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DIETS OF NESTING NORTHERN GOSHAWKS IN THE WARNER MOUNTAINS, CALIFORNIA

Rebecca L. Promessi¹, John O. Matson^{1,3}, and Mary Flores²

ABSTRACT.—Diets of Northern Goshawks (*Accipiter gentilis*) in western and eastern North America show regional differences. This variation may be explained by the opportunistic feeding behavior of Northern Goshawks and the greater number of potential prey species in western North America. We predicted that a population of Northern Goshawks in the Warner Mountains of California would take significantly more mammals than birds as prey. Goshawk diet in the Warner Mountains was determined by pellet analysis and prey remains. A total of 33 samples from 23 nest sites was collected and analyzed. Diets were quantified by determining the minimum number of individuals per sample at each nest site. As predicted, Warner Mountain Goshawks preyed more heavily on mammalian than avian prey species. Of the 221 individuals identified, 126 (57%) were mammals, while 95 (43%) were birds. These results are in accord with the suggestion that there are potentially more mammalian prey species in western North America than in eastern North America.

Key words: Northern Goshawks, *Accipiter gentilis*, food habits, Warner Mountains.

The Northern Goshawk (*Accipiter gentilis*), largest of the accipiter hawks, has a Holarctic distribution, inhabiting temperate and boreal forests (Reynolds et al. 1994, Squires and Reynolds 1997). The North American subspecies, *Accipiter gentilis atricapillus*, inhabits deciduous, coniferous, and mixed montane forests across the continent (Reynolds et al. 1994, Bosakowski 1999).

Northern Goshawks are opportunistic feeders, eating a wide variety of prey depending on geographic location, season, and forest type (Boal and Mannan 1994, Squires and Reynolds 1997, Bosakowski 1999). Their diet consists primarily of birds and mammals, but they may consume reptiles and insects on occasion (Squires and Reynolds 1997).

The diet of Northern Goshawks appears to vary regionally. In the New Jersey–New York highlands, Northern Goshawks prey more heavily on avian than mammalian species (Bosakowski et al. 1992). A similar pattern was noted by Meng (1959) for New York and Pennsylvania and Grzybowski and Eaton (1976) for New York. Boal and Mannan (1994) found ground squirrels to be the most abundant prey item of Northern Goshawks nesting on the Kaibab Plateau of northern Arizona. Reynolds et al. (1994) reported similar findings for the same

region. Snowshoe hares and arctic ground squirrels comprised the majority of the diet of Northern Goshawks nesting in the Yukon Territory (Doyle and Smith 1994). Studies by Younk and Bechard (1994) in Nevada and McCoy (1999) in the Cascade Mountains of northern California follow the same trend of mammalian prey exceeding the number of avian prey.

Four studies on Northern Goshawks in the West had more birds than mammals in the diet (Schnell 1958, Reynolds and Meslow 1984, Bull and Hohmann 1994, Watson et al. 1998). While the data in the last 3 studies did not show statistically significant differences, Schnell's (1958) study reported significant differences in favor of birds. Despite these 4 studies and because of the large number of studies indicating a difference in food habits between eastern and western populations of Northern Goshawks, Bosakowski (1999) suggested that mammalian prey items become a larger component of the Goshawk diet in western North America than in eastern North America. Bosakowski (1999) based this hypothesis on the assumption that more lagomorph and ground squirrel species are available in western North America than in eastern North America. While this may be the case for ground squirrels, including chipmunk

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species, it is hardly the case for lagomorphs (Hall 1981).

Although the diets of Northern Goshawks nesting in areas adjacent to the Warner Mountains have been examined (Schnell 1958, Reynolds and Meslow 1984, McCoy 1999), the Warner Mountain population has not yet been thoroughly investigated. Two studies did include some information about the diets of Northern Goshawks in the Warner Mountains (Reynolds and Meslow 1984, Bloom et al. 1986). However, in both studies the diets were determined from a variety of localities and it was unclear how much of their data came from the Warner Mountains. The purpose of this study was to determine the diets of Northern Goshawks nesting in the Warner Mountains.

STUDY AREA

This study was conducted in the California portion of the Warner Mountains in the extreme northeastern corner of California. The Warner Mountains are a faulted range of volcanic origin (Schoenherr 1992, Hickman and Roberts 1993) with the highest point of the range, Eagle Peak, extending above 3000 m (Hickman and Roberts 1993). The area is 1 of 4 ranger districts of the Modoc National Forest managed by the United States Forest Service (USFS). Although the northern end of the range extends into southeastern Oregon, this study did not include that portion.

During summer 2001 we located nests by surveying areas containing suitable Northern Goshawk habitat. Much of the Warner Mountains is composed of mixed conifer forests, with ponderosa pine (*Pinus ponderosa*) and white fir (*Abies concolor*) occurring frequently at mid-elevations (Schoenherr 1992). Northern Goshawks are known to nest in these forests throughout the range (Bloom et al. 1986).

Surveys focused on regions in which members of the USFS had located nests in the past. In summer 2001 we located 12 nest sites. Seven of these were determined to be active nesting sites for the 2001 season and were referred to as Del Pratt, Rock Lake, East Creek, Shields Creek, Fitzhugh Creek, Smalls Canyon, and Hacker Flat nests.

METHODS

Prior to consumption, Northern Goshawks regularly remove the hair and feathers from

their prey. In addition, Northern Goshawks regurgitate pellets containing bones and keratinous parts that are not easily digestible (Reynolds and Meslow 1984). These behaviors take place either at the nest site itself or at perches commonly referred to as "plucking posts" (Reynolds and Meslow 1984, Bosakowski 1999). In addition to pellets, plucked prey remains (bones, hair, and feathers) are commonly found at the nest trees and plucking posts. It is possible to identify the various species eaten by examining pellets and prey remains (Reynolds and Meslow 1984). While there may be biases associated with the determination of diet from pellet contents and prey remains (Reynolds and Meslow 1984, Marti 1987), studies have shown the method to sufficiently represent food habits of raptors (Real 1966, Callopy 1983).

We collected pellets and prey remains from all nest sites and plucking posts, placing them in plastic bags that we labeled and stored for subsequent analysis. Each collection from a given nest site was considered to be a single sample, and each of these samples consisted of several pellets and prey remains. In addition to samples collected in 2001, samples previously collected (1996–1999) by members of the USFS were examined and included in the data for this study.

Individual pellets were dissected by hand as described by Marti (1987). Pellet contents and prey remains were then identified to species or genus or were noted as unidentified bird or mammal. Reference specimens from the Museum of Birds and Mammals at San Jose State University were used along with relevant taxonomic keys to identify prey species.

Each sample was analyzed separately. Bones, teeth, hair, and feathers were separated and matched (feathers, beaks, and bones of birds, and bones, teeth, and hair tufts of mammals) so that the minimum number of individuals per sample could be determined (Reynolds and Meslow 1984). We counted remains of the same species as more than 1 individual only if we noted the presence of more than 1 of the same identifying item(s).

Species composition and minimum number of individuals of mammalian and avian prey in each sample were determined. A chi-square goodness-of-fit was used to determine if there was a significant difference in the number of mammals versus birds identified in combined samples.

TABLE 1. Northern Goshawk prey, minimum number of individuals from 23 nests in the Warner Mountains, California.

Mammals	Number	Birds	Number
<i>Tamiasciurus douglasi</i>	22	<i>Colaptes auratus</i>	15
<i>Spermophilus lateralis</i>	22	<i>Cyanositta stelleri</i>	13
<i>Spermophilus beldingi</i>	16	<i>Turdus migratorius</i>	8
<i>Spermophilus beecheyi</i>	2	<i>Dendragapus obscurus</i>	5
<i>Spermophilus</i> sp.	13	<i>Sphyrapicus thyroideus</i>	3
<i>Tamias</i> sp.	16	<i>Oreortyx pictus</i>	3
<i>Sylvilagus</i> sp.	6	<i>Piranga ludoviciana</i>	2
<i>Lepus</i> sp.	4	<i>Carduelis pinus</i>	2
Unknown lagomorph	1	<i>Agelaius phoeniceus</i>	2
<i>Mustela frenata</i>	1	<i>Dendroica coronata</i>	1
<i>Glaucomys sabrinus</i>	1	<i>Aegolius acadicus</i>	1
<i>Peromyscus maniculatus</i>	1	<i>Bombycilla</i> sp.	1
<i>Sorex</i> sp.	2	<i>Picoides pubescens</i>	1
<i>Microtus</i> sp.	1	<i>Phasianus colchicus</i>	1
<i>Neotoma cinerea</i>	1	<i>Sitta</i> sp.	1
Unidentified mammal	19	<i>Spizella</i> sp.	1
		<i>Perisoreus canadensis</i>	1
		Unidentified bird	27
TOTAL MAMMALS	126 (57.01%)	TOTAL BIRDS	95 (42.99%)

TABLE 2. Mammals and birds comprising $\geq 5\%$ of prey taken by Northern Goshawks in the Warner Mountains. Percent based on the minimum number of individuals identified.

Species	Percent of category (mammal or bird)	Percent of all individuals identified
MAMMALS		
Ground squirrels ^a	42.06	23.98
Douglas squirrel	17.46	9.95
Chipmunks	12.69	7.24
Lagomorphs	8.73	5.00
BIRDS		
Northern Flicker	15.79	6.79
Steller's Jay	13.68	5.88

^aSee Table 1 for list of species.

RESULTS

During summer 2001 we collected 22 samples from 12 Northern Goshawk active nest sites in the Warner Mountains, 7 of which were determined to be active sites in 2001. In addition to the 22 samples collected in 2001, 11 samples, 1 each from 11 different nest sites collected in previous years, were examined and included in the data for this study. Thus, we analyzed a total of 33 samples from 23 nests.

During the study Northern Goshawks in the Warner Mountains of California consumed at least 13 mammalian species and 17 avian species (Table 1). In counting the minimum number of prey items, we identified 221 individuals. Of these, 126 (57%) were mammals and 95 (43%) were birds. The difference between

mammals and birds in the samples was significant ($\chi^2 = 4.348$, $df = 1$, $P \leq 0.05$).

Ground squirrels (*Spermophilus* sp.) were most commonly found, accounting for 42% of the mammals identified and 24% of all individuals identified (Table 2). Other frequently occurring prey items ($\geq 5.0\%$ of prey individuals identified) included Douglas squirrel (*Tamiasciurus douglasi*), chipmunks (*Tamias* sp.), Northern Flicker (*Colaptes auratus*), Steller's Jay (*Cyanositta stelleri*), and lagomorphs (*Sylvilagus* sp. or *Lepus* sp.).

DISCUSSION

Northern Goshawks nesting in the Warner Mountains prey more heavily on mammals than birds. Data from this study support the

concept that Northern Goshawks nesting in western North America take more mammals as prey than those nesting in the eastern portion of the continent. Our findings are consistent with other studies that have been conducted throughout the western region of the United States (Boal and Mannan 1994, Reynolds et al. 1994, Younk and Bechard 1994, McCoy 1999) and Canada (Doyle and Smith 1994; Table 3). Of the 11 studies conducted in the western portion of the continent, 6 reported significantly more mammals than birds in the diets (Boal and Mannan 1994, Doyle and Smith 1994, Reynolds et al. 1994, Younk and Bechard 1994, McCoy 1999, present study). Schnell (1958), based on a single nest, found significantly more birds than mammals in their diet. Schnell's findings suggest that Northern Goshawks in the Sierra Nevada of California take a larger number of birds than mammals, despite foraging in a western forest where the availability of mammalian prey items is purportedly greater than in eastern forests. It is possible that the food habits of this single nesting pair differed from other pairs and did not reflect the habits of the population as a whole. The 3 studies conducted in eastern Oregon and Washington (Reynolds and Meslow 1984, Bull and Hohmann 1994, Watson et al. 1998), while not showing statistically significant results, do not fit the pattern for the rest of western North America. The reasons for the deviation are unclear but the percentage of mammals in the diet exceeded that in the eastern studies (Table 3).

Northern Goshawks take a significantly higher proportion of birds than mammals (Table 3) in New York, New Jersey, and Pennsylvania (Meng 1959, Bosakowski et al. 1992). Of 231 total prey items captured by nesting Northern Goshawks in the region, 70% were identified as birds, while 30% were mammals (Bosakowski et al. 1992). Meng (1959) reported a similar trend after identifying a total of 185 prey items taken by nesting Northern Goshawks in Pennsylvania and New York. Of these 185 prey items, 61% were birds, while 39% were mammals. Similarly, Grzybowski and Eaton (1976) reported the same percentages of birds and mammals as Meng (1959) after examining 77 prey items taken by Northern Goshawks in southwestern New York.

Northern Goshawk food habit variations between eastern and western populations are

TABLE 3. Frequency of birds and mammals in the diets of Northern Goshawks in different regions of North America.

Location	Source	Number (%) mammalian prey	Number (%) avian prey	Techniques ^a	P-value ^b	Direction ^c
New Jersey—New York	Bosakowski et al. 1992	70 (30.30)	161 (70.00)	Pellets and remains	= 0.05	B
Southwest New York	Grzybowski and Eaton 1976	30 (38.96)	47 (61.04)	Remains	> 0.05	B
New York—Pennsylvania	Meng 1959	72 (38.92)	113 (61.08)	Pellets and remains	= 0.05	B
Canada: Yukon Territory	Doyle and Smith 1994	312 (76.10)	98 (23.90)	Observation and remains	= 0.05	M
Northern California	McCoy 1999	169 (72.53)	64 (27.47)	Observation	= 0.05	M
California	Bloom et al. 1986	122 (52.14)	112 (47.86)	Remains	> 0.05	M
California	Schnell 1958	27 (30.68)	61 (69.32)	Observation	= 0.05	B
Arizona	Boal and Mannan 1994	281 (76.00)	89 (24.00)	Observation	= 0.05	M
Arizona	Reynolds et al. 1994	75 (61.98)	46 (38.02)	Pellets and remains	= 0.05	M
Nevada	Younk and Bechard 1994	34 (67.00)	17 (33.00)	Observation	= 0.05	M
Oregon	Reynolds and Meslow 1984	103 (45.37)	125 (55.07)	Pellets and remains	> 0.05	B
Oregon	Bull and Hohmann 1994	39 (41.49)	55 (58.51)	Pellets and remains	> 0.05	B
Washington	Watson et al. 1998	465 (49.68)	471 (50.32)	Pellets and remains	> 0.05	B
California	Present study	126 (57.01)	95 (42.99)	Pellets and remains	= 0.05	M

^aDiet determined from analysis of regurgitated pellets; prey remains found, or by direct observation of prey items delivered to the nest site.

^bP-value determined by the present study using a chi-square goodness-of-fit analysis, df = 1.

^cDirection refers to whether the study reports more mammals or birds; M = mammals, B = birds.

likely due to differences in the prey base (Bosakowski 1999). While the number of species of small mammals, especially ground squirrels (*Tamias* sp. and *Spermophilus* sp.), available as prey items is greater in western boreal forests (Hall 1981), without information about population structure, the availability of these species as potential prey items remains unknown.

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LITERATURE CITED

- BLOOM, P.H., G.R. STEWART, AND B.J. WALTON. 1986. The status of the Northern Goshawk in California, 1981–1983. Administrative Report 85-1. State of California, Department of Fish and Game, Sacramento.
- BOAL, C.W., AND R.W. MANNAN. 1994. Northern Goshawk diets in ponderosa pine forests on the Kaibab Plateau. *Studies in Avian Biology* 16:97–102.
- BOSAKOWSKI, T. 1999. The Northern Goshawk: ecology, behavior, and management in North America. Hancock Wildlife Raptor Series. Hancock House Publishers, Blaine, WA. 80 pages.
- BOSAKOWSKI, T., D.G. SMITH, AND R. SPEISER. 1992. Niche overlap of two sympatric nesting hawks *Accipiter* spp. in the New Jersey–New York highlands. *Ecography* 15:358–372.
- BULL, E.L., AND J.H. HOHMANN. 1994. Breeding biology of Northern Goshawks in northeastern Oregon. *Studies in Avian Biology* 16:103–105.
- CALLOPY, M.W. 1983. A comparison of direct observations and collections of prey remains in determining the diet of Golden Eagles. *Journal of Wildlife Management*. 47:360–368.
- DOYLE, F.I., AND J.M.N. SMITH. 1994. Population responses of Northern Goshawks to the 10-year cycle in numbers of snowshoe hares. *Studies in Avian Biology* 16:122–129.
- GRZYBOWSKI, J.A., AND S.W. EATON. 1976. Prey items of Goshawks in southwestern New York. *Wilson Bulletin* 88:669–670.
- HALL, E.R. 1981. The mammals of North America. 2nd edition. John Wiley & Sons, New York.
- HICKMAN, J.C., AND W. ROBERTS. 1993. Geographic subdivisions of California. Pages 37–44 in J.C. Hickman, editor, *The Jepson manual: higher plants of California*. University of California Press, Berkeley.
- MARTI, C.D. 1987. Raptor food habits studies. Pages 67–80 in B.A.G. Pendleton, B.A. Millsap, K.W. Cline, and D.M. Bird, editors, *Raptor management techniques manual*. National Wildlife Federation, Washington, DC.
- MCCOY, R.H. 1999. Effects of prey delivery on the fledging success of the Northern Goshawk. Unpublished master's thesis, Humboldt State University, Arcata, CA.
- MENG, H. 1959. Food habits of nesting Cooper's Hawks and Goshawks in New York and Pennsylvania. *Wilson Bulletin* 71:169–174.
- REAL, J. 1996. Biases in the diet study methods in the Bonelli's Eagle. *Journal of Wildlife Management* 60:632–638.
- REYNOLDS, R.T., AND E.C. MESLOW. 1984. Partitioning of food and niche characteristics of coexisting *Accipiter* during breeding. *Auk* 101:761–779.
- REYNOLDS, R.T., S.M. JOY, AND D.G. LESLIE. 1994. Nest productivity, fidelity, and spacing of Northern Goshawks in Arizona. *Studies in Avian Biology* 16:106–113.
- SCHOENHERR, A.A. 1992. A natural history of California. University of California Press, Berkeley.
- SCNHELL, J.H. 1958. Nesting behavior and food habits of Goshawks in the Sierra Nevada of California. *Condor* 60:377–403.
- SQUIRES, J.R., AND R.T. REYNOLDS. 1997. Northern Goshawk (*Accipiter gentilis*). Pages 1–31 in A. Poole and F. Gill, editors, *The birds of North America*, No. 298. Academy of Natural Sciences, Philadelphia, PA, and American Ornithologists' Union, Washington, DC.
- WATSON, J.W., D.W. HAYS, AND S.P. FINN. 1998. Prey of breeding Northern Goshawks in Washington. *Journal of Raptor Research* 32:297–305.
- YOUNK, J.V., AND M.J. BECHARD. 1994. Breeding ecology of the Northern Goshawk in the high-elevation aspen forests on northern Nevada. *Studies in Avian Biology* 16:119–121.

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