

Seasonal Diets of Newfoundland Martens, *Martes americana atrata*

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We analyzed scats (n = 679) and stomach contents (n = 25) collected from 1980-2003 to assess the relative frequencies of food types utilized by Newfoundland Marten (*Martes americana atrata*) during summer and winter. Meadow Voles (*Microtus pennsylvanicus*) were the most prevalent food item occurring in 80% and 47.5% of samples from summer and winter, respectively. Apart from Snowshoe Hares (*Lepus americana*), which occurred in 28% of winter samples, all other food types occurred in <16% of samples during each season. Diet breadth was widest during winter and may be related to a lower availability of Meadow Voles during this time of year.

Key Words: Newfoundland Marten, *Martes americana atrata*, diet, food habits, Meadow Voles, *Microtus pennsylvanicus*, scat.

The Newfoundland Marten (*Martes americana atrata*) is one of only 14 native terrestrial mammals on the island of Newfoundland (Dodds 1983) and is currently listed by the Committee on the Status of Endangered Wildlife in Canada as Endangered. Though this species has been the focus of considerable research, basic information on seasonal diet patterns of Newfoundland Marten is lacking.

The potential prey base for Newfoundland Marten, a genetically distinct subspecies (Kyle and Strobeck 2003) of the American Marten (*Martes americana*), is limited. Newfoundland has a reduced diversity of small mammal prey species (8 species) compared with neighboring mainland areas such as Labrador (17 species) and Nova Scotia (23 species; Tucker 1988). Further, only one arvicoline rodent, the Meadow Vole (*Microtus pennsylvanicus*), fully overlaps with, and occurs in forested habitats used by Marten (Thompson and Curran 1995; Tucker 1988; Sturtevant and Bissonette 1997).

Home range size of Marten on the island of Newfoundland is exceptionally large (Bateman 1986; B. Hearn, unpublished data). Gosse (*In press* *Journal of Mammalogy*) and may reflect the low diversity and abundance of small and medium-sized mammals (Lindstedt et al. 1986; Thompson and Colgan 1987). Southern Red-backed Voles (*Clethrionomys gapperi*), a major food item of marten across their North American range (Buskirk and MacDonald 1984; Simon et al. 1999), were first recorded in western Newfoundland in 1999 and their distribution and abundance is expanding (Hearn et al. 2005). Herein we report the diversity of food types consumed by Newfoundland Marten over an 18-year period prior to the widespread establishment of Southern Red-backed Voles on the

island. This study will provide insight into the feeding ecology of Newfoundland Marten and will allow future comparisons of foraging patterns following expected changes in small mammal communities.

Study Area and Methods

Scats were collected opportunistically during field studies between 1995-2003 and were air and/or oven-dried prior to storage. Most scats (70%) were collected near Little Grand Lake in western Newfoundland (57°50'00N, 48°38'00W) prior to 1999. The remainder was collected in Terra Nova National Park in eastern Newfoundland (53°50'00N, 48°30'W). Stomachs from carcasses turned in by trappers in western Newfoundland were refrigerated and washed prior to examination. Prey items were identified based on the coloration and banding patterns of mammalian guard hairs, and on the remains of indigestible material including teeth, feathers, seeds and insect exoskeletons; a reference collection and an identification manual (Adorjan and Kolenosky 1969) aided in this process. We pooled these data with other published (Bateman 1986) and unpublished (Snyder 1986*; Tucker 1988; Drew 1994) data on food habits of Newfoundland marten collected from 1980 to 1991 (Table 1). Samples were categorized by season (winter, 1 November to 31 April; summer, 1 May to 31 October) whenever possible. Prey items were placed into one of 10 categories; (1) Meadow Voles, (2) Southern Red-backed Voles, (3) Masked Shrews (*Sorex cinereus*), (4) Snowshoe Hares (*Lepus americanus*), (5) Red Squirrels (*Tamiasciurus hudsonicus*), (6) unidentified mammals, (7) Moose (*Alces alces*) and Caribou (*Rangifer tarandus*) carrion, (8) insects, (9) avian remains, and (10) berries. Samples collected during earlier studies (Bateman

TABLE 1. Data source, collection period, and number of samples collected.

Data source	Number of samples	Sampling period
M. Bateman (1986)	56	1980-1982
J. Snyder (1986*)	25 ^a	1984-1986
B. Tucker (1988)	194	1986-1987
G. Drew (1994)	12	1990-1991
This study	417	1995-2003
Total	704	1980-2003

a = stomach contents from carcasses.

1986; Snyder 1986*; Tucker 1988; Drew 1994) were analyzed by the original investigators using similar techniques. Contents are expressed as frequency of occurrence rather than volumetric estimates to maintain consistency with earlier reporting. Furthermore, volumetric estimates of prey items would provide little additional information since most scats were entirely composed of one food type. Shannon diversity indices (Krebs 1998) were calculated for samples collected during summer, winter, and for both seasons combined. Samples were not partitioned according to sex since the sex of the animal depositing the scat was known for <15% of the samples. Moreover, previous studies indicate that significant differences in inter-sexual diet are not apparent (Nagorsen et al. 1989; Nagorsen et al. 1991; Thompson and Colgan 1990; Simon et al. 1999).

Results

A total of 704 samples (679 scats and 25 stomach contents) were collected from 1980-2003 (Table 2). Meadow Voles were the most prevalent prey item in scats and stomach contents, occurring in 70.5% of all samples (pooled over sites, seasons, and years). Snowshoe Hares were the second most frequent prey item. Other food types consumed by Marten included Masked Shrews, Red Squirrels, Moose and Caribou carrion, insects, birds, berries, and unidentified mammals; however, overall frequency of occurrence for each of these items was <10%. Southern Red-backed Vole remains were found in a single scat collected near Little Grand Lake in 1999; this coincides with the first record of this species on the island of Newfoundland (Hearn et al. 2005). Insect exoskeletons were identified as vespid wasps. Most bird remains were from smaller passerines, however, Ruffed Grouse (*Bonasa umbellus*) and Willow Ptarmigan (*Lagopus lagopus*) were identified from samples collected in southwestern Newfoundland during the winters of 1980-1982 (Bateman 1986). Eggshells were also found in several scats. Scats contained a variety of berries including Creeping Snowberry (*Gaultheria hispidula*), Wild Sarsparilla (*Aralia nudicaulis*), blueberry (*Vaccinium* spp.), Bunchberry (*Cornus canadensis*), Common Raspberry (*Rubus idaeus*), and Three-Leaved False Solomon's Seal (*Smilacina trifolia*). The Shannon

diversity index for the pooled data was 1.6. Eighty-eight percent of scats contained only one food item, consequently, the importance of larger prey items such as Snowshoe Hare and carrion is likely under-represented (Poole and Graf 1996; Cumberland et al. 2001) since these foods result in the production of fewer scats due to a lack of indigestible material per volume of food ingested (Zielinski 1986).

Comparisons of summer and winter diet pattern indicated that Meadow Voles were the most prevalent food item throughout the year, though frequency of occurrence was nearly double during summer (Table 2). Berries were the second most common food type found in samples collected in the summer. In winter, 28% of samples contained Snowshoe Hare remains indicating a 10-fold increase in use of this food item compared with summer. The frequency of Masked Shrews and birds was consistent between seasons though both food categories occurred in relatively few samples (Table 2). All other food types, except for berries and insects, which are highly seasonal food items, had higher percentages of occurrence in winter. This more balanced occurrence of food types in winter samples resulted in a higher diversity index ($H' = 1.89$) in this season versus summer ($H' = 1.36$).

Discussion

Newfoundland Marten consumed essentially all possible prey species available to them suggesting a generalist foraging strategy. These findings are in agreement with earlier studies (Buskirk and MacDonald 1984; Thompson and Colgan 1990; Martin 1994) that collectively have reported a highly diverse diet, and opportunistic use of locally available prey (Nagorsen et al. 1989; Nagorsen et al. 1991; Martin 1994). Meadow Voles were the most frequent component of the year-round diet of Newfoundland Marten and were particularly prevalent in samples collected from early spring to late autumn. Marten commonly consume Meadow Voles in other regions (Buskirk and MacDonald 1984; Slough et al. 1989; Martin 1994; Poole and Graf 1996; Simon et al. 1999), but the frequency of occurrence found in samples from this study is the highest known to us. On the island of Newfoundland, Meadow Voles occur in coniferous forests in addition to open, grassy areas (Cameron 1958; Folinsbee et al. 1973; Thompson and Curran 1995; Sturtevant and Bissonette 1997) thus their distribution fully overlaps with habitats used by Marten. The importance of Meadow Voles may have been more pronounced historically, since many of the prey species currently utilized by Marten were intentionally or accidentally introduced to insular Newfoundland over the last 150 years [i.e., Snowshoe Hare (Dodds 1960), Moose (Pimlott 1953), Masked Shrew (MacLeod 1960), Red Squirrel (Payne 1976), Southern Red-backed Vole (Hearn et al. 2005)], Ruffed and Spruce Grouse (Hancock 1981*). In contrast to this study, Marten on the Queen Charlotte Islands and

TABLE 2. Frequency of occurrence of food items found in 679 Marten scats and 25 stomachs in Newfoundland in winter, summer, and both seasons combined (pooled over study sites and years).

Food item	Summer n = 400	Winter n = 236	Seasons combined ^a n = 704
Meadow Vole (<i>Microtus pennsylvanicus</i>)	80	47.5	70.5
Southern Red-backed Vole (<i>Clethrionomys gapperi</i>)	0.25	0	0.1
Masked Shrew (<i>Sorex cinereus</i>)	10.5	10.6	9.9
Snowshoe Hare (<i>Lepus americanus</i>)	2.8	28	11.4
Red Squirrel (<i>Tamiasciurus hudsonicus</i>)	1.0	7.6	3.4
Unidentified mammal	4.3	10.2	4.3
Moose (<i>Alces alces</i>)/Caribou (<i>Rangifer tarandus</i>) carrion	2.5	8.9	3.6
Insects	2.0	0.4	1.4
Avian remains	7.2	10.2	8.8
Berries	15.5	0.8	9.7
Shannon Diversity Index (H')	1.36	1.89	1.60

^a Includes samples where the season of deposition was unknown; %frequency of occurrence values do not sum to 100% across food items.

Vancouver Island had a smaller component of small mammals in their diet and primarily foraged on birds, carrion, and salmonid fishes (Nagorsen et al. 1989; Nagorsen et al. 1991). This ability to utilize locally available food sources reflects the opportunistic nature of Marten foraging behavior.

Snowshoe Hares were consumed throughout the year but were more prevalent in samples collected during winter. This seasonal difference may reflect a decrease in the abundance or availability of Meadow Voles associated with snow conditions and a switch to a more available prey type. The importance of Snowshoe Hares to the winter diet and overall population performance of Marten has been documented for Newfoundland marten (Bateman 1986) as well as for other northern regions (Cowan and Mackie 1950; Raine 1983; Thompson and Colgan 1987; Thompson and Colgan 1990; Poole and Graf 1996). Furthermore, Cumberland et al. (2001) documented that larger prey, including Snowshoe Hares (8.0%), grouse (12.2%) and Red Squirrels (10.8%), represented only 31% of the diet by frequency of occurrence but accounted for approximately 95% of the caloric intake by marten in New Brunswick. We suspect that the introduced Snowshoe Hare (Dodds 1983) is now a critical food resource for Newfoundland marten in winter, the most energetically stressful period annually (Thompson 1986; Buskirk et al. 1988).

In addition to preying on more Snowshoe Hares during winter, Marten increased consumption rates of carrion, Red Squirrels, birds, unidentified mammals, and Masked Shrews. This is consistent with the pattern observed by Thompson and Colgan (1990) where a wider breadth of diet was noted during winters when prey abundance was low. Masked Shrews appeared in samples for both seasons at similar frequencies but were recorded in only 2 of 22 food-habit studies reviewed by Martin (1994). Shrews have low body mass and may only be utilized in years of food scarcity. Birds are a common food source used by Marten across their range

(Martin 1994) and the frequency of occurrence reported here approximated the mean reported from other studies (14.5% frequency of occurrence). Similar to Snowshoe Hares, carrion likely provided a significant source of biomass, hence total calories, during winter.

The remains of a Southern Red-backed Vole in a scat collected from southwestern Newfoundland in 1999 coincided with the first record of this species for the island (Hearn et al. 2005). Scats were not collected after 1999 in areas where Marten and Southern Red-backed Vole distributions overlap (Hearn et al. 2005), thus we were unable to assess use of this newly available prey item. Red-backed Voles are heavily utilized by American Marten elsewhere (Buskirk and MacDonald 1984; Slough et al. 1989; Thompson and Colgan 1990; Simon et al. 1999), and we anticipate increased utilization of this forest vole as its distribution and abundance expands.

Several researchers have noted fluctuating levels of prey and subsequent changes in population performance of Marten. Thompson and Colgan (1987) reported reduced population density, enlarged home ranges, and lower reproductive performance of Marten during a synchronous decline in principal prey species on their study area in northcentral Ontario. Poole and Graf (1986) suggested that the Snowshoe Hare population cycle has a significant impact on Marten populations in the northern boreal forest, and Marten harvests in Canada are historically well synchronized with Snowshoe Hare numbers (Bulmer 1974; Fryxell et al. 1999). Similarly, a decrease in small mammal numbers in central Labrador was implicated in the reduction in female to juvenile ratios and the overall harvest of Marten in the following trapping season (Simon et al. 1999). It is unknown whether Newfoundland Marten are food limited and additional research is required to understand the relationships between fluctuating prey levels and population performance for this Endangered species.

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