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Seasonal and Sexual Differences in American Marten Diet in Northeastern Oregon

Abstract

Information on the diet of the American marten (*Martes americana*) is vital to understanding habitat requirements of populations of this species. The frequency of occurrence of prey items found in 1014 scat samples associated with 31 radiocollared American martens in northeastern Oregon included: 62.7% vole-sized prey, 28.2% squirrel-sized prey, 22.4% insects, 19.5% birds, 13.3% plant material, and 2.4% lagomorphs. A significantly higher proportion of voles (*Microtus* spp.), southern red-backed voles (*Clethrionomys gapperi*), and chipmunks (*Tamias* spp.) were found in the summer diet compared with the winter, and a higher proportion of northern flying squirrels (*Glaucomys sabrinus*), unidentified squirrels, bushy-tailed woodrats (*Neotoma cinerea*), and mountain cottontails (*Sylvilagus nuttallii*) were found in the winter diet compared with summer. Insects and plant remains represented a higher proportion of the diet in summer than winter. Females preyed on a higher proportion of shrews (*Sorex* spp.) and chipmunks, while males preyed on a higher proportion of southern red-backed voles.

Introduction

The American marten *(Martes americana)* is considered to be a habitat specialist in the western U.S. (Buskirk and Powell 1994, Raphael and Jones 1997), but studies of its food habits indicate that martens are generalist predators, feeding on a variety of small mammals, birds, insects, fish, carrion, and vegetation (Martin 1994). In theory, a generalist predator will switch to alternative prey species when preferred prey are not readily available and will select food items that result in energy returns equal to or higher than the energy expended capturing and consuming that food (Ben-David et al. 1997).

Martin (1994) reviewed 22 studies reporting marten diet. Voles were reported as important food items across the range of the marten and were dominant in half the diets; only 2 of the studies reviewed did not find voles to represent at least 10% of the diet. Seasonally abundant foods (e.g., insects and fruit) were eaten when available in Idaho (Koehler and Hornocker 1977). In Alaska, voles and fruit were important food items during the autumn but declined in importance over the winter (Buskirk and MacDonald 1984). In California, vole representation in the diet decreased in late winter and spring diet, while ground squirrel and chipmunk representation in the diet increased in the summer (Zielinski et al. 1983). In southeast Alaska, use of salmon and voles changed seasonally (Ben-David et al. 1997).

Intersexual differences in marten diet have been reported in relatively few studies. On Vancouver Island in British Columbia, female martens consumed more small mammal and small bird prey than did males, but there was extensive dietary overlap between the sexes (Nagorsen et al. 1989). In contrast, Thompson and Colgan (1990) found no sexual differences in diet in Ontario.

Marten food habits differ substantially in different geographic areas (Martin 1994). Consequently, research findings in one area may not be applicable in other habitats or localities. The National Forest Management Act of 1976 (USDA 1978) mandated that viable populations of all native species be maintained on federal lands. On National Forests, managers are required to provide adequate habitat to sustain viable populations of martens. Knowledge of marten diet is critical for effectively managing habitat for martens and their prey. My objectives in this study were to determine the seasonal and sexual differences in diets of martens in northeastern Oregon.

Methods

The study area encompassed about 400 km^2 in the Blue Mountains in northeastern Oregon. The landscape was a mosaic of uneven-aged stands in four forest types (Johnson and Hall 1990): lodgepole pine *(Pinus contorta)*, subalpine fir *(Abies lasiocarpa)*, grand fir *(Abies grandis)*, and Douglas-fir *(Pseudotsuga menziesii)*. Approximately

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% of the study area had been managed with partial overstory removals, regeneration cuts, and selection harvests. Topography consisted of moderately steep mountains dissected by drainages with permanent water in the form of springs and streams. The elevation ranged from 1320 to 1980 m.

Daytime maxima in summer normally exceeded 24°C, and winter low temperatures were typically below freezing with extremes of -15°C being common. Annual precipitation averaged 78 cm with about 60% falling as snow. At the highest elevations, snow was present from late October through April each year with maximum depths of 1.5 m. At the lowest elevation, snow was present from December until March, with maximum depths of 0.5 m.

I determined diet from direct observation of martens with prey, from prey remains, and from scats collected at rest sites and dens from January 1994 until October 1997. Thirty-one radiocollared martens (12 females and 19 males) were located on the ground visually, an average of once per week in the winter and twice per week in the summer. The marten or the specific structure (e.g., tree, log, underground site) that the marten was using was located. When a marten was located, I attempted to see the animal and record any foraging information. The immediate vicinity (within 30-m radius) was searched for scats and prey remains. Many of the marten locations in the winter were at subnivean rest sites, which were revisited immediately after the snow melted to search for scats and prey remains. Prey remains and scats were put in plastic bags and labeled with the date, number of scats, age of scat (fresh or old), and identifying number of the marten. Fresh scats were determined to have been deposited within a week based on a dark color and moist condition; old scats had been deposited longer than a week. Individual scats could not be separated at some dens and rest sites with latrines. Rest sites used by more than one marten were labeled with both marten numbers because I could not be certain which had deposited the scat; scats collected at these sites were excluded in the comparisons between sexes. When old scats were collected, they were classified as “winter,” “summer,” or “unknown” based on their appearance and when they were collected. Summer scats were those that I determined had been deposited between 18 April and 14 October; winter scats were deposited between 15 October and 17 April of each year. These dates were selected because temperatures were below freezing and snow started falling by mid-October; by mid-April, snow was melting and temperatures were typically above freezing. Scats and prey remains were frozen until they were analyzed.

Individual scats were placed in a nylon bag with a waterproof label, soaked for 10-12 hours in a mild bleach and detergent solution, and dried. Each scat sample was separated into three components: guard hairs; bones and teeth; and non-diagnostic material (mainly gray underfur). Feathers, insects, plant remains, and other materials were removed and identified if possible. Feathers usually did not survive the digestive process well enough to be identified to species, so feathers in a scat were recorded as bird remains. Fruits were identified to species by using a reference collection of berries collected in the study area. Insects were identified to the lowest taxon possible; very small fragments of insects found in scats with bird remains were considered secondary prey from the bird and not counted.

Identification of small prey (e.g., voles) was based on skull fragments, lower jaws, and teeth. After the bones were identified, guard hairs were identified using a compound microscope. Detecting the presence of larger prey often depended solely on identification of guard hairs because of the frequent lack of diagnostic bones or teeth. It is likely this method over estimated the larger prey items because remains from the same individual prey could be contained in more than one scat. This overestimation of larger prey items plus the unknown bird species consumed made a calculation of biomass inappropriate. Sources used for identification included Stains (1958), Hoffman and Pattie (1968), Glass (1973), Brunner and Coman (1974), Moore et al. (1974), Zielinski (1986), Thompson et al. (1987), and Jones and Manning (1992).

Frequency of occurrence for all prey items was determined. For each prey species that occurred in >10 scat samples, a chi-square analysis (Snedecor and Cochran 1980) was used to compare the frequency of occurrence between sexes and between summer and winter. A significance level of 0.05 was used for these tests.

Results

Prey items representing 17 mammal species, birds, fish, 6 species of fruits, and insects were identified in 1014 scat samples (Table 1). By frequency of occurrence, the majority (63%) of the scat samples contained vole-sized prey (primarily *Microtus* spp. and southern red-backed voles), and 28% squirrel-sized prey. Seven mammal species were not equally represented in the scats in the summer and winter. A significantly higher proportion of *Microtus* (X^2 = 167.20, 1 df, P < 0.001), southern red-backed voles (X^2 = 12.65, 1 df, P < 0.001), and chipmunks (X^2 = 24.09, 1 df, P < 0.001) were found in the summer, whereas, a higher proportion of northern flying squirrels (X^2 = 7.754, 1 df, P = 0.005), unidentified squirrels (X^2 = 21.536, 1 df, P < 0.001), bushy-tailed woodrats (X^2 = 4.776,

TABLE 1. Frequency of occurrence (%) of prey items found in 1014 scat samples from 31 radiocollared American martens during summer (18 April-14 October) and winter (15 October-17 April) in northeastern Oregon, 1993-1997.

Prey item	Summer	Winter	All year
Mammals			
Vole *(Microtus* spp.*)*	50.2	9.6	27.4
Southern red-backed vole *(Clethrionomys gapperi)*	30.3	19.4	24.6
Unknown vole	12.4	11.0	12.7
Deer mouse *(Peromyscus maniculatus)*	10.4	8.4	7.8
Unknown shrew *(Sorex* spp.*)*	4.9	6.4	4.7
Unknown chipmunk *(Tamias* spp.*)*	6.5	0.6	2.7
Northern pocket gopher *(Thomomys talpoides)*	3.9	2.0	2.6
Coast mole *(Scapanus orarius)*	-	0.4	0.2
Bat *(Myotis* spp.*)*	-	0.2	0.1
Total vole-sized prey	83.1	46.1	62.7
Unknown squirrel	11.1	24.4	17.3
Northern flying squirrel *(Glaucomys sabrinus)*	2.6	7.2	4.3
Red squirrel *(Tamiasciurus hudsonicus)*	2. 9	3.0	3.3
Bushy-tailed woodrat *(Neotoma cinerea)*	1.3	4.0	2.5
Unknown ground squirrel *(Spermophilus* spp.*)*	-	0.2	0.1
Weasel *(Mustela* spp.*)*	0.7	1.0	0.8
Total squirrel-sized prey	18.6	39.7	28.2
Snowshoe hare *(Lepus americanus)*	2.2	1.2	1.4
Mountain cottontail *(Sylvilagus nuttallii)*	-	1.8	0.9
Unknown lagomorph	-	-	0.1
Total hares and rabbits	2.2	3.0	2.4
Unknown cervid	-	2.6	2.0
Common porcupine *(Erethizon dorsatum)*	0.3	-	0.2
Birds	15.3	19.8	19.5
Egg shell	0.7	-	0.2
Fish	-	0.4	0.2
Insects (total)	31.3	15.6	22.4
Wasps	24.9	7.6	15.6
Ants	4.2	3.8	3.9
Other insects	11.1	6.0	7.8
Plants (total)	27.5	5.2	13.3
Big huckleberry *(Vaccinium membranaceum)*	5.4	0.2	2.6
Grouse huckleberry *(V. scoparium)*	3.9	-	1.4
Currant *(Ribes* spp.*)*	8.4	0.1	3.9
Strawberry *(Fragaria* spp.*)*	3.0	0.2	1.1
Rose *(Rosa* spp.*)*	0.3	0.6	0.5
Raspberry *(Rubus idaeus)*	0.9	-	0.3
Wood fibers, lichen, grass	7.8	4.0	4.8
Number of scat samples	307	501	1014

1 df, P = 0.029), and mountain cottontails (X^2 = 5.577, 1 df, P = 0.018) were found in the winter (Table 1).

Seventy-four percent of the scat samples could be attributed to either male or female martens. Significant differences occurred between males and females in the occurrence of shrews (X^2 = 7.48, 1 df, P = 0.006), chipmunks (X^2 = 4.57, 1 df, P = 0.033), and southern red-backed voles (X^2 =10.185,1 df, P < 0.001) in scats. Females preyed on a higher proportion of shrews and chipmunks than males, whereas males took a higher proportion of southern red-backed voles. Birds comprised 19.5% of the prey items in the scats, though species could not be determined from scat remains (Table 1). Eggs shells were found in some scats suggesting that nests were raided. No significant differences were detected in the occurrence of birds in scats by sex or by season.

Remains of insects were found in 22% of the scats; the majority were bald-faced hornets or yellowjackets (referred to as wasps collectively). Significant differences were found in the occurrence of insects between summer and winter (XI = 27.77, P < 0.001). Though most of the wasp remains were in scats in the summer, some were found in October, November, and February; martens were observed excavating yellowjacket nests in October and November.

Overall, 13% of marten scats contained plant material. Fruit from big huckleberry, grouse huckleberry, and currant comprised most of the plant material in scats, although grass, lichen, and wood fibers occurred year round in small amounts. Significant differences in frequency of fruits occurred between seasons (X^2 = 67.99, P < 0.001). As one would expect, the majority of plant material in the form of fruit was available in the summer.

Prey remains of 8 mammalian and 13 avian species were found at dens and rest sites (Table 2) and were biased toward larger prey items and birds, because they were not entirely consumed.

TABLE 2. Species and number of prey remains found at American marten rest sites and dens during summer (18 April-14 October) and winter (15 October-17 April) in northeastern Oregon, 1993-1997. Items are listed in order of importance within each broad taxonomic group.

Prey species	Summer	Winter
Mammals		
Red squirrel (*Tamiasciurus hudsonicus*)	3	12
Snowshoe hare (*Lepus americanus*)	1	3
Northern flying squirrel (*Glaucomys sabrinus*)	2	2
Unknown chipmunk (*Tamias* spp.)	4	
Mountain cottontail (*Sylvilagus nuttallii*)	2	1
Unknown lagomorph	2	
Unknown vole	1	1
Columbian ground squirrel (*Spermophilus columbianus*)	1	
Birds		
Ruffed grouse (*Bonasa umbellus*)	3	5
Common raven (*Corvus corax*)		7
Unknown woodpecker (*Picoides* spp.)	2	1
Pileated woodpecker (*Dryocopus pileatus*)	2	1
American robin (*Turdus migratorius*)	3	
Northern flicker (*Colaptes auratus*)	2	
Swainson's thrush (*Catharus ustulatus*)	1	
Unknown warbler or golden-crowned kinglet (*Regulus satrapa*)	1	
Unknown sparrow	1	
Flammulated owl (*Otus flammeolus*)	1	1
Unknown thrush		1
Brown creeper (*Certhia americana*)		1
Dark-eyed junco (*Junco hyemalis*)		2
Insects		
Yellowjacket (*Vespula* spp.)	2	1
Yellowjacket or bald-faced hornet (*Dolichovespula* spp.)	2	

Identification of the bird species is the primary value of the prey remains. The most abundant bird species were grouse and common ravens, while 5 of the 13 species were cavity nesters. Prey remains of ravens were found only in the winter and only at rest sites of males. Evidence at rest sites based on tracks, feathers, and whitewash suggested that martens killed the ravens at their roost trees. Cavity-nesting birds were likely captured in nest or roost cavities.

Discussion

The diversity of prey taken by martens in this study suggests that this species is functioning as a generalist predator. The shift from taking mostly vole-sized prey in the summer, to taking larger prey (squirrels, woodrats, and lagomorphs) in the winter, may be influenced by the availability and vulnerability of prey, as well as energy constraints. Some mammals hibernate, and others remain under the snow, where they are inaccessible to martens except in subnivean spaces. Red squirrels and snowshoe hares are often on the snow surface, whereas voles rarely are. Taking larger prey items in the winter may be more energy efficient, depending on the search and capture effort involved. Zielinski (In press) suggested that martens increased their foraging efficiency by hunting and eating larger prey in the winter than in the summer. A reduction in their activity in the winter, presumably a result of taking larger prey less frequently, could also be an adaptation to cold stress. Lachowski (1997) also reported that snowshoe hares and red squirrels were more frequently consumed in winter (35%) than in summer (17%) in Maine.

The findings of this study showed similar trends to those reported elsewhere in the interior Northwest. Newby (1951) found that 45% of the food items in marten scats were mammals, 43% were insects, 7% were plant remains, and 4% were birds in Washington; use of insects and plants was higher in summer, whereas use of mammals and birds was higher in winter. In Montana, mammals were found in 93% of the scats, fruits in 29%, insects in 19%, and birds in 12% (Weckwerth and Hawley 1962). Representation in the diet varied by season with the highest use of birds and insects in spring and summer, highest use of fruit during summer and fall, and highest use of mammals in winter (Weckwerth and Hawley 1962). In Idaho, 99% of the scats contained mammals, 12% fruits, 9% insects, and 5% birds (Koehler and Hornocker 1977); use of insects, birds, and plants was highest in summer, whereas use of mammals was highest in winter. Compared with the above studies, the present study typically reported similar use of mammals, higher use of birds, and higher use of insects. Use of plants in the present study was similar to use reported by Koehler and Hornocker (1977), higher than Newby (1951), and lower than Weckwerth and Hawley (1962). Quantification of prey abundance would be required to determine if differences in use of prey among these studies was a function of selection or availability.

Of the literature reviewed by Martin (1994), the present study reported the highest use of insects except for Newby (1951). Yellowjackets are consumed primarily in the western United States where these insects are abundant in forests. Bald-faced hornets typically have aerial nests, and yellowjackets have both aerial nests and nests in woody debris on or in the ground (Borror and Delong 1971). In this study, both types of nests were readily accessible to martens by midsummer, but only yellowjacket ground nests were available in winter under snow because aerial nests were destroyed by inclement weather in the fall.

This study identified the importance of vole-sized and squirrel-sized mammalian prey, insects, plants, and birds to the American marten in northeastern Oregon. The diversity of prey and the seasonal differences in representation of the food items portrays the opportunistic nature of this species. Consideration of these prey species and their habitat requirements is essential in effectively managing habitat for martens.

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