mientras que el otro era un ejemplar nacido el año anterior, por lo que sospechamos que podría ser un pollo de la pareja que colabora con sus progenitores para sacar adelante la nidada y, de está forma, va cogiendo experiencia mientras llega a la madurez sexual que se produce un año después.

[Traducción de los autores]

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FOOD HABITS OF PEREGRINE FALCONS IN KENTUCKY

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Many studies on Peregrine Falcons (*Falco peregrinus*) include observations of prey taken (White et al. 2002). As a consequence of the Peregrine Falcon's cosmopolitan distribution and adaptability, inferences derived from food habit studies often are limited to the study area in which they were conducted (Ratcliffe 1993, Schneider and Wilden 1994, Rejt 2001, Serra et al. 2001). In the Midwestern United States, a large proportion (0.70) of the restored Peregrine Falcon population occupies structurally similar human-made breeding locations (Tordoff et al. 2001); however, land use adjacent to these breeding locations often is variable and may be reflected in the diet of the birds. For example, in Kentucky, three pairs of Peregrine Falcons occupy human-made breeding locations including bridges and power plants. Land use adjacent to the breeding locations varies from predominantly urban at one breeding location to predominantly rural at the other two breeding locations.

Food-habits data from this population would be useful in enhancing our understanding of prey use among habitat types within the region, monitoring potential expo-

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sure to contaminants in restored populations, and developing future management and conservation strategies. However, few studies have quantified Peregrine Falcon food habits in this region (Myers and Pease 1995). As part of a statewide effort to monitor Peregrine Falcons, our objective was to quantify and to compare the diet of Peregrine Falcons in Kentucky among habitats and seasons.

STUDY AREAS AND METHODS

The study area is a 175-km segment of the Ohio River Valley in the Outer Bluegrass Physiographic Region of Kentucky. Breeding locations include an interstate bridge spanning the Ohio River in Jefferson County (Louisville, KY; Urban **I**), and smokestacks associated with power plants in Trimble and Carroll counties (Rural **I** and **II**, respectively). The topography at these sites is nearly level to moderately sloping and dominated by upland oaks (i.e., *Quercus rubra, Q. alba*), hickories (*Carya* spp.), and yellow-poplar (*Liriodendron tulipifera*) on the slopes and pin oak (*Quercus palustris*), eastern cottonwood (*Populus deltoides*), silver maple (*Acer saccharinum*), and eastern sycamore (*Platanus occidentalis*) in the floodplains.

Land use adjacent to these breeding locations was the most notable difference among sites. To characterize general landscape attributes at these sites, we used a geographic information system (GIS; ArcView®, ESRI, Redlands, California) and Kentucky and Indiana GAP analysis Program data (Center for Remote Sensing and GIS 1996, Mid-American Remote Sensing Center 2001) to determine the proportion of three land use classes, including urban/developed, agriculture, and forest, within a 10-km radius of each breeding location.

We collected prey remains and pellets, and recorded visual observations of foraging Peregrine Falcons at territorial sites during March 1999–December 2001. During spring and summer, Peregrine Falcons bring much of their prey to the nest associated with courtship and the feeding of young, allowing a greater number of specimens to be collected compared to fall and winter (Ratcliffe 1993). We examined pellet contents according to the methods of Sabo and Laybourne (1994). We compared prey remains to museum specimens for identification (Oro and Tella 1995). Each species identified in a pellet or as a prey remain was considered to be one occurrence, unless multiples of the same body part were present (Mersmann et al. 1992).

We calculated and compared percent occurrence and percent biomass of prey taken over all sites, among sites and seasons, and according to seasonal status of the prey (i.e., resident, summer resident, winter resident, transient; Mengel 1965). For analyses among seasons, we classified samples as spring (March–May), summer (June–August), fall (September–November), and winter (December–February). We calculated percent biomass by multiplying the number of individuals in a species by the mean mass for that species and then divided that value by the total biomass of all species (Dunning 1984, Corser et al. 1999). We calculated Simpson's index of diversity ($1\text{-}D$) and compared diversity indices among sites and seasons (Krebs 1989). Simpson's index varies between 0 and 1, with diversity increasing as values approach one.

Table 1. Percent occurrence and percent biomass of prey taken by three pairs of Peregrine Falcons in Kentucky based on prey remains, pellets, and observations of prey captures ($N = 465$), March 1999–December 2001 [a] Scientific names of bird species are given in Appendix

SPECIES	FREQUENCY (%)	BIOMASS (%)
European Starling[b,c,d]	35	14
Rock Dove[b,c,d]	27	70
Eastern Meadowlark[b,c,d]	8	3
Blue Jay[b,c,d]	7	3
Brown-headed Cowbird[c,d]	5	1
Red-winged Blackbird[c,d]	4	1
Northern Flicker[c,d]	3	2
Common Grackle[b,c,d]	2	1
Mourning Dove[b,c,d]	2	1
Northern Mockingbird[c,d]	2	0.4

[a] Species comprising <1% of observations (0.1–0.7% of total biomass) included American Robin[c], Killdeer[c], Red-bellied Woodpecker[c], Eastern Towhee[c,d], House Sparrow[c], Wood Thrush[d], Yellow-billed Cuckoo[b], Northern Cardinal[c], Scarlet Tanager[c], Northern Rough-winged Swallow[c], American Coot[c], Pectoral Sandpiper[d], Bonaparte's Gull[d], Common Nighthawk[d], Brown Thrasher[d], White-eyed Vireo[d], Cedar Waxwing[d], Hairy Woodpecker[d], Baltimore Oriole[c], and a bat[c].

[b] Species recorded at Jefferson County, KY (Urban **I**).

[c] Species recorded at Trimble County, KY (Rural **I**).

[d] Species recorded at Carroll County, KY (Rural **II**).

We derived 95% confidence intervals for Simpson's index using a jackknife resampling technique (Krebs 1989), and we report results as Simpson's index ± 95% confidence interval.

RESULTS

General landscape attributes differed among breeding locations. Urban **I** is predominantly urban/developed (0.70), with some agriculture (0.14), and little forest (0.07 of landscape within 10-km radius). Rural **I** and Rural **II** are largely agriculture (0.48 and 0.46, respectively) and forest (0.44 and 0.47, respectively), with little urbanization/development (0.02 and 0.01, respectively).

In all, we collected 465 samples ($N = 384$ prey remains, $N = 54$ pellets, $N = 27$ observed prey captures). We collected 212 samples at Rural **I**, 192 at Rural **II**, and 61 at Urban **I**. At Urban **I**, many prey remains were inaccessible and likely fell into the Ohio River. We identified 21 different prey species at Rural **I**, 20 at Rural **II**, and six at Urban **I** (Table 1). We identified 20 different prey species during spring, 24 during summer, five during fall, and seven during winter. Across all sites and seasons combined, Rock Doves (*Columba livia*) and European Starlings (*Sturnus vulgaris*) were the most frequent prey and comprised 84% of the total biomass in the diet of Pere-

Table 2. Comparison of percent occurrence and percent biomass of prey taken among three pairs of Peregrine Falcons in Kentucky based on prey remains, pellets, and observations of prey captures (N = 465), March 1999–December 2001.[a] Scientific names are given in Appendix.

	Jefferson County (Urban I; N = 61)		Trimble County (Rural I; N = 212)		Carroll County (Rural II; N = 192)	
Species	Frequency (%)	Biomass (%)	Frequency (%)	Biomass (%)	Frequency (%)	Biomass (%)
European Starling	12	2	18	8	60	32
Rock Dove	75	95	23	67	16	56
Eastern Meadowlark	0	0	13	6	3	2
Blue Jay	0	0	9	4	7	4
Brown-headed Cowbird	0	0	9	2	0	0
Red-winged Blackbird	0	0	9	3	0	0

[a] Percent occurrence and percent biomass of all other species was ≤5%.

grine Falcons in Kentucky (Table 1). Peregrine Falcons preyed heavily on resident birds (>97%).

At Urban **I**, Rock Doves and European Starlings were the most frequent prey, but Rock Doves comprised 95% of the biomass in the diet (Table 2). At Rural **I**, Rock Doves, European Starlings, and Eastern Meadowlarks (*Sturnella magna*) had the highest percent occurrence and together comprised 81% of the biomass in the diet (Table 2). At Rural **II**, European Starlings were the most frequent prey; however, Rock Doves were a majority of the biomass in the diet of falcons (Table 2). The diet of at Rural **I** was most diverse (1-D = 0.88 ± 0.01), followed by Rural 2 (1-D = 0.63 ± 0.04), and Urban **I** (1-D = 0.52 ± 0.24).

In spring (N = 112), European Starlings, Eastern Meadowlarks, and Rock Doves were the most frequent prey taken and comprised the majority of the biomass in the diet (Table 3). In summer (N = 319), European Starlings and Rock Doves together comprised ≥70% occurrence and >90% of the biomass in the diet (Table 3). During fall (N = 14), European Starlings and Blue Jays (*Cyanocitta cristata*) were the most frequent prey and comprised the majority of the biomass in the diet (Table 3). In winter (N = 20), European Starlings were the majority of the diet in terms of occurrence and biomass (Table 3). The diet of Peregrine Falcons was most diverse in spring (1-D = 0.88 ± 0.01), slightly less diverse in fall and summer (1-D = 0.80 ± 0.06, and 1-D = 0.75 ± 0.01, respectively), and least diverse in winter (1-D = 0.62 ± 0.15).

Discussion

Results of this study are consistent with other research that identified Rock Doves as a primary prey item in the

Table 3. Comparison of percent occurrence and percent biomass of prey taken by Peregrine Falcons among seasons in Kentucky based on prey remains, pellets, and observations of prey captures (by/ N = 465), March 1999–December 2001.[a] Scientific names of bird species are given in Appendix.

	Spring (N = 112)		Summer (N = 319)		Fall (N = 14)		Winter (N = 20)	
Species	Freq. (%)	Biomass (%)	Freq. (%)	Biomass (%)	Freq. (%)	Biomass (%)	Freq. (%)	Biomass (%)
European Starling	22	12	37	13	36	19	65	40
Rock Dove	14	51	33	78	14	50	5	20
Eastern Meadowlark	18	10	0	0	0	0	5	3
Blue Jay	13	7	0	0	29	16	10	6
Common Grackle	7	5	0	0	0	0	0	0
Northern Flicker	5	5	0	0	14	12	5	5
Brown-headed Cowbird	0	0	6	1	7	2	0	0
Red-winged Blackbird	0	0	5	1	0	0	0	0
Red-bellied Woodpecker	0	0	0	0	0	0	5	2
American Coot	0	0	0	0	0	0	5	24

[a] Percent occurrence and percent biomass of all other species was ≤5%.

diet of Peregrine Falcons in urban and industrial habitats (Barber and Barber 1988, Myers and Pease 1995, Cade et al. 1996a). Worldwide, Peregrine Falcons consistently rely on Columbidae as their main prey (Ratcliffe 1993, White et al. 2002). Other species recorded in the diet of urban Peregrine Falcons represented locally abundant and resident species (Barber and Barber 1983, 1988, Bell et al. 1996, Rejt 2001). Peregrine Falcons in Kentucky exhibited similar tendencies; however, the percent occurrence and biomass of European Starlings in the diet of Peregrine Falcons at Rural I and II were higher than in other studies of urban and non-urban areas of (4.1–11.2% occurrence and 3–5% biomass) in North America (Barber and Barber 1988, Myers and Pease 1995, Corser et al. 1999, Rejt 2001). Herbert and Herbert (1965) reported Peregrine Falcons feeding regularly on European Starlings when they nested near roosting colonies. We observed roosting colonies of European Starlings at both power plants in this study, which may have accounted for their frequent occurrence in the diet of these pairs.

Throughout their range, Peregrine Falcons have been documented to prey on a diverse assemblage of taxa (Ratcliffe 1993, White et al. 2002); however, few studies have compared the diversity of prey in the diets of Peregrine Falcons among territorial pairs. Based on description data, Bell et al. (1996) suggested that one pair of Peregrine Falcons appeared to exhibit a more diverse diet than two other pairs that nested on bridges in the vicinity of San Francisco Bay, CA. Similarly, in our study Peregrine Falcons at Rural I had a more diverse diet compared to the other rural pair. The proximity of Rural I and Rural II to each other and their similarities in breeding structure type (i.e., power plants) would imply similar availability of prey assemblages. The differences in diversity we observed between these two pairs may be attributed to a difference in preference. Several studies examining the diet of Peregrine Falcons have demonstrated individual preferences for a specific prey type. For example, Cade et al. (1996a) surveyed Midwestern Peregrine Falcon food habits and identified cases in which some birds concentrated on single species such as Common Nighthawks (*Chordeiles minor*) in Minnesota or cuckoos (*Cuculus* sp.) in Wisconsin. Nonetheless, information on prey species abundance would be necessary to determine whether differences were attributed to availability of prey or to preference.

Seasonal variation in the diet of Peregrine Falcons could likely represent differences in prey availability (Cade et al. 1996a, Serra et al. 2001). For example, migratory species increase in frequency in the diets of Peregrine Falcons during spring and fall, whereas the percentage of resident birds decreases (Ratcliffe 1993, Cade et al. 1996a, Rejt 2001, Serra et al. 2001). Results of this study reflected the lowest frequency of Rock Doves and European Starlings in the spring coinciding with the presence of migratory species such as Common Nighthawks and Scarlet Tanagers (*Piranga olivacea*). Also, the presence of migratory species during spring coincided with an increase in diversity in the diet. Some species may be more conspicuous to Peregrine Falcons in the spring because of their mating displays. For example, the increase in the frequency of Eastern Meadowlarks in this study may be attributed to flashy mating displays exhibited in the spring.

Monitoring efforts are important to endangered species recovery (Cade et al. 1996b). Continued vigilance is necessary to assure long-term success of restored populations. For example, although there are no data linking use of urban or industrial breeding locations to reproductive maladies, potential contaminants and possible routes of exposure through prey should be examined (e.g., Fimreite et al. 1970, DeMent et al. 1986, Cade and Bird 1990, Mora et al. 2002). Monitoring food habits and other detailed aspects of feeding ecology in restored Peregrine Falcon populations can be useful in detecting long-term population exposure to food-related threats and in developing proactive management strategies.

RESUMEN.—Colectamos restos de presas y egagropilas de sitios nido, e hicimos observaciones visuales de captura de presas ($N = 465$) para tres parejas de halcón peregrino (*Falco peregrinus*) que anidaron en Kentucky de marzo a diciembre de 2001. Las aves residentes dan cuenta del 97% de la dieta del halcón, y específicamente la paloma zorita (*Columba livia*) y el estornino europeo (*Sturnus vulgaris*) abarcan el 62% de las presas tomadas. La dieta de una pareja rural del halcón peregrino fue más diversa (índice de diversidad = 0.88 ± 0.01) que la de otras parejas. La dieta fue más diversa en primavera (índice de diversidad = 0.88 ± 0.01) comparada con otras estaciones. A pesar de las diferencias en el hábitat (urbano versus rural), los halcones peregrinos consistentemente hicieron presa sobre estorninos europeos y palomas zoritas mas que sobre otras especies. Los esfuerzos de monitoreo para restaurar las poblaciones de halcones peregrinos pueden beneficiarse de estudios cuantitativos de los hábitos alimenticios, especialmente donde las especies de presa consumidas pueden ser indicadores de la calidad ambiental.

[Traducción de César Márquez]

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Appendix. Common and scientific names of prey taken by three pairs of Peregrine Falcons nesting in Kentucky based on observations of prey remains, pellets, and prey captures (N = 465), March 1999–December 2001.

FAMILY	SCIENTIFIC NAME	COMMON NAME
Rallidae	*Fulica americana*	American Coot
Charadriidae	*Charadrius vociferus*	Killdeer
Scolopacidae	*Calidris melanotos*	Pectoral Sandpiper
Laridae	*Larus philadelphia*	Bonaparte's Gull
Columbidae	*Columba livia*	Rock Dove
	Zenaida macroura	Mourning Dove
Cuculidae	*Coccyzus americanus*	Yellow-billed Cuckoo
Caprimulgidae	*Chordeiles minor*	Common Nighthawk
Picidae	*Picoides villosus*	Hairy Woodpecker
	Melanerpes carolinus	Red-bellied Woodpecker
	Colaptes auratus	Northern Flicker
Vireonidae	*Vireo griseus*	White-eyed vireo
Corvidae	*Cyanocitta cristata*	Blue Jay
Hirundinidae	*Stelgidopteryx serripennis*	Northern Rough-winged Swallow
Turdidae	*Hylocichla mustelina*	Wood Thrush
	Turdus migratorius	American Robin
Mimidae	*Mimus polyglottos*	Northern Mockingbird
	Toxostoma rufum	Brown Thrasher
Sturnidae	*Sturnus vulgaris*	European Starling
Bombycillidae	*Bombycilla cedrorum*	Cedar Waxwing
Thraupidae	*Piranga olivacea*	Scarlet Tanager
Emberizidae	*Pipilo erythrophthalmus*	Rufous-sided Towhee
Cardinalidae	*Cardinalis cardinalis*	Northern Cardinal
Icteridae	*Sturnella magna*	Eastern Meadowlark
	Agelaius phoeniceus	Red-winged Blackbird
	Quiscalus quiscula	Common Grackle
	Molothrus ater	Brown-headed Cowbird
	Icterus galbula	Baltimore Oriole
Passeridae	*Passer domesticus*	House Sparrow
Vespertilionidae	*Myotis* sp.	Bat