

DIET OF URBAN AND SUBURBAN TAWNY OWLS (*STRIX ALUCO*) IN THE BREEDING SEASON

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ABSTRACT.—The diet of tawny owls (*Strix aluco*) was studied during the breeding seasons 1988–90 in an urban and a suburban area in Toruń, Poland. Two amphibian, 18 bird, and 14 mammal species were recorded as prey in a sample of 312 pellets. From 600 prey items found in both sites, the house sparrow (*Passer domesticus*) was the most frequently taken bird prey and the common vole (*Microtus arvalis*) the most frequently taken mammal prey. Significantly more mammals than birds were taken at the suburban site than at the urban site ($P < 0.001$). At the urban site, the proportion of birds (except for tits [*Parus* spp.] and house sparrows) increased over the course of the breeding season, while the proportion of *Apodemus* spp. decreased. Similarly, at the suburban site the proportion of all birds increased and the proportion of *Microtus* spp. decreased. House sparrows at the urban site and Eurasian tree sparrows (*Passer montanus*) and tits at the suburban site were taken in higher proportion than their availability. An examination of dietary studies from elsewhere in Europe indicated that there was a positive correlation between mean prey size and increasing proportion of birds in tawny owl diets ($P = 0.003$).

KEY WORDS: tawny owl; diet; urban and rural area; bird selection; prey-size selection.

Dieta de *Strix aluco* urbano y suburbano en la estación reproductiva

RESUMEN.—Se estudió la dieta de *Strix aluco* durante las estaciones reproductivas de 1988 a 1990 en un área urbana y suburbana en Toruń, Polonia. Dos anfibios, 18 aves y 14 especies de mamíferos fueron registrados como presa en una muestra de 312 egagrópilas. De 600 categorías de presas encontradas en ambos sitios, *Passer domesticus* fue el ave-presa más frecuente junto al mamífero *Microtus arvalis*. Se consumieron significativamente más mamíferos que aves en el sitio suburbano que en el urbano ($P < 0.001$). En el sitio urbano, la proporción de aves (excepto para *Parus* y *P. domesticus*) incrementó a medida que transcurría la estación reproductiva, mientras que la proporción de *Apodemus* spp. disminuyó. Similarmente, en el sitio suburbano la proporción de todas las aves incrementó y la proporción de *Microtus* spp. disminuyó. Tanto *P. domesticus* en el sitio urbano como *Passer montanus* y *Parus* spp. en el sitio suburbano fueron consumidos en una proporción mayor a su disponibilidad. Un examen de estudios dietarios en Europa indicó que hubo una correlación positiva entre el tamaño promedio de presas y el incremento de la proporción de aves en la dieta de búhos ($P = 0.003$).

[Traducción de Ivan Lazo]

Increasing numbers of animal species are adapting to urban environments; among birds, omnivorous and granivorous species most frequently inhabit towns (Tomiałojć and Profus 1977, Zalewski 1994). Predatory birds are also increasingly colonizing urban areas, and thus become important links in the urban food webs. Such birds have to either find a habitat containing natural food resources or change their feeding ecology. The tawny owl (*Strix aluco*) is an example of a polyphagous species (Mikkola 1983), that can inhabit many environments and adapt to preying on the most abundant species.

In this paper I compare tawny owl diets during the breeding season between an urban and a suburban area. I focus on diet changes throughout the

breeding period, and diet changes in relation to bird prey availability in both study areas.

STUDY AREA AND METHODS

The study took place in and around the city of Toruń, central Poland (53°01'N, 18°35'E). The human population of Toruń is 200 000 and the city covers an area of 115.8 km². Forests of pine (*Pinus sylvestris*) predominate on sandy soil around the city. Oaks (mainly *Quercus robur*) and birches (*Betula verrucosa*) form admixtures in the pine forest.

The urban site consisted of a park (2.1 ha) and a cemetery (3.7 ha) located near the city center. The eastern side of the urban area joined a small villa district, and on the northern side it was bordered by an open grassland area with residential estates behind it (the Chrobry residential district). The suburban site (17 ha) was located 3

km from the city center. It was a 60–70-yr-old pine forest with deciduous trees (black alder [*Alnus glutinosa*], maple [*Acer* sp.], and horsechestnut [*Aesculus hippocastanum*]) and a rich shrub layer. A small stream flowed through this site which resembled the forest surrounding Toruń. On the eastern side it was flanked by buildings, and on the western side by a large open grass area.

Tawny owl pellets were collected between February and June in 1988, 1989, and 1990 in the urban site, and in 1989 and 1990 in the suburban one. At both sites, pellets were collected from one or two breeding pairs of owls in the same territories in each year. These pellets were gathered regularly from roosts of adults and young owls and also near nests. The pellets were analyzed by standard methods. Prey remains were identified using keys for mammals (Pucek 1981), birds (Moreno 1985, 1986), and amphibians (Böhme 1977). The number of vertebrate prey were calculated separately for each sample of pellets found at the same time on the basis of skulls, jaws, or other bone elements. Insects were identified and counted based on exoskeleton remains. For each site the frequency of occurrence and percentage biomass were calculated. Conversion factors were applied (Table 1), using 20 g as the standard weight for small mammals (Southern 1954). Thus, total weight of prey was converted to "prey units." Pellets were collected during three periods: (1) egg laying and hatching (from 1 February to 15 March); (2) nestling (from 16 March to 30 April); and (3) fledgling—when young owls were fledged but still dependent on their parents (from 1 May to 30 June). This division was based on observations of breeding and young tawny owls around Toruń. The *G*-test was used to test the proportions of prey items in the owls' diet (Sokal and Rohlf 1981). For both study sites, the proportion of each bird species in the diet was then compared with its relative abundance in the bird community (Ozga 1990, Zalewski and Przystalski 1993, Zalewski 1994) close to where the pellets had been collected. In all the sites, breeding birds were censused by the territorial mapping method. In urban green areas censuses were carried out in 1988–89, in the Chrobry district in 1989, and in the suburban forest in 1989–90.

RESULTS

In the urban site 223 pellets were found (30, 96, and 97 in consecutive years). In the suburban forest 89 pellets were collected (11 and 78 in consecutive years). In all, 18 species of birds, 14 species of mammals, and two species of amphibians (common frog [*Rana temporaria*], and spadefoot toad [*Pelobates fuscus*]) were recorded.

Comparison of Owl Diets Between the Urban and Suburban Areas. At the urban site, tawny owls preyed mainly on birds (66.6% by numbers and 68.2% by biomass). The most important prey were the house sparrow and the Eurasian tree sparrow (Table 1). Larger birds such as the collared dove (*Streptopelia decaocto*) and European starling (*Sturnus vulgaris*) contributed a high percentage by biomass (23.8%).

Significantly more mammals than birds were taken at the suburban site than at the urban site ($G = 125.64$, $df = 1$, $P < 0.001$). These were mainly common voles (*Microtus arvalis*) and *Apodemus* spp. which together comprised 39.8% prey by numbers and 36.7% of the prey biomass. At the urban site, mammals composed only 30.5% of tawny owl prey, and rabbits were also important food items (11.4% of the prey biomass). Amphibians were not a significant component of the owls' diet, especially in town. Invertebrates were recorded in the diet during the study at both sites (Table 1). The mean weight of prey in the urban sites was 37.6 g, and 28.6 g in the suburban site.

Little change occurred in the diet composition of tawny owls at the urban site through the breeding season (Table 2). However, the proportion of *Apodemus* spp. decreased from the first stage of the breeding season (1 February to 15 March) to the next two stages. Likewise, the proportion of tits and mammals decreased. By contrast, except for tits and sparrows, the proportion of birds and house mice (*Mus musculus*) increased, although in the latter case to a minor degree.

Amphibians from the genus *Rana* were important in the diet of the suburban owls in March and April when they migrated from the places of hibernation. In later months, their frequency decreased (Table 2). In contrast, the contribution of spadefoot toads increased as the breeding season progressed, associated with this species' shift to terrestrial life in May and June (Juszczak 1987). The proportion of birds increased greatly in the later stages of the breeding season, although the increase in house sparrows was minor. The proportion of insectivorous mammals, especially the common shrew (*Sorex araneus*), also increased. The frequency of *Microtus* spp., however, dropped noticeably from February to June. Nevertheless, throughout the study the proportion of mammals in the diet was invariably above 50%.

Bird Prey. Comparison of the proportions of bird species in the tawny owl diet with their relative availability indicated that the most abundant bird species were taken (Table 3). Ivlev's electivity index (modified by Jacobs 1974) was calculated to quantify tawny owls' selectiveness for a few bird species. House sparrows were clearly preferred by the owls in the urban site ($D = 0.39$). Eurasian tree sparrows comprised a large proportion of the diet, although they were not common birds. Tawny owls preyed on house martins (*Delichon urbica*) to a greater extent than

Table 1. Tawny owl diet composition in the breeding season (1 February to 30 June) in 1988–90. (Cf = conversion factor in 'prey units' [see text], N = number of individuals, % N = percent of prey specimens, % B = percent of prey biomass.) Remains of insects were not included in biomass calculations.

PREY SPECIES	Cf	URBAN SITE			SUBURBAN SITE			TOTAL		
		N	% N	% B	N	% N	% B	N	% N	% B
<i>Rana</i> spp.	1.6	10	2.6	2.3	67	30.1	33.6	77	12.8	12.0
<i>Pelobates fuscus</i>	0.9	1	0.3	0.1	9	4.0	2.5	10	1.7	0.9
Anura subtotal		11	2.9	2.4	76	34.1	36.1	87	14.5	12.9
<i>Streptopelia decaocto</i>	10.0	12	3.2	16.9	—	—	—	12	2.0	11.7
<i>Delichon urbica</i>	0.8	14	3.7	1.6	—	—	—	14	2.3	1.1
<i>Sturnus vulgaris</i>	4.0	12	3.2	6.9	—	—	—	12	2.0	4.7
<i>Turdus merula</i>	4.0	2	0.5	1.1	2	0.9	2.5	4	0.7	1.6
<i>Phoenicurus phoenicurus</i>	0.8	2	0.5	0.2	—	—	—	2	0.3	0.1
<i>P. ochrurus</i>	0.8	2	0.5	0.2	—	—	—	2	0.3	0.1
<i>Erithacus rubecula</i>	0.8	—	—	—	1	0.5	0.3	1	0.2	0.1
<i>Parus major</i>	1.0	13	3.5	1.8	4	1.8	1.3	17	2.8	1.7
<i>P. caeruleus</i>	0.5	3	0.8	0.2	—	—	—	3	0.5	0.1
<i>P. palustris/ater</i>	0.5	—	—	—	1	0.5	0.2	1	0.2	0.1
<i>Pica pica</i>	9.5	1	0.3	1.3	—	—	—	1	0.2	0.9
<i>Garrulus glandarius</i>	8.5	—	—	—	1	0.5	2.7	1	0.2	0.8
<i>Fringilla coelebs</i>	1.0	—	—	—	2	0.9	0.6	2	0.3	0.2
<i>Passer domesticus</i>	1.5	146	38.7	30.9	9	3.9	4.2	155	25.9	22.6
<i>P. montanus</i>	1.0	27	7.2	3.8	2	0.9	0.6	29	4.8	2.8
<i>Carduelis chloris</i>	1.5	5	1.3	1.1	—	—	—	5	0.8	0.7
<i>Serinus serinus</i>	0.5	2	0.5	0.1	—	—	—	2	0.3	0.1
<i>Emberiza citrinella</i>	1.2	1	0.3	0.2	—	—	—	1	0.2	0.1
Unidentified passerines	1.5	9	2.4	1.9	1	0.5	0.5	10	1.7	1.5
Aves subtotal		251	66.6	68.2	23	10.4	12.9	274	45.7	51.0
<i>Talpa europaea</i>	5.0	1	0.3	0.7	2	0.9	3.1	3	0.5	1.5
<i>Sorex araneus</i>	0.5	1	0.3	0.1	9	3.9	1.4	10	1.7	0.5
<i>Eptesicus serotinus</i>	1.2	1	0.3	0.2	—	—	—	1	0.2	0.1
<i>Oryctolagus cuniculus</i>	20.0	4	1.0	11.4	—	—	—	4	0.7	7.8
<i>Mus musculus</i>	0.8	34	9.0	3.8	4	1.8	1.0	38	6.3	3.0
<i>Rattus norvegicus</i>	5.0	1	0.3	0.7	1	0.5	1.6	2	0.3	1.0
<i>Micromys minutus</i>	0.4	7	1.8	0.4	1	0.5	0.1	8	1.3	0.3
<i>Apodemus agrarius</i>	1.2	19	5.0	3.2	4	1.8	1.5	23	3.8	2.7
<i>A. sylvaticus</i>	1.2	2	0.5	0.3	12	5.3	4.5	14	2.3	1.6
<i>A. flavicollis</i>	1.2	1	0.3	0.2	—	—	—	1	0.2	0.1
<i>Apodemus</i> spp.	1.2	14	3.7	2.4	21	9.4	7.9	35	5.8	4.1
<i>Arvicola terrestris</i>	4.5	1	0.3	0.6	—	—	—	1	0.2	0.4
<i>Clethrionomys glareolus</i>	1.2	9	2.4	1.5	13	5.8	4.9	22	3.7	2.5
<i>Microtus oeconomus</i>	1.4	—	—	—	4	1.8	1.8	4	0.7	0.5
<i>M. arvalis</i>	1.4	19	5.0	3.7	52	23.3	22.8	71	11.8	9.7
<i>Microtus</i> spp.	1.4	1	0.3	0.2	1	0.5	0.4	2	0.3	0.3
Mammals subtotal		115	30.5	29.4	124	55.5	51.0	239	39.8	36.1
Total vertebrates		377			223			600		
<i>Melolontha</i> spp.		28			—			28		
Carabidae		6			2			8		
<i>Geotrupes</i> spp.		—			13			13		
Coleoptera		3			6			9		
Total invertebrates		37			21			58		

Table 2. Variation in tawny owl diet between the three stages of the breeding period in the urban and suburban sites in 1988-90. (*N* = number of individuals, %*N* = percent occurrence of prey.)

PREY SPECIES	1 FEB to 15 MARCH		16 MARCH to 30 APRIL		1 MAY to 30 JUNE		G-TEST	
	<i>N</i>	% <i>N</i>	<i>N</i>	% <i>N</i>	<i>N</i>	% <i>N</i>	<i>G</i>	<i>P</i>
Urban site								
<i>Rana</i> spp.	5	4.2	4	2.5	1	1.0	2.05	ns
<i>Pelobates fuscus</i>	—	—	—	—	1	1.0	—	
Anuran subtotal	5	4.2	4	2.5	2	2.0	0.83	ns
<i>Parus major</i>	7	5.8	6	3.8	—	—	5.00	ns
<i>Passer domesticus</i>	47	39.2	65	40.9	34	34.7	0.54	ns
Other birds	19	15.8	34	21.4	39	39.8	11.79	b
Birds subtotal	73	60.8	105	66.1	73	74.5	1.41	ns
Insectivora	1	0.8	1	0.6	—	—	0.27	ns
<i>Mus musculus</i>	5	4.2	17	10.7	12	12.2	4.60	ns
<i>Apodemus</i> spp.	21	17.5	11	6.9	4	4.1	10.09	b
<i>Microtus</i> spp.	7	5.8	8	5.0	4	4.1	0.31	ns
Other mammals	8	6.7	12	8.2	3	3.1	2.54	ns
Mammal subtotal	42	35.0	50	31.4	23	23.5	2.40	ns
Total prey	120	100.0	159	100.0	98	100.0		
Number of pellets	61		86		76			
Suburban site								
<i>Rana</i> spp.	50	35.0	14	28.0	3	10.0	15.49	c
<i>Pelobates fuscus</i>	4	2.8	1	2.0	4	13.3	12.37	c
Anuran subtotal	54	37.8	15	30.0	7	23.3	3.44	ns
<i>Parus major</i>	2	1.4	1	2.0	1	3.3	0.85	ns
<i>Passer domesticus</i>	3	2.1	3	6.0	3	10.0	5.61	ns
Other birds	3	2.1	5	10.0	2	6.7	7.69	ns
Birds subtotal	8	5.6	9	18.0	6	20.0	9.79	b
Insectivora	4	2.8	3	6.0	4	13.3	7.87	a
<i>Mus musculus</i>	2	1.4	1	2.0	1	3.3	0.85	ns
<i>Apodemus</i> spp.	18	12.6	13	26.0	6	20.0	4.78	ns
<i>Microtus</i> spp.	50	34.9	3	6.0	4	13.3	24.66	c
Other mammals	7	4.9	6	12.0	2	6.7	3.36	ns
Mammal subtotal	81	56.6	26	52.0	17	56.7	0.26	ns
Total prey	143	100.0	50	100.0	30	100.0		
Number of pellets	45		21		12			

^a *P* < 0.05.
^b *P* < 0.01.
^c *P* < 0.001.

predicted from this species' abundance in the Chrobry residential district (*D* = -0.40; Table 3). The yellowhammer (*Emberiza citrinella*), a species absent from the city of Toruń, was also a prey item, suggesting these owls also hunted in nonurban areas.

In the suburban site, house sparrows breeding close to the forest contributed the largest proportion

to the diet. Among forest bird species, tawny owls preferred the Eurasian tree sparrow (*D* = 0.56) and tits (*D* = 0.53) which nested only in the forest. Although the chaffinch (*Fringilla coelebs*) was a dominant species in the suburban forest, it was not taken in proportion to its availability by tawny owls (*D* = -0.41). The owls did not prey on chiffchaff (*Phyl-*

Table 3. Proportion of birds in tawny owl diet (%N = percent by number) and their relative abundance in the bird community in various habitats. (UGA = urban green areas [Zalewski and Przystalski 1993], OCH = the Chrobry residential district [Ożga 1990], SF = suburban forest [Zalewski 1994], + = occurring in the forest and breeding in the surrounding areas.)

SPECIES	URBAN SITE			SUBURBAN SITE	
	%N	UGA	OCH	%N	SF
<i>Passer domesticus</i>	58.2	+	37.7	39.1	+
<i>Passer montanus</i>	10.7	2.9	1.6	8.7	2.4
<i>Parus</i> spp.	6.4	9.2	1.8	21.6	7.8
<i>Fringilla coelebs</i>	—	10.3	1.2	8.7	19.1
<i>Delichon urbica</i>	5.6	—	12.7	—	—
<i>Streptopelia decaocto</i>	4.8	2.9	28.4	—	—
<i>Sturnus vulgaris</i>	4.8	19.5	2.8	—	3.4
<i>Turdus merula</i>	0.8	0.6	0.4	8.7	9.0
<i>Erithacus rubecula</i>	—	—	—	4.4	4.3
<i>Carduelis chloris</i>	2.0	1.7	0.4	—	0.8
<i>Phoenicurus phoenicurus</i>	0.8	2.9	—	—	0.8
<i>P. ochruros</i>	0.8	—	0.6	—	—
<i>Pica pica</i>	0.4	2.3	0.6	—	—
<i>Garrulus glandarius</i>	—	—	—	4.4	0.8
<i>Serinus serinus</i>	0.8	5.7	—	—	3.5
<i>Emberiza citrinella</i>	0.4	—	—	—	—
<i>Phylloscopus collybita</i>	—	—	—	—	9.8
<i>Sylvia atricapilla</i>	—	—	—	—	6.2
Other passerines	3.5	42.0	11.8	4.4	32.1
Density (pairs/10 ha)		150.0	183.4		75.4

loscopus collybita) and the blackcap (*Sylvia atricapilla*), despite the fact that they were the most abundant species ($D = -1$; Table 3).

DISCUSSION

In rural areas the diet of the tawny owl is composed mainly of small mammals (Bocheński 1990, Goszczyński et al. 1993). In towns, mammals are less important dietary components (Manganaro et al. 1990, Galeotti et al. 1991, Goszczyński et al. 1993). However, in both these environments the proportional contribution of mammals is lower in spring and summer while higher in autumn and in winter (Bocheński 1990, Manganaro et al. 1990, Galeotti et al. 1991). In Toruń, between February and June the proportion of *Apodemus* spp. (especially of *A. agrarius*) decreased. Similarly the proportion of *Apodemus* spp. decreased in the diet in other studies of tawny owl diet in nonurban environments (Southern 1954, Yalden 1985, Kirk 1992). Apart from seasonal changes, annual variation in diet was recorded depending on rodent availability (Gruzdev and Likhachev 1960, Görner and Kramer 1973, Galeotti et

al. 1991). Often, the alternative food source in the years of low rodent number was birds. This adaptability to alternative food may enable tawny owls to penetrate areas with few rodents but many birds.

In Toruń, as in many other European cities, the major food of tawny owls was birds (Manganaro et al. 1990, Galeotti et al. 1991, Goszczyński et al. 1993), particularly the house sparrow and other synanthropic species (collared dove and the house martin). In urban areas house sparrows are also important prey for sparrowhawks (*Accipiter nisus*; Frimer 1989) and long-eared owls (*Asio otus*; von Dathe 1988). A considerable increase in avian prey in tawny owl diets was recorded in May and June, which coincided with arrival of migrants on their breeding territories in spring. Similar increases in the relative contribution of birds in the diet of these owls have been noted in other habitats (Gruzdev and Likhachev 1960, Glutz and Bauer 1980, Manganaro et al. 1990, Kirk 1992). In Toruń, the population density of house sparrows, a resident species, did not change during this study. The density of tits did change because these birds were more frequent in

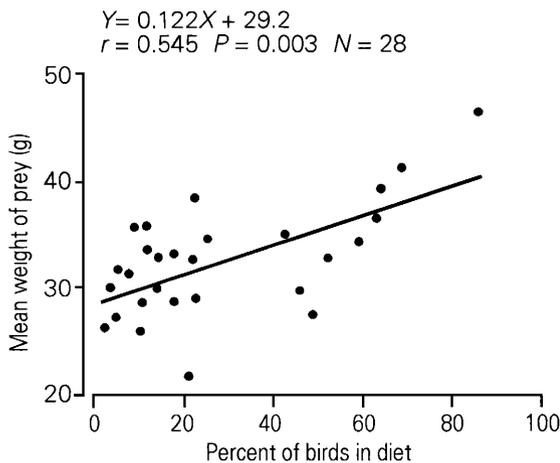


Figure 1. Relationship between the mean prey size and proportion of birds in tawny owl diets in Europe (Schnurre 1961, Görner and Kramer 1973, Glutz and Bauer 1980, Wendland 1980, Yalden 1985, Cerveny and Obuch 1988, Bocheński 1990, Manganaro et al. 1990, Wasilewski 1990, Gramsz 1991). Only studies with at least 200 prey items were included.

Toruń in February and March than in later stages of the breeding season (D. Czeszczewik pers. comm.). However, in the suburban forest their importance increased in the diet from April to June.

In suburban forests, Eurasian tree sparrows and tits were preferred by the owls, and were frequent in this owl's diet in other European areas (Schnurre 1961, Wendland 1980, Bocheński 1990, Manganaro et al. 1990). Interestingly, tawny owls did not prey on chaffinches although this species is dominant in many forest areas (e.g., in the suburban forest it constitutes 19.2% of the bird community). The chaffinch has been the predominant prey species of the tawny owl in only a few places (Southern 1954).

Because tawny owls rely on hearing to locate prey (Southern 1954, Mikkola 1983), higher noise levels in urban habitats may interfere with prey capture. Also, because there are fewer rodents in town, the owls focus mainly on birds. Birds are probably more difficult to catch than the majority of nocturnal, terrestrial, and vocally noisy small mammals. Other dietary studies of tawny owls in Europe show that increasing proportions of birds were correlated with an increase in mean size of prey items ($r = 0.545$, $P = 0.003$, Fig. 1). Hunting large prey may be an energetic compensation for diminished hunting time. In Toruń, wild rabbits were an important addition

to the owls' diet, as were larger birds such as pigeons and ducks (Harrison 1960, Bogucki 1967, Galeotti et al. 1991).

Thus, because the tawny owl can adapt to preying on alternative food sources and can tolerate the close presence of humans, the species may become increasingly abundant in towns.

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