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DIET AND TROPHIC CHARACTERISTICS OF GREAT HORNED OWLS IN SOUTHWESTERN IDAHO

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Abstract.—We studied the diet of Great Horned Owls (*Bubo virginianus*) in the Snake River Birds of Prey National Conservation Area in southwestern Idaho for 14 breeding seasons. The diet included 89.2% mammals by number and 91.2% by mass. Kangaroo rats (*Dipodomys* spp.) were the most common prey overall, but montane voles (*Microtus montanus*), *Peromyscus* spp., Great Basin pocket mice (*Perognathus parvus*) and Townsend's pocket gophers (*Thomomys towsendii*) were most common at some collection sites. Estimated mean mass of prey was 44.5 g (range 20.5–82.6 g at individual nests), and food-niche breadth (dietary diversity estimated by $1/\Sigma p_i^2$) was 7.32 (range 1.55–6.85 at individual nests). Lower mean overlap in diet occurred between nests in the same year than between years at the same nest. Species of prey taken were significantly correlated with the general habitat types in which the nest was located. Diets of owls in areas of intensive agriculture overlapped little (42%) with those in rangeland habitats.

DIETA Y CARACTERISTICAS TRÓFICAS DE *BUBO VIRGINIANUS* EN EL SUROESTE DE IDAHO

Sinopsis.—Estudiamos la dieta de *Bubo virginianus* en el Area Nacional de Conservación para Aves de Rapiña de Snake River, en el suroeste de Idaho, durante 14 temporadas de reproducción. La dieta incluyó 89.2 mamíferos por número (91.2 por masa). La presa más comunmente ingerida fué *Dipodomys*, pero en algunos puntos de colección las especies *Microtus montanus. Peromyscus* sp., *Perognathus parvus*, y *Thomomys towsendii* fueron las más abundantes. El promedio estimado de masa de presa fué de 44.5 g (alcance de 20.5 a 82.6 g en nidos individuales), y la amplitud del nicho de comida (diversidad en dieta estimada por $1/\Sigma p_i^2$) fué de 7.32 (alcance de 1.55 a 6.85 en nidos individuales). El mayor solapamiento en dieta ocurrío entre nidos en el mismo año que entre años en el mismo nido. Hay una correlación significativa entre especies tomadas como presa con los tipos de habitat en que el nido se localizó. La dieta de los Bubo én areas de agricultura intensiva sobrelaparon poco (42%) con aquellos en habitats salvajes.

The Great Horned Owl (*Bubo virginianus*) is one of the most common, widespread, and relatively well known raptors in the Americas (Johnsgard 1988). Surprisingly, many gaps exist in the data needed to understand predation by this species across spatial and temporal scales. Diet information from many habitats is inadequate, and very few studies have compiled information in an area for long enough to know how diet varies and what causes the variation. Marti et al. (1993a) found only 25 studies in North America that identified ≥50 prey individuals. Only three investigations have attempted to find patterns in Great Horned Owl feeding ecology, and all were hindered by the lack of dietary data (Donázar et al. 1989, Jaksić and Marti 1984, Jaksić et al. 1986).

Our objective was to describe the variation by habitat and time in the diet of a breeding Great Horned Owl population.

STUDY AREA

We conducted our study on the Snake River Birds of Prey National Conservation Area (NCA) in southwestern Idaho (42°50′N, 115°50′W). Vegetation in the NCA is characteristic of shrub-steppe communities with big sagebrush (*Artemisia tridentata*), shadscale (*Atriplex confertifolia*), and winterfat (*Ceratoides lanata*) associations dominating (Knick et al., in press; U.S. Department of the Interior 1979a). The Snake River, bounded by cliffs from 2–125 m in height, is the major physiographic feature of this area. Irrigated agricultural land is interspersed with native desert, especially close to the river, creating a mosaic of vegetation types. Elevation ranges from 770 m at the canyon bottom to 1000 m at the rim. Summers are hot and dry (July mean temperature = 24.0 C), and winters are cold (January mean temperature = −0.5 C). Most of the annual precipitation ($\bar{x}$ = 20 cm) falls in the winter (U.S. Department of the Interior 1979a).

METHODS

We collected regurgitated pellets and prey remains at nests and roosts associated with nests in 1973 and 1980–1992 during the nesting season (March–June). We used standard methods to identify and quantify prey and to calculate quantitative estimators of the diet (Marti 1987). The few vertebrate prey items that could not be identified to at least the generic level were excluded from analyses. All invertebrate prey were identified to at least the taxonomic order. Food-niche breadth was estimated with Levins' (1968) modification of Simpson's index: $FNB = 1/\Sigma p_i^2$, where p_i = the frequency of each prey type in a diet. This index was applied at two levels of prey resolution. FNB_{cl}, in which prey categories were taxonomic classes, provided an indication of prey-capture versatility (i.e., larger values at this level indicate the capture of diverse broad categories of prey; Greene and Jaksić 1983). FNB_{sp}, in which prey categories were species or genera for vertebrate prey and order for invertebrate prey, provided an estimate of diet breadth. We quantified prey size by calculating geometric mean prey mass (GMPM; Sokal and Rohlf 1995) using mean

prey mass in Steenhof (1983). We assessed similarity of diets between sites and years with a symmetrical overlap index (Pianka 1973): $O = \Sigma p_i \Sigma q_i / (\Sigma p_i^2 \Sigma q_i^2)^{1/2}$ where p_i = the frequency of a prey type in one diet sample and q_i = the frequency of the same prey type in a second sample.

We evaluated habitat composition within a 1.1-km radius around each Great Horned Owl nest. This radius is similar to that used by Rusch et al. (1972) and is based on the average home range size reported for 12 radio-tagged male owls from four studies in Minnesota, Wisconsin, and Colorado (Andersen and Rongstad 1984, 1989; Fuller 1979; Petersen 1979). The amounts of grassland, shrubland, agriculture, and palustrine wetland habitat within each radius were calculated from the Raptor Research and Technical Assistance Center's geographic information system using ARC/INFO software. Wetlands were digitized from 1:24,000-scale U.S. Fish and Wildlife Service wetlands maps (U.S. Department of the Interior 1979b). We used habitat information from the 1979 vegetation map of the NCA for nests with diet data from 1973–1985. This map was developed through manual interpretation of low-level aerial photographs and field verification of vegetative stands (U.S. Department of the Interior 1979a). Habitat information from the 1991 vegetation map of the NCA was used for nests with diet data from 1986–1992. This map was developed through supervised classification of satellite imagery (Knick et al., in press).

RESULTS

Twenty-six collections of pellets and prey remains from 14 nesting areas yielded 1472 prey individuals. Six taxonomic classes were represented in the prey, but mammals dominated the diet (Table 1). Overall, kangaroo rats (*Dipodomys* spp.) were the most common prey type, but four other mammalian genera dominated diets by number at individual collection sites (Table 2). Food-niche breadth for all diet samples combined was $FNB_{sp} = 7.32$ and $FNB_{cl} = 1.25$. At nests where sample size was ≥40 prey individuals, however, FNB_{sp} varied from 1.55–6.85 and FNB_{cl} varied from 1.00–1.56 (Table 2). Food-niche breadths varied widely from year to year even at the same collection sites (Table 2) indicating that time and location affected food-niche breadths.

Geometric mean prey mass for the entire sample was 44.5 g (SD = 17.26) and ranged from 20.5–82.6 g at individual sites (Table 2). Leporids contributed the greatest biomass to the Great Horned Owl diet (49.6%; Table 1) although they constituted only 7.7% of the diet by number.

Diet samples appeared to be more similar between years at the same nest than were diets at different nests within a year (Table 2). Dietary overlap between years at the same nest averaged 83% (SD = 0.12), which was significantly greater than the mean dietary overlap between nests in the same years ($\bar{x}$ = 56%, SD = 0.20; z-transformed $U = 3.01$, $P = 0.01$). Furthermore, diets in contiguous years were more alike ($\bar{x}$ = 92%, SD = 0.04) than diets from non-contiguous years at the same nest ($\bar{x}$ = 76%, SD = 0.16; z-transformed $U = 2.13$, $P = 0.03$).

TABLE 1. Diet of the Great Horned owl in the Snake River Birds of Prey National Conservation Area, Idaho, 1973, 1980–1992 (14 yr).

Prey	No. individuals	% individuals	% biomass
Arachnida	(92)	(6.2)	(tr.)
Scorpionida	88	6.0	tr.[a]
Solpugida	4	0.3	tr.
Insecta	(9)	(0.6)	(tr.)
Orthoptera	1	0.1	tr.
Coleoptera	8	0.5	tr.
Osteichthyes	(1)	(0.1)	(tr.)
unidentified fish	1	0.1	tr.
Reptilia	(4)	(0.3)	(0.3)
Hypsiglena torquata	1	0.1	tr.
unidentified snake	3	0.2	0.3
Mammalia	(1313)	(89.2)	(91.2)
Sorex vagrans	8	0.5	tr.
unidentified bat	1	0.1	tr.
Sylvilagus nuttallii	70	4.8	19.2
Lepus californicus	17	1.1	14.3
unidentified leporid	27	1.8	16.1
Spermophilus townsendii	6	0.4	0.6
Thomomys townsendii	133	9.0	14.6
Perognathus parvus	39	2.6	0.4
Dipodomys ordii	382	25.9	11.1
Reithrodontomys megalotis	30	2.0	0.2
Peromyscus spp.	221	15.0	2.3
Neotoma cinerea	30	2.0	4.6
Neotoma lepida	34	2.3	2.0
unidentified woodrat	3	0.2	0.3
Microtus montanus	246	16.7	4.7
Mus musculus	65	4.4	0.7
Mustela frenata	1	0.1	0.1
Aves	(53)	(3.6)	(8.2)
Falco sparverius	1	0.1	0.1
Phasianus colchicus	3	0.2	1.9
Callipepla californicus	1	0.1	0.1
unidentified galliform	1	0.1	0.4
Fulica americana	1	0.1	0.4
Columbia livia	5	0.3	0.9
Tyto alba	1	0.1	0.3
Sturnus vulgaris	4	0.3	0.2
Agelaius phoeniceus	2	0.2	tr.
unidentified passerine	19	1.3	0.6
unidentified bird	15	1.0	3.4
Totals	1472	100.0	100.0

[a] Less than 0.01%.

Diet composition at nests reflected the general habitat types within a 1.1-km radius of the site. Diets overlapped only 42% between a group consisting of the two sites (Ebb's and Kitten's) within intensive agriculture (>50% of the area around the nest in agriculture) and the group of seven sites within pure rangeland (>90% rangeland). The proportion of prey

TABLE 2. Dominant prey and trophic characteristics at individual collection sites for Great Horned Owls in the Snake River Birds of Prey National Conservation Area, Idaho.[a]

Collection site	Year	FNB_{sp}	FNB_{cl}	GMPM	Most common prey	
					Genus	% of diet
Rangeland Sites						
Fawn Draw	1973	3.04	1.21	82.6	*Dipodomys*	55
Powerline	1973	2.33	1.02	31.6	*Dipodomys*	48
Rosie	1973	5.71	1.56	39.1	*Peromyscus*	24
Beercase	1973	2.25	1.00	27.4	*Peromyscus*	61
Beercase	1981	4.72	1.74	20.5	*Dipodomys*	28
Hoot Owl Draw	1980	6.53	1.16	48.6	*Microtus*	30
Massacre Draw	1980	6.19	1.32	27.6	*Perognathus*	29
Sinker Creek Mouth	1981	6.85	1.20	54.4	*Dipodomys*	28
Agricultural Sites						
Ebb's	1980	4.92	1.13	33.2	*Microtus*	36
Ebb's	1981	6.18	1.15	69.2	*Microtus*	28
Ebb's	1985	3.43	1.26	62.8	*Microtus*	48
Kitten's	1987	1.55	1.03	30.9	*Microtus*	80
Castle Rock Cave	1987	4.36	1.14	66.4	*Thomomys*	41
Castle Rock Cave	1989	5.01	1.11	43.5	*Dipodomys*	33
Castle Rock Cave	1990	3.92	1.22	36.4	*Dipodomys*	44
Castle Rock Cave	1991	6.21	1.21	45.1	*Dipodomys*	30
Castle Rock Cave	1992	5.29	1.45	37.5	*Dipodomys*	32

[a] Where sample size ≥ 40 prey individuals.

species associated with upland or dryland habitats (i.e., *Dipodomys, Peromyscus, Perognathus, Neotoma, Perognathus, Sylvilagus,* and *Lepus*; Hall 1981) found at all collection sites was significantly correlated with the amount of range habitat surrounding the site ($r = 0.69$, $P = 0.03$, df = 9). Likewise, the proportion of prey species associated with mesic or agriculture habitats (i.e., *Microtus, Mus, Reithrodontomys,* and *Sorex*; Hall 1981) was significantly correlated with the amount of agriculture habitat around the site ($r = 0.67$, $P = 0.03$, df = 9). Furthermore, the most common prey at six of the seven sites within rangeland habitats (>90% shrub and grasslands) was either *Dipodomys* or *Peromyscus* or *Perognathus*. *Microtus* was the dominant prey at two of the three collection sites associated with agriculture (Table 2). The exception was Castle Rock Cave where *Thomomys* and *Dipodomys* dominated the diet (Table 2). Much of the farmland around this site was fallow, and the area under irrigation within a 1.1-km radius decreased from 40% in 1987 to <20% in 1992. Overall the proportion of upland or dryland prey ($\bar{x} = 63\%$; range 30–68%) found at this site from 1987–1992 was similar to the amount of fallow fields and range habitats around the nest (48–69%).

Although *Microtus* occurred in the diet (2.5–61.7%) at all sites, the three sites in which diets were dominated by *Microtus* (Table 2) were associated with irrigated agriculture or wetlands. Kitten's and Ebb's sites

contained >50% of irrigated cropland or pasture and palustrine emergent wetlands within a 1.1-km radius of the nest. Hoot Owl Draw, the exceptional range site where *Microtus* dominated the diet (Table 2), contained >3 ha of palustrine emergent wetlands around the nest–most within 500 m.

None of the trophic parameters differed significantly between agricultural land and rangeland (FNB_{sp}: agriculture $\bar{x}$ = 4.51, range $\bar{x}$ = 4.70, *z*-transformed $U = 0.34$, $P = 0.74$; FNB_{cl}: agriculture $\bar{x}$ = 1.19, range $\bar{x}$ = 1.28, *z*-transformed $U = 0.48$, $P = 0.63$; GMPM: agriculture $\bar{x}$ = 47.22, range $\bar{x}$ = 41.46, *z*-transformed $U = 0.91$, $P = 0.36$).

DISCUSSION

Early ornithological literature portrayed the Great Horned Owl as a ferocious and opportunistic predator. Bent (1938:306) claimed that "almost any living creature that walks, crawls, flies, or swims, except the larger mammals, is legitimate prey." Errington et al. (1940) believed that Great Horned Owls were the most opportunistic of all the predators they studied. Similarly, Craighead and Craighead (1956) asserted that the species takes a wider range of prey than any other North American raptor.

In spite of their reputation for dietary diversity and opportunistic foraging, North American Great Horned Owls prey primarily on mammals. The average proportion of mammals by number of individuals in 25 studies (references in Marti et al. 1993a) was 86.2% (range 58–100%). Great Horned Owls, though, exhibit diversity among their mammalian prey and seem to prey opportunistically on a variety of mammals; nine genera were the most common prey in studies noted above (Marti et al. 1993a; *Sylvilagus, Lepus, Thomomys, Perognathus, Dipodomys, Peromyscus, Neotoma, Microtus,* and *Rattus*).

Although Great Horned Owls can take a large range of prey in size and type, the diet of the population we studied was not the most diverse in an assemblage of 17 predators on the NCA (Marti et al. 1993b); three other predators ranked higher than the Great Horned Owl in FNB_{sp} including two raptors (Northern Harrier, *Circus cyaneus*; Red-tailed Hawk, *Buteo jamaicensis*). In FNB_{cl}, the Great Horned Owl was less diverse than 11 other predators including eight raptor species. Geographic and temporal dietary variation in Great Horned Owl diets paralleled that of Barn Owls (*Tyto alba*) in the NCA (Marti 1988); both species showed greater similarity in diet among years at the same nest than among nests in the same year. Great Horned Owl diets appeared to vary more in time and by habitat than did Barn Owl diets, suggesting that the Great Horned Owl can take a wider range of prey. Interpretation of our Great Horned Owl data must be cautious because we had few cases in which diet data were available for the same nest from more than 1 yr. Additionally, data from multiple years at the same nest often were not from contiguous years (Table 2).

The habitat variation we observed in Great Horned Owl diets may have been the result of predation by the owls on the array of prey in the habitat

surrounding a particular nest; types of prey taken were significantly correlated with the general habitat types in which the nest was located. This agrees with Rusch et al. (1972) who reported similar observations of Great Horned Owls in Alberta, and supports their interpretation about the generalistic nature of predation by these owls. We observed, though, that some owls appeared to respond opportunistically to the availability of certain prey. For example, the dominance of *Microtus* in the diet at Hoot Owl Draw suggests that the owls focused on a limited area of wetland habitat, possibly because it contained high prey densities and/or highly vulnerable prey.

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NORTH AMERICAN LOON FUND GRANTS

The North American Loon Fund (NALF) announces availability of 1997 Grants in support of management, research, and educational projects directly related to the conservation of the family Gaviidae.

Proposals in the range of $500 to $3000 are most likely to be considered for funding. High priorities include: 1) Identify and refine locations of important habitat areas for all loons during migration and winter, and juvenile loons during summer; 2) Obtain more information on the population dynamics of all species of loons, including the average age of initial breeding, annual survival rate, longevity, and dispersal and sources of mortality; 3) Design methods and establish population trends for regions with significant loon populations but where trends are currently unknown.

Deadline for submission of proposal is 15 December 1996. Funding awards will be announced by 30 March 1997. Please submit guideline request to North American Loon Fund, 6 Lily Pond Rd., Gilford, NH 03246.