WINTER DIET OF FISHERS IN BRITISH COLUMBIA

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ABSTRACT—We identified the stomach contents of fishers (*Martes pennanti*) collected during winter between 1989 and 1993 from throughout British Columbia. Eighteen types of mammalian and avian prey were found in 256 stomachs. The most commonly occurring species of prey were snowshoe hares (*Lepus americanus*), red squirrels (*Tamiasciurus hudsonicus*), and southern red-backed voles (*Clethrionomys gapperi*). The diets of fishers varied between sexes; female fishers consumed small prey more frequently than did males. This difference in diets is likely related to the extreme sexual dimorphism of fishers and perhaps differences in habitats where males and females forage. The composition and breadth of the winter diets have implications for understanding habitat relationships of fishers.

Key words: fisher, *Martes pennanti,* diet, sexual dimorphism, British Columbia

Fishers (*Martes pennanti*) are typical of generalist predators, consuming most species that they can capture and kill (Powell 1993). Although fishers specialize on porcupines (*Erethizon dorsatum*) or snowshoe hares (*Lepus americanus*) (Powell 1993) in many areas, their diet can be quite broad. Other prey include deer (*Odocoileus* spp., primarily as carrion), squirrels (*Tamiasciurus* and *Glaucomys* spp.), cricetid and arvicolid rodents (for example, mice and voles), shrews (*Sorex* spp.), birds (mostly passerines and galliforms), American martens (*M. americana*), snakes, fish, insects, and arachnids, as well as berries, other vegetation, and hypogeous fungi (Coulter 1966; Clem 1977; Kelly 1977; Arthur and others 1989; Giuliano and others 1989; Kuehn 1989; Martin 1994; Zielinski and others 1999).

Several factors may affect diets within and among populations of fishers. First, fishers coexist with other predators and many different prey communities throughout their range and this is expressed in the diversity of their diets. Second, fishers may respond to prey availabil-

ity by switching prey when abundance of their primary prey decreases (Powell and Brander 1977). Several researchers have also reported that the diet of fishers varies among seasons (Powell and others 1997; Zielinski and others 1999). Third, juvenile fishers may not have adequately developed hunting skills, so they may be more reliant upon easily obtainable, low-benefit foods such as vegetation or fruit (Giuliano and others 1989). Finally, sexual dimorphism of fishers may affect the composition of their diet within populations through niche separation specific to food. However, several authors have been unable to detect expected dietary differences between males and females (Giuliano and others 1989; Van Why and Giuliano 2001).

Knowledge of the composition of the winter diet of fishers is important for several reasons. Fishers are active year-round; however, during winter they experience an energy bottleneck because energy costs are high and food availability is low compared to other seasons (Powell 1993). Hence, decreased availability of prey during winter may affect survival. Knowledge of the composition and breadth of the winter diet among populations of fishers is important for understanding and predicting effects of

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habitat alteration on the feeding ecology of fishers and therefore individual and population responses to changes in habitat. Understanding the composition and breadth of diets within populations is also useful in predicting responses by fishers to changes in prey availability and may explain differences in habitats used by males and females.

Most of the published information about the diets of fishers is from studies conducted in eastern North America. Little is known about the diets of fishers in northwestern coniferous forests (for example, British Columbia) where vertebrate communities are different than those in eastern and southern portions of the species' range. Thus, habitat management that is based on diet studies from eastern populations may not be appropriate for western forest types. Our objectives were to describe the winter food habits of fishers in British Columbia and to compare diets of different age and sex classes. This information will improve understanding of the habitat relationships of fishers in western coniferous forests and provide habitat managers with better information to help minimize the effects of habitat alterations on fisher prey species.

METHODS

The British Columbia Ministry of Environment, in cooperation with trappers, collected 256 fisher carcasses from throughout British Columbia between 1989 and 1993 (Fig. 1). All carcasses were collected during the winter trapping season (November to February). Upon receipt of each skinned carcass, we determined the sex of the animal and removed the entire stomach as well as 2 premolars for cementum aging (Poole and others 1994). We defined juvenile fishers as those younger than 1 y and adults as those >1 y.

We washed the stomach contents to remove unidentifiable tissue and detritus. We then airdried the remaining material and spread it across 1-cm^2 grid paper. We selected 15 hairs from each stomach using randomly selected grid coordinates. When possible, we identified hairs to species by comparison to reference samples and following methods of Moore and others (1974) and Kennedy and Carbyn (1981). We scanned the stomach contents and identified large items, such as teeth, skull fragments, and feathers. For some mammals, we could
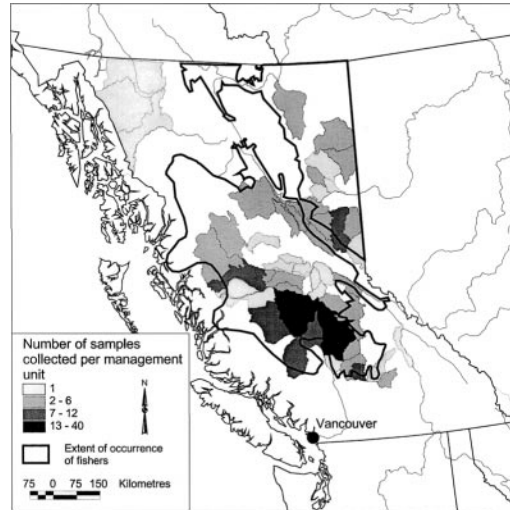

FIGURE 1. Number of stomach samples collected from wildlife managements units in British Columbia between 1989 and 1993. The extent of occurrence of fishers from Weir (2003) is shown by solid line. Extent of occurrence is the area contained within the shortest continuous imaginary boundary that can be drawn to encompass all the known, inferred or projected sites of present occurrence, excluding cases of vagrancy.

classify remains only to genus or family. We identified feathers to order following Day (1966).

We recorded the occurrence and number of prey types in each stomach. We compared number of prey types found in each stomach between or among sex and age classes using normal approximations to Mann-Whitney U-tests. We combined prey types into food groups based upon categories of taxa or habitat (for example, aquatic mammals) and analyzed the occurrence of these food groups in relation to the sex and age of fishers using Chi-square goodness-of-fit tests. For goodness-of-fit analyses that showed statistically significant results, we used Bonferroni-adjusted Z-tests for proportions to determine which categories were different among sex or age classes. We only included stomachs that included prey remains in our analyses. Before the research began, we set the acceptable Type I error to 0.05 for our analyses.

RESULTS

We identified 18 types of prey in 256 stomachs of 142 female (64 adult, 76 juvenile, 2 un-

TABLE 1.   Prey types recorded in fisher stomachs collected between 1989 and 1993 in British Columbia. All stomachs were collected between November and February. n = 215 stomachs.

Prey types	Frequency (stomachs)	Percentage of stomachs
Soricidae	32	14.9
Leporidae		
snowshoe hare	84	39.1
Sciuridae		
northern flying squirrel (*Glaucomys sabrinus*)	18	8.4
red squirrel	72	33.5
Castoridae		
beaver	40	18.6
Cricetidae		
deer mouse (*Peromyscus maniculatus*)	34	15.8
bushy-tailed woodrat (*Neotoma cinerea*)	4	1.9
Arvicolidae		
southern red-backed vole	50	23.3
Microtus spp.	17	7.9
muskrat	37	17.2
Erethizontidae		
porcupine	42	19.5
Mustelidae		
marten	23	10.7
fisher	21	9.8
weasel (*Mustela* spp.)	1	0.5
Artiodactyla		
deer	21	9.8
moose	32	14.9
domestic cattle	4	1.9
Galliformes	19	8.8

known age) and 109 male (39 adult, 69 juvenile, 1 unknown age) fishers. We were unable to identify the sex or estimate the age of 5 and 6 carcasses, respectively. Non-digestible materials (for example, hair, feather, and bone) were found in 215 stomachs (Table 1), and 41 stomachs were empty. We recorded 551 occurrences of prey in these 215 stomachs. Sixty-four stomachs (30%) contained only 1 prey type, 151 stomachs (70%) contained ≥2 prey types, and 1 stomach contained 7 prey types ($\bar{x}$ = 2.56 prey types per stomach, s = 1.47). The Shannon diversity index (H', base 10 log, Krebs 1989:377) of prey types in our sample was 1.15.

Snowshoe hares were the most common species of prey identified in the stomachs that contained food items, occurring in 84 of 215 stomachs (39.1%). The occurrence of red squirrels (*T. hudsonicus*) was slightly less (33.5%), followed by southern red-backed voles (*Clethrionomys gapperi*; 23.3%), and porcupines (19.5%). Fisher hairs were present in 42 of 215 stomachs. In 18 of these occurrences, ≤5 fisher hairs were found in the sample of 15 hairs. We assumed that these hairs were likely the result of grooming and excluded these occurrences from further analyses. However, for the remaining 24 occurrences, >5 fisher hairs were identified and several of these stomachs contained bones, claws, and other non-digestible material from fishers (determined by comparison with museum specimens). Because 3 of these carcasses were fishers captured in foothold traps, we assumed that these cases could be the result of self-mutilation and excluded them from further analysis. We treated all other occurrences as incidences of predation on fishers. Thus, we estimated that fishers occurred as diet items in 9.8% (21 of 215) of all stomachs.

Based upon similar taxa and habitat-specific groups, we aggregated the 18 recorded prey types into 7 food groups: small mammals
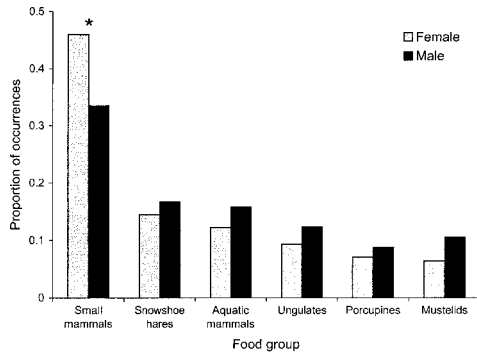
FIGURE 2. Winter diets described from stomach contents of female and male fishers collected between 1989 and 1993 in British Columbia. $n = 538$ food group occurrences; * indicates significant difference between sexes.

(mice, voles, shrews, and squirrels), galliform birds, snowshoe hares, porcupines, mustelids, ungulates (moose [*Alces alces*], deer [*Odocoileus* spp.], and domestic cattle [*Bos taurus*]), and aquatic mammals (beavers [*Castor canadensis*] and muskrats [*Ondatra zibethicus*]). Using these aggregations, small mammals were the most frequently occurring food group (227 of 551 food group occurrences; 41.2%), followed by snowshoe hares (15.2%), aquatic mammals (14.0%), ungulates (10.3%), mustelids (8.2%), porcupines (7.6%), and galliform birds (3.4%).

We compared diets among different sex and age classes of fishers. We did not detect significant differences in the number of prey types per stomach between juveniles ($\bar{x} = 2.66$ prey types per stomach, $s = 1.51, n = 121$) and adults ($\bar{x} = 2.46$ prey types per stomach, $s = 1.43, n = 90$; normal approximation to Mann-Whitney U-test, $Z = -0.977, P \leq 0.38$) or between sexes (males, $\bar{x} = 2.49$ prey types per stomach, $s = 1.47, n = 91$; females, $\bar{x} = 2.59$ prey types per stomach, $s = 1.45, n = 120$; normal approximation to Mann-Whitney U-test, $Z = -0.573, P \leq 0.57$). There were no significant differences in the frequency of occurrence of the 7 food groups between juvenile and adult fishers ($\chi^2 = 4.83$, df $= 6, P \leq 0.7$) or among the 4 sex-age class combinations ($\chi^2 = 20.14$, df $= 18, P \leq 0.32$). However, occurrences of food groups were significantly different between sexes ($\chi^2 = 13.09$, df $= 6, P \leq 0.04$; Fig. 2). Female fishers exploited the small mammal food group more

than did males (Bonferroni-adjusted $Z = 2.95$, $P \leq 0.03$).

DISCUSSION

Analysis of stomach contents revealed that fishers in British Columbia consume a variety of prey during winter; however, snowshoe hares, red squirrels, and southern red-backed voles were the most commonly occurring prey species. Other food groups (porcupines, galliform birds, ungulates, mustelids, and aquatic mammals) occurred less frequently, but because of their larger size may be relatively more important to the gross energy intake of fishers during winter. Whereas many authors have reported a variety of prey in fisher diets (Coulter 1966; Clem 1977; Kelly 1977; Banci 1989; Powell 1993), the stomach contents that we examined indicate that fishers in British Columbia consumed a greater diversity of food species during winter ($H' = 1.15$) than that documented elsewhere in North America (maximum $H' = 1.11$, from Ontario; Martin 1994). Martin (1994) noted that diversity indices of fisher diets in North America decreased with increasing occurrence of snowshoe hares. Although snowshoe hares were common in the winter diet of fishers in British Columbia, our study also had the most diverse winter diet reported, contrary to Martin's (1994) hypothesis.

In part, the high diversity of the diet that we observed may be from the province's high diversity of forest types and prey species. Because of its considerable topographical and climatic variability, British Columbia has 14 biogeoclimatic zones that have distinctive plant and animal communities (Meidinger and Pojar 1991). Within the province, fishers are distributed throughout about 400,000 km^2 and occur in at least 7 biogeoclimatic zones (Weir 2003), so it is likely that fishers in our sample were exposed to a wider variety of prey species than fishers in other studies. The large area over which samples were collected may have increased the diet diversity relative to studies that have more localized sample collections, thereby making dietary comparisons among studies problematic.

Additionally, past studies have used a variety of methods to assess the composition of fisher diets and these methods likely do not produce equivalent results. Researchers have determined diet from scats of a limited number

of study animals (for example, Zielinski and others 1999), stomach contents of trapper-killed fishers (for example, Clem 1977, this study), prey remains encountered during tracking, or combinations of these 3 methods (for example, Powell and others 1997). These different sampling methods likely affect the dietary measures obtained by the researchers and further confound difficulties in comparisons among regions. Regardless, broad comparisons of frequencies of occurrence for specific species will still be valid.

The diet of fishers in British Columbia was comprised of similar prey types as reported elsewhere within the species' range, but the frequencies of occurrence of several prey types were different than in other regions. Although snowshoe hares occurred more frequently in our sample than that reported by all but 1 other study (70% of fisher scats from Manitoba, Raine 1987), squirrels, mice, voles, and shrews were also commonly recorded. Many authors have concluded that fishers search primarily for larger prey such as snowshoe hares and porcupines (Powell and Brander 1977; Powell 1979; Kuehn 1989), but take smaller prey opportunistically (Powell 1993). Although other prey species were consumed frequently, our observations support this hypothesis: snowshoe hares were a substantial component of the winter diets of fishers in British Columbia.

Relative occurrences of mustelids in the stomachs of fishers in our study differed from those of many other published reports. Several authors have reported that fishers occasionally eat weasels and martens (for example, de Vos 1952; Coulter 1966; Raine 1987; Jones 1991), but not as frequently as we observed in our study. Our results also show that fishers occasionally ate conspecifics. Of the 10 stomachs that contained fisher hairs, claws and bones, 7 were from fishers trapped in quick-kill Conibear 120 or 220 sets. Thus, ingestion of fisher hair in these cases was not incidental to fighting foothold traps (for example, Coulter 1966). Several authors have noted that some martens and fishers occurring in the diets of fishers may be scavenged from trapper's sets, but others may have been preyed upon (Seton 1926; de Vos 1952; Raine 1987). Bull and Heater (2001) observed intraspecific predation among martens in northeastern Oregon, but noted that it occurred only during summer months and ani-

mals were rarely consumed. It is unclear if the relatively frequent occurrence of mustelids in our sample was the result of fishers scavenging animals killed by trappers or whether they were the result of predation.

Several studies have recorded beavers and muskrats in diets of fishers, and attributed the occurrences to scavenging trap bait (Clem 1977; Kelly 1977; Kuehn 1989), whereas others have suggested that fishers hunt them (Raine 1981) or feed on them as carrion (Leonard 1980). The low number of beaver and muskrat hairs occurring in stomachs containing these prey species suggests that fishers in our sample may have been eating skinned muskrat and beaver carcasses used as trap bait. It is unlikely that occurrences of these prey types was the result of consuming bait while trapped because most of the fishers that had these prey types in their stomachs were captured in quick-kill Conibear traps.

Many studies have concluded that ungulate carrion plays an important role in fisher diets (deVos 1952; Coulter 1966; Kelly 1977; Kuehn 1989). Kelly (1977) hypothesized that prior to European settlement, carrion scavenged from large carnivore kills formed an important component of fisher diets in eastern North America. Fishers in British Columbia appear to use ungulates frequently; ungulate hair occurred in 22.7% of the stomachs. This is similar to the results of diet analyses in Maine (24.4%, Coulter 1966), Ontario (44%, deVos 1952), and New Hampshire (27.5%, Kelly 1977). However, contrary to eastern studies, fishers in British Columbia tended to consume moose more often than deer. Additionally, anecdotal evidence of an attack by a radio-tagged fisher on an adult mule deer (*O. hemionus*) suggests that fishers may occasionally attempt to prey upon ungulates (A. Bowser, British Columbia Ministry of Environment, Williams Lake, BC, pers. comm.).

The differences we observed between the winter diets of male and female fishers may be related to sexual dimorphism and thus difference in foraging ability. The evolution of sexual dimorphism in Mustelidae has been considered by many researchers (Brown and Lasiewski 1972; Moors 1977, 1980; Erlinge 1979; Powell 1993; Holmes and Powell 1994); 1 explanation is that it minimizes diet overlap between sexes (Brown and Lasiewski 1972). Because female fishers are smaller, they should be more effi-

cient than males when foraging for small animals. As well, females are expected to be less able to exploit large prey. Conversely, the larger size of males allows them to exploit a broader prey base, but they are less efficient when preying on small animals (Powell 1993). This reduction in dietary overlap may reduce intraspecific competition for food.

Because fishers are sexually dimorphic, many researchers have expected to find dietary differences between sexes (Coulter 1966; Clem 1977; Leonard 1980; Giuliano and others 1989; Powell 1993). Although male fishers consume more carrion and fruit than do females (Giuliano and others 1989; Kuehn 1989), dietary overlap is still high, which led Giuliano and others (1989) to conclude that prey partitioning between the sexes is unlikely. In our study, male and female fishers exploited food resources differently, as predicted by Moors (1980). Sexual dimorphism in our study animals was 1.64 ($\bar{x}_M$ body mass:$\bar{x}_F$ body mass), which is above the ratio of 1.6 used by Ralls (1977) to define extreme dimorphism. Perhaps female fishers in British Columbia consumed smaller prey (mice, voles, shrews, and squirrels) more frequently than did males because of their smaller body size, which reduced diet overlap and competition for similar resources. It is unclear if the degree of sexual dimorphism in our sample of fishers was more extreme than that from other fisher studies, or if our large sample size may have enhanced our ability to detect differences between sexes.

The differences in diet between males and females may be expressed as differences in the foraging behaviour of each sex during winter. We expect that females will hunt in areas where small mammals and squirrels are abundant, whereas males will be more likely to forage in habitats where larger prey are abundant. Because prey and habitat are linked, it is reasonable to expect that habitat changes imposed by natural disturbances or forest harvesting will affect female fishers differently than males during winter.

Both Powell and others (1997) and Zielinski and others (1999) noted that diet composition of fishers changed among seasons. Trends we observed for diets of fishers were based on samples collected during winter only. Thus, our observations of the incidence of mustelids in the diet and the effects of sexual dimorphism may be a winter phenomenon only. Future research is warranted to determine if these same trends hold during other seasons.

By identifying the winter diet of fishers in British Columbia, habitat managers can better manage forested habitat for important prey such as snowshoe hares, red squirrels, and small rodents. Managing foraging habitat for fishers will involve a delicate balance between the competing habitat requirements of fishers and their prey. Snowshoe hares reach their highest densities in areas with dense understory (Wirsing and others 2002), which is typical of early successional forests. However, fishers appear to require some components of late-successional forests for other portions of their life history, particularly for resting and whelping (Weir and Harestad 2003). Additionally, other prey, such as red squirrels, reach their highest densities in late-successional forests (Obbard 1987). Thus, the supply of habitat for snowshoe hares may need to be reconciled with the requirements for late-successional forest by fishers and other prey. Maintaining a mosaic of early stand ages in close proximity to late-successional forests will likely be the most appropriate management strategy. Future research should focus on determining the best configuration of early- and late-successional habitats to supply foraging, resting, and whelping habitat for fishers.

LITERATURE CITED

ARTHUR SM, KROHN WB, GILBERT JR. 1989. Habitat use and diet of fishers. Journal of Wildlife Management 53:680–688.

BANCI V. 1989. A fisher management strategy for British Columbia. Victoria, BC: British Columbia Ministry of Environment, Wildlife Branch. Wildlife Bulletin B-63. 117 p.

BROWN JH, LASIEWSKI RC. 1972. Metabolism of weasels: the cost of being long and thin. Ecology 53: 940–943.

BULL EL, HEATER TW. 2001. Survival, causes of mortality, and reproduction in the American marten in northeastern Oregon. Northwestern Naturalist 82:1–6.

CLEM MK. 1977. Food habits, weight changes and habitat use of fisher (*Martes pennanti*) during winter [thesis]. Guelph, ON: University of Guelph. 49 p.

COULTER MW. 1966. Ecology and management of fishers in Maine [dissertation]. Syracuse, NY: Syracuse University. 183 p.

DAY MG. 1966. Identification of hair and feather remains in the gut and faeces of stoats and weasels. Journal of Zoology (London) 148:201–217.

DE VOS A. 1952. Ecology and management of fisher and marten in Ontario. Toronto, ON: Ontario Department of Lands and Forests. Technical Bulletin, Wildlife Service Number 1. 90 p.

ERLINGE S. 1979. Adaptive significance of sexual dimorphism in weasels. Oikos 33:233–245.

GIULIANO WM, LITVATIS JA, STEVENS CL. 1989. Prey selection in relation to sexual dimorphism of fishers (*Martes pennanti*) in New Hampshire. Journal of Mammalogy 70:639–641.

HOLMES T, POWELL RA. 1994. Morphology, ecology, and the evolution of sexual dimorphism in North American *Martes.* In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. p 72–84.

JONES JL. 1991. Habitat use of fisher in northcentral Idaho [thesis]. Moscow, ID: University of Idaho. 147 p.

KELLY GM. 1977. Fisher (*Martes pennanti*) biology in the White Mountain National Forest and adjacent areas [dissertation]. Amherst, MA: University of Massachusetts. 178 p.

*KENNEDY AJ, CARBYN LN. 1981. Identification of wolf prey using hair and feather remains with special reference to western Canadian national parks. Edmonton, AB: Canadian Wildlife Service. Internal report. 65 p. Available from: Micromedia Ltd., 20 Victoria Street, Toronto, ON M5C 2N8.

KREBS CJ. 1989. Ecological methodology. New York, New York, USA: Harper & Row. 654 p.

KUEHN DW. 1989. Winter foods of fishers during a snowshoe hare decline. Journal of Wildlife Management 53:688–692.

LEONARD RD. 1980. The winter activity and movements, winter diet, and breeding biology of the fisher (*Martes pennanti*) in southeastern Manitoba [thesis]. Winnipeg, MB: University of Manitoba. 181 p.

MARTIN SK. 1994. Feeding ecology of American martens and fishers. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: biology and conservation. Ithaca, NY: Cornell University Press. p 297–315.

MEIDINGER DV, POJAR J. 1991. Ecosystems of British Columbia. Victoria, BC: British Columbia Ministry of Forests, Research Branch. Special Report Service Number 6. 330 p.

MOORE TD, SPENCE LE, DUGNOLLE CE. 1974. Identification of the dorsal guard hairs of some mammals of Wyoming. Cheyenne, WY: Wyoming Game and Fish Department. Bulletin Number 14. 177 p.

MOORS PJ. 1977. Studies of the metabolism, food consumption and assimilation efficiency of a small carnivore, the weasel (*Mustela nivalis* L.). Oecologia 27:185–202.

MOORS PJ. 1980. Sexual dimorphism in the body size of mustelids (Carnivora): the roles of food habits and breeding systems. Oikos 34:147–158.

OBBARD ME. 1987. Red squirrel. In: Novak M, Baker JA, Obbard ME, Malloch B, editors. Wild furbearer management and conservation in North America. North Bay, Ontario, Canada: Ontario Trappers Association. p 264–281.

POOLE KG, MATSON GM, STRICKLAND MA, MAGOUN AJ, GRAF RP, DIX LM. 1994. Age and sex determination for American martens and fishers. In: Buskirk SW, Harestad AS, Raphael MG, Powell RA, editors. Martens, sables, and fishers: Biology and conservation. Ithaca, NY: Cornell University Press. p 204–224.

POWELL RA. 1979. Ecological energetics and foraging strategies of the fisher (*Martes pennanti*). Journal of Applied Ecology 48:195–212.

POWELL RA. 1993. The fisher: life history, ecology, and behavior. 2nd ed. Minneapolis, MN: University of Minnesota Press. 237 p.

POWELL RA, BRANDER RB. 1977. Adaptations of fishers and porcupines to their predator prey system. In: Phillips RL, Jonkel C, editors. Proceedings of the 1975 Predator Symposium. Missoula, Montana, USA. Montana Forestry Conservation Experimental Station, University of Montana. p 45–53.

POWELL SM, YORK EC, FULLER TK. 1997. Seasonal food habits of fishers in central New England. In: Proulx G, Bryant HN, Woodward PM, editors. *Martes*: taxonomy, ecology, techniques, and management. Edmonton, AB. Provincial Museum of Alberta. p 279–308.

RAINE RM. 1981. Winter food habits, responses to snow cover and movements of fisher (*Martes pennanti*) and marten (*Martes americana*) in southeastern Manitoba [thesis]. Winnipeg, MB: University of Manitoba. 139 p.

RAINE RM. 1987. Winter food habits and foraging be-

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* Unpublished.

haviour of fishers (*Martes pennanti*) and martens (*Martes americana*) in southeastern Manitoba. Canadian Journal of Zoology 65:745–747.

RALLS K. 1977. Sexual dimorphism in mammals: avian models and unanswered questions. American Naturalist 111:917–938.

SETON ET. 1926. Order Carnivora or flesh-eaters. Vol. II. Part II. Life XXXII: The fisher. In: Lives of game animals. Garden City, NY: Doubleday, Doran and Company. p 451–479.

VAN WHY K, GIULIANO WM. 2001. Fall food habits and reproductive condition of fishers, *Martes pennanti,* in Vermont. Canadian Field-Naturalist 115: 52–56.

WEIR RD. 2003. Status of the fisher in British Columbia. Victoria, BC: Ministry of Sustainable Resource Management, Conservation Data Centre, and Ministry of Water, Land and Air Protection, Biodiversity Branch. Wildlife Bulletin Number B-105. 47 p.

WEIR RD, HARESTAD AS. 2003. Scale-dependent habitat selectivity by fishers in south-central British Columbia. Journal of Wildlife Management 67: 73–82.

WIRSING AJ, STEURY TD, MURRAY DL. 2002. A demographic analysis of a southern snowshoe hare population in a fragmented habitat: evaluating the refugium model. Canadian Journal of Zoology 80:169–177.

ZIELINSKI WJ, DUNCAN NP, FARMER EC, TRUEX RL, CLEVENGER AP, BARRETT RH. 1999. Diet of fishers (*Martes pennanti*) at the southernmost extent of their range. Journal of Mammalogy 80:961–971.