). While pellets have been collected, they usually reveal just powdery pigeon feathers and little else; sometimes a bird ring.

Every autumn, the gutters have been cleared by steeplejacks and the remains from this – mainly skulls and carcasses – have been dried and identified. Searching for remains on the ground requires a thorough scan close to the church and up to 20m away to find feathers that have been blown down paths and alleys. A wider search, up to 50m from the roost/nest site, is carried out after strong winds. While every effort is made to collect as much prey as possible, many remains may be lost to the wind, scavengers and street cleaning. Some prey items such as the larger prey captures may be eaten away from the church and not carried back to be stored or eaten.

Remains were dried after each collection and bagged for subsequent analysis. Prey species were identified from experience and with the help of reference material. These included:

- Jenni & Winkler 1994
- Brown *et al.* 2003
- Dutch feather website, [michelklemann.nl/verensite/start/index.html](http://michelklemann.nl/verensite/start/index.html)
- The online library for bird feathers, [featherbase.info](http://featherbase.info)

Occasionally, items were confirmed by comparison with museum specimens, either at the Natural History Museum (Tring) or at Bristol's City Museum & Art Gallery. Average weights were taken from Snow and Perrins (1998).

The similar species Common Tern *Sterna hirundo* and Arctic Tern *Sterna paradisaea*, and Common Chiffchaff *Phylloscopus collybita* and Willow Warbler *Phylloscopus trochilus*, have been grouped together. This is because key distinguishing feathers, such as the outer primary feathers in the terns and the outer wings of the warblers, were missing and/or earlier identifications of remains was done without knowledge of distinguishing features. Therefore, in the early years, prey remains could have been from either of the two species in each pair. The books by Svensson (2005), Baker (2016) and Demongin (2016), have since helped with identifying all four species more accurately where the feathers/wings allow.

Some prey is cached by Peregrines and eaten over a period of time, so that the remains of individual items were sometimes found over a number of days. The minimum number of individual prey items was established by checking, for example, for duplication of the same wing feathers or legs as well as for feathers from birds of a different age or sex class. Feather condition and weather-related damage was important in assessments of how fresh the remains were.

## Results

During the past 20 years 5,426 remains of 102 species of bird and three species of mammal have been found and identified. *Figure 1* (by frequency) and *Figure 2* (by biomass) summarise the main groups of prey taken by the peregrines. Feral Pigeon includes just *Columba livia* while doves and pigeons include common Wood Pigeon *Columba palumbus*, Eurasian Collared Dove *Streptopelia decaocto*, European Turtle Dove *Streptopelia turtur* and Stock Dove *Columba oenas*.

Within the passerines, the top species to be eaten in the Common Blackbird *Turdus merula* (5.18% by frequency and 2.76% by biomass), followed by Redwing *Turdus iliacus* (4.68% and 1.52%) and the Common Starling *Sturnus vulgaris* (9.31% and 3.63%). Within the waders, Common Snipe *Gallinago gallinago* was the most common prey item (2.82% and 1.61%), followed by European Golden Plover *Pluvialis apricaria* (1.36% and 1.56%), Eurasian Woodcock *Scolopax rusticola* (1.22% and 1.90%) and Northern Lapwing *Vanellus vanellus* (1.11% and 1.32%). See *Appendix 1* for all species and totals taken during this 20-year period.

Regular (often annual) yet unusual prey includes nocturnal migrants such as Spotted Crake *Porzana porzana* and Corn Crake *Crex crex*, and other species such as Common Cuckoo *Cuculus canorus*, Pied Avocet *Recurvirostra avosetta* and Common Kingfisher *Alcedo atthis*.

## Discussion

These preliminary descriptive results of our 20-year study reveal a huge breadth in the diet of the urban Peregrine at one location. Through personal communications with other Peregrine workers across the UK, the results from our study appear to reflect what urban Peregrines at other sites are also eating. Certainly, our comparison with data from the cities of Bath and Bristol also showed this (Drewitt & Dixon 2008).

The results also reveal more about what many of the prey species are doing, for example, that rare Corncrakes, Spotted Crakes and Turtle Doves are passing over this part of England. The study builds further on our paper published after 15-years in the Devon Bird Report (Drewitt & Dixon 2012), where we discuss nocturnal birds, Feral Pigeons, estuary birds and scarce species, in more detail.

Our findings at St. Michael's Church in Devon contributed towards the theory that Peregrines hunt at night in the UK, later confirmed by web camera footage from Derby cathedral, England (Drewitt 2008). Since then many sites across the UK and other parts of Europe have discovered a range of nocturnally migrating species that are most likely to be caught at night (per. comms. with various peregrine workers). Night-hunting has also been recorded in many other parts of the world (Drewitt & Dixon 2008, Drewitt 2014). These suggest night hunting is happening on a wide scale, and is often supported by web camera recordings at night where prey is still obviously still alive when it is brought in. Night feeding of young has also been recorded in Poland and the UK, and may be more widespread (Rejt 2004, Kettle *et al.* 2016). Our 20-year study and beyond, continues to develop this remarkable story and reveal how adaptable the Peregrine is.

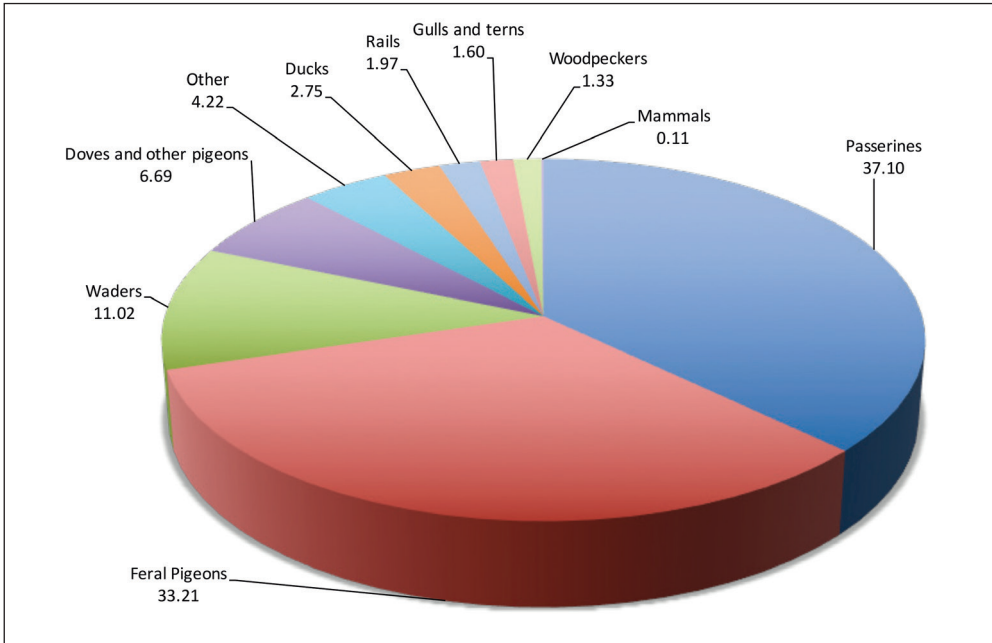


Figure 1. Frequency of prey taken by urban Peregrines in Exeter, England, 1997–2017 (n = 5,426)  
 1. ábra A városi vándorsólymok prédáinak gyakorisága – Exeter, Anglia, 1997–2017 (n = 5426)

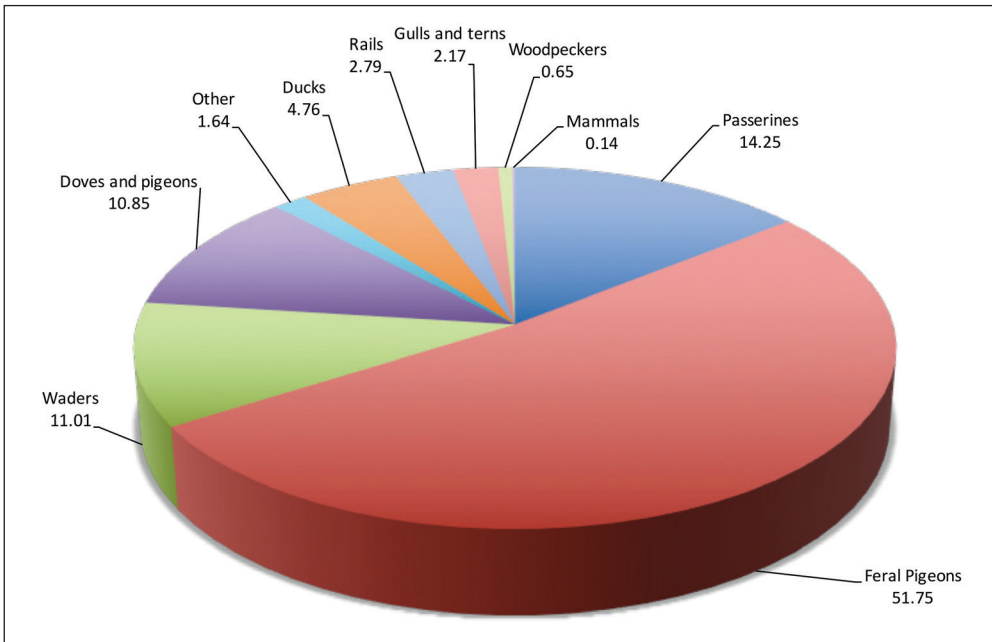


Figure 2. Prey (by biomass) taken by urban Peregrines in Exeter, England, 1997–2017 (n = 5,426)  
 2. ábra A városi vándorsólymok prédái (biomassza szerint) – Exeter, Anglia, 1997–2017 (n = 5426)

## Next steps

In 2018–2019 Ed Drewitt will be studying this comprehensive diet work in more detail, using detailed statistics to look at the diversity of prey across time and whether there are significant differences in prey throughout the year and comparing with other sites such as Bath and Bristol, in the west of England. This will also compliment Ed's 10-year study on the movements of Peregrines and natal dispersal using colour rings.

## Conclusion

The Exeter Peregrines have provided us with the largest single site study of the prey of this species in the world, in both longevity and sample size. The results provide an insight not only into what the Peregrines themselves are eating but also into the bird species that are occurring locally around Exeter. We will continue to collect prey remains from this site until we have data for a 25 years period and meanwhile, Ed will be analysing the current results in more detail.

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Appendix 1. Prey species identified from remains at St. Michael’s Church, Exeter, Devon, 1997–2017. Average weights taken from Snow & Perrins (1998)

1. melléklet A Szent Mihály templomban talált táplálék-maradványok alapján azonosított prédafajok – Exeter, Devon, 1997–2017. Átlag tömegek Snow & Perrins (1998) alapján számolva

Name	n	%	Unit mass (g)	Total biomass (g)	% biomass
<i>Mareca strepera</i>	1	0.02	775	775	0.07
<i>Mareca penelope</i>	1	0.02	750	750	0.07
<i>Anas crecca</i>	146	2.69	325	47450	4.54
<i>Aythya fuligula</i>	1	0.02	750	750	0.07
<i>Coturnix coturnix</i>	12	0.22	105	1260	0.12
<i>Oceanodroma leucorhoa</i>	1	0.02	45	45	0.004
<i>Puffinus puffinus</i>	1	0.02	417	417	0.04
<i>Tachybaptus ruficollis</i>	21	0.39	161.5	3391.5	0.32
<i>Accipiter nisus</i>	5	0.09	226	1130	0.11
<i>Rallus aquaticus</i>	23	0.42	130	2990	0.29
<i>Crex crex</i>	9	0.17	160	1440	0.14
<i>Porzana porzana</i>	2	0.04	90	180	0.02
<i>Gallinula chloropus</i>	72	1.33	330	23760	2.27
<i>Fulica atra</i>	1	0.02	800	800	0.08
<i>Haematopus ostralegus</i>	10	0.18	540	5400	0.52
<i>Recurvirostra avosetta</i>	8	0.15	275	2200	0.21
<i>Vanellus vanellus</i>	60	1.11	230	13800	1.32
<i>Pluvialis apricaria</i>	74	1.36	220	16280	1.56
<i>Pluvialis squatarola</i>	1	0.02	235	235	0.02
<i>Charadrius hiaticula</i>	22	0.41	64	1408	0.13
<i>Numenius phaeopus</i>	18	0.33	480	8640	0.83
<i>Numenius arquata</i>	1	0.02	920	920	0.09
<i>Limosa lapponica</i>	9	0.17	340	3060	0.29



Name	n	%	Unit mass (g)	Total biomass (g)	% biomass
<i>Limosa limosa</i>	46	0.85	320	14720	1.41
<i>Arenaria interpres</i>	2	0.04	117.5	235	0.02
<i>Calidris canutus</i>	17	0.31	135	2295	0.22
<i>Calidris alba</i>	5	0.09	57	285	0.03
<i>Calidris alpina</i>	47	0.87	47.5	2232.5	0.21
<i>Scolopax rusticola</i>	66	1.22	300	19800	1.90
<i>Lymnocyrtes minimus</i>	6	0.11	70.5	423	0.04
<i>Gallinago gallinago</i>	153	2.82	110	16830	1.61
<i>Actitis hypoleucos</i>	2	0.04	55	110	0.01
<i>Tringa ochropus</i>	4	0.07	86	344	0.03
<i>Tringa totanus</i>	36	0.66	117.5	4230	0.2
<i>Tringa nebularia</i>	4	0.07	200	800	0.08
<i>Chroicocephalus ridibundus</i>	39	0.72	300	11700	1.12
<i>Larus argentatus</i>	4	0.07	974	3896	0.37
<i>Thalasseus sandvicensis</i>	13	0.24	245	3185	0.3
<i>Sternula albifrons</i>	1	0.02	56	56	0.01
<i>Sterna dougallii</i>	2	0.04	112.5	225	0.02
<i>Sterna hirundo/S. paradisea</i>	28	0.52	237.5	3572.5	0.34
<i>Columbia livia</i>	1802	33.21	300	540600	51.75
<i>Columba oenas</i>	4	0.07	300	1200	0.11
<i>Columba palumbus</i>	161	2.97	449	72289	6.92
<i>Streptopelia turtur</i>	12	0.22	140	1680	0.16
<i>Streptopelia decaocto</i>	186	3.43	205	38130	3.65
<i>Cuculus canorus</i>	17	0.31	117.5	1997.5	0.19
<i>Athene noctua</i>	4	0.07	180	720	0.07
<i>Apus apus</i>	126	2.32	43.5	5481	0.52
<i>Alcedo atthis</i>	11	0.20	40	440	0.04
<i>Dendrocopos major</i>	65	1.20	85	5525	0.53
<i>Picus viridis</i>	7	0.13	185	1295	0.12
<i>Falco tinnunculus</i>	1	0.02	204	204	0.02
<i>Garrulus glandarius</i>	27	0.50	165	4455	0.43
<i>Pica pica</i>	49	0.90	227	11123	43106.00
<i>Coloeus monedula</i>	54	1.00	220	11880	43114.00
<i>Corvus frugilegus</i>	1	0.02	310	310	0.03
<i>Corvus corone</i>	8	0.15	510	4080	0.39
<i>Corvus corax</i>	1	0.02	657.5	657.5	0.06
<i>Cyanistes caeruleus</i>	19	0.35	11	209	0.02
<i>Parus major</i>	21	0.39	18	378	0.04

Name	n	%	Unit mass (g)	Total biomass (g)	% biomass
<i>Alauda arvensis</i>	25	0.46	38	950	0.09
<i>Riparia riparia</i>	2	0.04	13.5	27	0.002
<i>Hirundo rustica</i>	6	0.11	19	114	0.001
<i>Delichon urbicum</i>	11	0.20	19	209	0.02
<i>Phylloscopus collybita/ Ph.trochilus</i>	4	0.07	9	36	0.003
<i>Acrocephalus schoenobaenus</i>	1	0.02	9	9	0.0008
<i>Sylvia atricapilla</i>	13	0.24	23.5	305.5	0.03
<i>Sylvia communis</i>	2	0.04	19	38	0.003
<i>Regulus regulus</i>	1	0.02	5.75	5.75	0.0005
<i>Troglodytes troglodytes</i>	1	0.02	9.5	9.5	0.0009
<i>Sitta europaea</i>	1	0.02	22.5	22.5	0.002
<i>Sturnus vulgaris</i>	505	9.31	75	37875	3.63
<i>Turdus merula</i>	281	5.18	102.5	28802.5	2.76
<i>Turdus pilaris</i>	90	1.66	100	9000	0.86
<i>Turdus philomelos</i>	76	1.40	82.5	6270	0.6
<i>Turdus iliacis</i>	254	4.68	62.5	15875	1.52
<i>Turdus viscivorus</i>	22	0.41	125	2750	0.26
<i>Muscicapa striata</i>	2	0.04	17	34	0.003
<i>Erithacus rubecula</i>	10	0.18	17.5	175	0.02
<i>Oenanthe oenanthe</i>	8	0.15	23.5	188	0.02
<i>Cinclus cinclus</i>	4	0.07	66.5	266	0.03
<i>Passer domesticus</i>	112	2.06	31	3472	0.33
<i>Prunella modularis</i>	20	0.37	20.50	410	0.04
<i>Motacilla cinerea</i>	1	0.02	18	18	0.001
<i>Motacilla alba</i>	59	1.09	21	1239	0.12
<i>Anthus pratensis</i>	19	0.35	18.5	351.5	0.03
<i>Fringilla coelebs</i>	92	1.70	23.5	2162	0.21
<i>Fringilla montifringilla</i>	3	0.06	23.5	70.5	0.01
<i>Pyrrhula pyrrhula</i>	9	0.17	21	189	0.02
<i>Chloris chloris</i>	114	2.10	28.5	3249	0.31
<i>Linaria cannabina</i>	3	0.06	18.5	55.5	0.01
<i>Acanthis caberet</i>	1	0.02	10.5	10.5	0.001
<i>Carduelis carduelis</i>	59	1.09	16.5	973.5	0.090
<i>Serinus canaria</i>	1	0.02	28	28	0.002
<i>Spinus spinus</i>	4	0.07	14.5	58	0.01
<i>Emberiza citrinella</i>	2	0.04	30.5	61	0.01
<i>Emberiza schoeniclus</i>	4	0.07	20.5	82	0.01

Name	n	%	Unit mass (g)	Total biomass (g)	% biomass
<b>Feral or escaped cagebirds</b>					
<i>Psittacula krameri</i>	3	0.06	117.5	352.5	0.03
<i>Nymphicus hollandicus</i>	15	0.28	90	1350	0.13
<i>Melopsittacus undulates</i>	11	0.2	28	308	0.03
<b>Unidentified birds</b>					
Unidentified cage bird	1	0.02	28	28	0.002
Unidentified wader	7	0.13	110	770	0.07
Unidentified passerine	11	0.2	32	352	0.03
<b>Mammals</b>					
<i>Sciurus carolinensis</i>	1	0.02	550	550	0.05
<i>Rattus norvegicus</i>	2	0.04	397.5	795	0.08
<i>Nyctalus noctula</i>	3	0.06	29.5	88.5	0.01
<b>TOTAL</b>	<b>5426</b>	<b>100.00</b>			<b>100.00</b>

