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# HABITAT USE AND DIET OF FISHERS

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**Abstract:** We studied habitat use and diets of 43 radio-collared fishers (*Martes pennanti*) in south-central Maine from January 1984 to August 1987. Coniferous stands were preferred for rest sites during spring, summer, and fall when fishers usually rested in the branches of coniferous trees. During winter, fishers usually rested in ground burrows in mixed stands. Active fishers used a variety of forest types, especially during summer. During winter, fishers hunted intensively in dense patches of coniferous undergrowth, where snowshoe hare (*Lepus americanus*) tracks were common, and used deciduous stands less than expected by availability. Winter foods included apples, porcupines (*Erethizon dorsatum*), hares, gray squirrels (*Sciurus carolinensis*), red squirrels (*Tamiasciurus hudsonicus*), flying squirrels (*Glaucomys sabrinus*), mice (*Peromyscus* spp.), voles (*Clethrionomys gapperi* and *Microtus* spp.), and shrews (*Sorex* spp. and *Blarina* spp.). Because of the diversity of the fisher's diet, optimal habitat probably includes a mixture of forest types, including some coniferous cover.

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During most of the twentieth century, fishers were found primarily in northern coniferous forests (Powell 1982). However, fishers probably inhabited more southern areas of deciduous forest before European settlement (Hagemeier 1956). Fishers use a variety of forest types, including mature conifer (deVos 1952, Coulter 1966) and mixed conifer-deciduous forests (Coulter 1966, Kelly 1977, Powell 1977), and forested wetlands with conifer undergrowth (deVos 1952, Kelly 1977). Strickland et al. (1982) suggested that fishers could inhabit any forested area that supported a suitable prey base; however, Allen (1983) concluded that fishers need dense, mature, coniferous or mixed forests for winter cover. Fishers eat a variety of foods, including snowshoe hares, porcupines, squirrels, mice, shrews, various fruits, and carrion (Coulter 1966, Kelly 1977, Powell 1977).

From 1979 to 1984, annual fisher harvest density in several townships in south-central Maine was 1/6.7 km<sup>2</sup>, the highest ever reported in Maine (Me. Dep. Inland Fish. Wildl. 1986), although the area contained more open land and less mature forest than predicted by Allen's (1983) model of optimum fisher habitat. Fisher carcasses from the area were among the heaviest ever reported (Rego 1984), which suggested food and habitat conditions were favorable. Our purpose was to determine if fishers in south-central Maine preferred certain habitats, if habitat use differed between resting and active fishers, and if habitat use was related to fisher diet and prey distribution.

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## STUDY AREA

The study area encompassed approximately 500 km<sup>2</sup> of northeastern Waldo and southern Penobscot counties, Maine, extending from Penobscot Bay to approximately 50 km inland. Elevations ranged from sea level to 370 m. Climate was moderately cool, with temperatures ranging from a mean low of -9 C in January to a mean high of 20 C in July (U.S. Weather Bur. 1982).

In 1880, 82% of the area was farmland (U.S. Bur. Census 1880). Many farms were abandoned between 1880 and 1980, so that much of

Table 1. Classification of forest types in south-central Maine, 1984–87.

Stratum	Forest type	Characteristics
Overstory <sup>a</sup>	Deciduous	Total canopy ≥50%, deciduous species >75%.
	Coniferous	Total canopy ≥50%, coniferous species >75%.
	Mixed	Total canopy ≥50%, neither type >75%.
	Scrub	Forest land, total canopy <50%, includes small clearcuts.
	Wetland	Bog, meadow, shallow marsh with emergent vegetation.
Understory <sup>b</sup>	Open	<0.5 stems/m <sup>2</sup> .
	Sparse	≥0.5 and <3 stems/m <sup>2</sup> .
	Dense	≥3 stems/m <sup>2</sup> .
	Coniferous	≥75% coniferous species.
	Deciduous	≥75% deciduous species.
	Mixed	<75% deciduous and <75% coniferous species.

<sup>a</sup> Woody stems ≥7.5 cm diam.  
<sup>b</sup> Woody stems <7.5 cm diam.

the land reverted to second-growth forest. During the study, human population density was approximately 15/km<sup>2</sup> (U.S. Bur. Census 1982), and most of the area was covered with a mixture of forest types interspersed with small farms and pastures. Balsam fir (*Abies balsamea*), eastern hemlock (*Tsuga canadensis*), white pine (*Pinus strobus*), oaks (*Quercus* spp.), maples (*Acer* spp.), and birches (*Betula* spp.) were common in upland areas, and red spruce (*Picea rubens*), black spruce (*P. mariana*), and tamarack (*Larix laricina*) were common in lowlands (Vonk 1975).

METHODS

Between January 1984 and August 1987 we live-trapped 22 adult (≥1 yr) (11 M, 11 F) and 21 juvenile (<1 yr) (17 M, 4 F) fishers in south-central Maine (Arthur 1988). Each fisher was fitted with a radio collar (Model S2B5, Telonics, Inc., Mesa, Ariz.; use of manufacturers' names does not imply U.S. gov. endorsement of commer. products), released, and then located 1–4 times/month from the air (Mech 1983) and ≥1 time/week by triangulation from ≥3 ground points. We assessed telemetry error by locating transmitters placed by another observer and by comparing visual observations of resting fishers with locations determined by telemetry.

We investigated habitat use without regard to fisher activity by determining overstory type present at 950 independent (i.e., separated by ≥16 hr) (Arthur 1987) aerial locations of the 43 fishers. The forest stand surrounding each location was classified by visually estimating mean canopy closure and proportions of coniferous and deciduous species present (Table 1). We used a minimum area of 2 ha to identify stands.

We obtained aerial locations during daylight hours in all seasons.

We also determined overstory type surrounding 950 points randomly placed within a 574-km<sup>2</sup> area that was almost entirely occupied by radio-collared fishers. We excluded locations of 1 adult and 5 juvenile males that travelled widely outside this area. We plotted random points on false-color infra-red photographs (scale = 1:24,600) taken in November 1984, and classified overstory stands using the criteria used with fisher locations. Classifications were verified by comparing photographs with areas of known overstory types. Occurrences of forest types at fisher locations and random points were compared using the procedure of Marcum and Loftsgaarden (1980). Separate analyses were conducted for locations obtained during spring (Mar–May), summer (Jun–Aug), fall (Sep–Nov), and winter (Dec–Feb).

Radio-collared fishers located by triangulation from ground points were classified as resting if radio signals did not fluctuate in strength or change direction between successive readings. We verified this by observing resting fishers after homing on their radio signals on 157 occasions involving 18 males and 13 females. We determined overstory type present at each site and compared these with types found around random points. We also classified each site according to its location in a tree or on the ground.

We determined habitats used by active fishers during winter by following their trails in snow. We located trails 12–72 hours after a snowfall, by surveying roads in the area or by homing on the radio signal from a resting fisher. Most trails were estimated to be ≥12 hours old and were

Table 2. Overstory types at random points and fisher locations in south-central Maine, 1984–87.

Season	Overstory	Random points (%) <sup>a</sup>	Aerial locations			Rest sites		
			n	%	CI <sup>b</sup>	n	%	CI <sup>b</sup>
Spring						54		
	Deciduous	25.6	26	9.9	7.4–	4	7.4	6.7–
	Coniferous	6.0	59	22.5	8.9+	16	29.6	9.7+
	Mixed	59.1	171	65.3	10.8	34	63.0	10.9
	Scrub	4.9	3	1.2	3.0–	0	0	1.9–
	Wetland	4.5	3	1.2	2.9–	0	0	1.9–
Summer						28		
	Deciduous	25.6	38	16.6	8.7–	2	7.1	6.7–
	Coniferous	6.0	29	12.7	7.2	8	28.6	9.6+
	Mixed	59.1	151	65.9	10.8	17	60.7	11.0
	Scrub	4.9	11	4.8	4.8	1	3.6	4.3
	Wetland	4.5	0	0	1.9–	0	0	1.9–
Fall						31		
	Deciduous	25.6	38	13.6	8.1–	5	16.1	8.6–
	Coniferous	6.0	45	16.1	7.9+	5	16.1	7.9+
	Mixed	59.1	186	66.4	10.7	19	61.3	11.0
	Scrub	4.9	5	1.8	3.4	1	3.2	4.1
	Wetland	4.5	6	2.1	3.5	1	3.2	4.1
Winter						44		
	Deciduous	25.6	14	7.8	6.8–	6	13.6	8.1–
	Coniferous	6.0	56	31.3	9.8+	4	9.1	6.3
	Mixed	59.1	107	59.9	11.1	31	70.5	10.4+
	Scrub	4.9	2	1.1	2.9–	3	6.8	5.6
	Wetland	4.5	0	0	1.9–	0	0	1.9–

<sup>a</sup> n = 782, forested types only.  
<sup>b</sup> 95% CI = % of fisher locations ± indicated value; + = preference, – = avoidance at P < 0.05 (Z-test).

followed in either direction, but those judged to be especially fresh were followed backwards to avoid disturbing the fisher. We measured distance travelled along fisher trails in each habitat by pacing. In addition to classifying overstory types, we identified 7 understory types, based on density and relative proportions of coniferous and deciduous species (Table 1).

We determined availability of forest types along 18 randomly placed transects, each consisting of 3 1-km lines oriented in a triangle. Ends of the 3 lines were separated by 250 m to avoid duplicate sampling by 2 consecutive lines. Previous studies indicated that fishers avoided open land (deVos 1952, Kelly 1977, Raine 1983) so we selected transects to sample only forested land and discarded those that were >20% open land (i.e., farms, housing, lakes, and ponds). We compared proportions of distances travelled in each forest type between fisher trails and transects with Ivlev’s (1961) index of electivity. Values could range from –1 (strong avoidance) to 1 (strong preference).

We often could not measure the distance fishers travelled in areas with many hare tracks,

because both species circled, zig-zagged, and backtracked so much that the fisher tracks were obscured. We examined distribution of these dense patches of hare tracks by defining a patch as an area ≥10 m across with ≥1 hare trail/m. We compared proportions of the total distance within hare patches falling within each habitat with proportions of the total transect distance falling within each type using Ivlev’s (1961) index.

We also recorded tracks of prey species along fisher trails and transects. Because of difficulties in distinguishing trails, we recorded tracks of red, gray, and flying squirrels as 1 group, and mice, voles, and shrews as small mammals.

We compared rates at which fishers encountered prey trails with rates along transects. We calculated rates by dividing the number of prey trails crossing a fisher trail or transect by the number of days since the last snowfall (trails/day), and then dividing by the distance travelled (trails/day/km). We examined distribution of prey among habitats by comparing trails/day for each species in each type along transects with the number expected based on the proportion

Table 3. Proportional use of rest sites by fishers<sup>a</sup> in south-central Maine, 1984–87.

Site	Dec-Feb (n = 53)	Mar-May (n = 47)	Jun-Aug (n = 36)	Sep-Nov (n = 44)
Burrow	0.58	0.11	0	0.20
Cavity	0.19	0.19	0.06	0.34
Nest <sup>b</sup>	0.23	0.70	0.94	0.46

<sup>a</sup> Excluding F thought to be using natal dens.  
<sup>b</sup> Includes all open nests in trees and tree branches.

of the total transect distance within each type. We evaluated use using Chi-square goodness-of-fit and Bonferroni-Z-tests (Neu et al. 1974).

We collected fisher scats while snow tracking. Scats were air-dried for 24 hours at approximately 90 C. Prey remains were identified by hairs, bones, and teeth, which were compared with reference specimens and a key (Adjoran and Kolenosky 1969). When a scat contained remains of >1 type of food, the item occupying the greatest proportion by volume was identified as the predominant food of the scat. While snow-tracking fishers, we also recorded behavior that seemed related to the presence of live prey, kills, or carrion, and we examined live-trapped fishers during fall and spring for imbedded porcupine quills or other injuries that might indicate predatory behavior.

RESULTS

Our telemetry tests indicated that locations determined from the air were usually ≤10 m from the correct positions. Locations determined by ground triangulation were usually within 150 m. Our greatest errors occurred when triangulation was attempted from >1.5 km; therefore, we usually located fishers from ≤1 km (Arthur 1987).

Habitat Use

All aerial locations (n = 782) were in forested habitats, although only 83% of the study area was forested (farms, housing and roads, and open water occupied 10, 5, and 2% of the area, respectively). To reduce the possibility of Type II errors (Alldredge and Ratti 1986), we assumed fishers avoided open areas and compared habitat use among 5 forest types (Table 2). Deciduous stands were avoided (used less than expected) during all seasons (P < 0.01), coniferous stands were preferred (used more than expected) (P < 0.05) during all seasons except summer, and mixed stands were used in proportion to their

Table 4. Distribution of winter transects, fisher trails, and hare patches by overstory type<sup>a</sup> in south-central Maine, 1985–86.

Overstory type	Transects (%)	Fisher trails		Hare patches	
		%	Index <sup>b</sup>	%	Index
Deciduous	24	21	−0.07	5	−0.65
Coniferous	17	26	+0.21	31	+0.29
Mixed	56	51	−0.05	63	+0.06
Scrub	2	1	−0.33	1	−0.31
Wetlands	1	1	0	0	−1.00

<sup>a</sup> Excluding non-forest types.  
<sup>b</sup> Index = (X − Y)/(X + Y); X = % fisher trails or hare patches, Y = % transects (Ivlev 1961).

availability (P > 0.05) during all seasons (Table 2). Scrub stands were avoided during winter and spring (P < 0.05) and wetlands were avoided (P < 0.05) during all seasons except fall (Table 2).

Fishers rested in different habitats, depending on season and type of site. Fishers used 3 types of rest sites: ground burrows, tree cavities, or tree nests (Table 3). Tree nests were used most often during most of the year. These usually were clumped growths or “witches brooms” (Wynne and Sherburne 1984) in balsam fir trees. Squirrel or raptor nests were used occasionally. Ground burrows (probably excavated by woodchucks [*Marmota monax*]) were used more commonly during winter. Snow burrows were never used, although fishers often tunnelled through ≤1.5 m of snow to reach a ground burrow. Fishers rested in tree cavities during short periods in fall and spring when snow was absent, nights were cool (<0 C), and days were mild. Cavities also were used as natal dens by 3 females during spring 1987. All dens were in hollow aspen (*Populus tremuloides*) trees and were used for 2–12 weeks. Other rest sites were rarely reused.

Fishers rarely rested on the ground surface. Observer’s movements caused fishers to flush from rest sites on 27 occasions (13% of attempts). Several flushes were of fishers resting in trees, but others may have been of fishers resting on the ground.

Fishers always rested in forested areas (Table 2). Use of forest types was related to site type, because tree nests usually were in coniferous trees, cavities usually were in deciduous trees, and burrows occurred in all forest types. Thus, deciduous stands were avoided during all seasons (P < 0.01); coniferous stands were preferred (P < 0.01) during all seasons except win-



Table 5. Distribution of winter transects, fisher trails, and hare patches by understory type<sup>a</sup> in south-central Maine, 1985–86.

Understory type	Transects (%)	Fisher trails		Hare patches	
		%	Index <sup>b</sup>	%	Index
Open	21	30	+0.18	23	+0.05
Deciduous					
Sparse	17	14	−0.10	8	−0.36
Dense	3	1	+0.08	4	+0.14
Coniferous					
Sparse	33	36	+0.04	23	−0.18
Dense	4	3	−0.14	32	+0.78
Mixed					
Sparse	20	14	−0.18	9	−0.38
Dense	2	2	0	1	−0.33

<sup>a</sup> Excluding non-forest types.  
<sup>b</sup> Index = (X − Y)/(X + Y); X = % fisher trails or hare patches, Y = % transects (Ivlev 1961).

ter ( $P > 0.05$ ); and mixed stands were used in proportion to their availability ( $P > 0.05$ ) during all seasons except winter, when they were preferred ( $P < 0.01$ ). Scrub stands and wetlands were used infrequently during all seasons (Table 2).

During winter, we followed 56 fisher trails for 33.8 km and surveyed 46.5 km along 18 transects. The proportion of distance travelled by fishers in stands with coniferous overstories was greater than that on transects; fishers used hardwood, mixed, and scrub stands less (Table 4). Stands with no understory and those with sparse coniferous understories were used most frequently (Table 5), and these were usually found with coniferous overstories. However, index values showed no strong preference or avoidance for understory or overstory types, which suggested that fishers travelled widely in all types. Our results may be misleading, because we underestimated the distance that fishers travelled in dense patches of hare tracks.

Hare patches were associated with coniferous overstories and dense understories (Tables 4 and 5), and fishers probably used these types more than tracking indicated.

Fisher prey species showed a variety of habitat preferences (Tables 6 and 7). Although porcupines avoided coniferous stands ( $P < 0.05$ ), hares preferred them ( $P < 0.05$ ), and small mammals were equally abundant in all types ( $\chi^2 = 9.0$ , 4 df,  $P = 0.06$ ). Deciduous stands were avoided by hares and squirrels ( $P < 0.05$ ), but used by porcupines. Many deciduous stands also contained apples. Small mammals showed no preferences for understory types ( $\chi^2 = 10.3$ , 6 df,  $P = 0.11$ ), but hares preferred dense understories ( $P < 0.05$ ) and squirrels and porcupines were most common in sparse understories (Table 7). Encounter rate (tracks/day/km) for porcupine trails was lower on fisher trails than on transects ( $P = 0.0009$ ), but there were no differences for squirrels ( $P = 0.67$ ), small mammals ( $P = 0.82$ ), hares ( $P = 0.25$ ), or all species combined ( $P = 0.10$ ) (Table 8).

Diet

We collected 68 fisher scats during December–March; these contained 20 food types (Table 9). Apple was the most common item and usually composed the greatest proportion of a scat. Porcupines and snowshoe hares were the 2 most common mammal species. When grouped together, the 3 species of squirrel were the most common mammal prey, and small mammals (i.e., mice, voles, and shrews) were second.

We found tracks and signs indicating 3 kills: 2 of porcupines and 1 of a mouse. We found fresh porcupine quills in captured fishers on 12 occasions involving 9 animals (all M). These represented 26% of all captures of males ( $n = 46$ ) and 32% of all males captured ( $n = 28$ ). Fishers often foraged around apple trees in winter and

Table 6. Distribution of prey tracks/day in snow by overstory type,<sup>a</sup> south-central Maine, 1985–86.

Overstory type	Transect (%)	Hare		Porcupine		Squirrel		All <sup>b</sup>	
		%	CI <sup>c</sup>	%	CI <sup>c</sup>	%	CI <sup>c</sup>	%	CI <sup>c</sup>
Deciduous	24	4	1.9−	39	17.3	14	4.8−	12	2.3−
Coniferous	17	33	4.5+	2	5.0−	20	5.6	25	3.1+
Mixed	56	62	4.6+	59	17.4	64	6.7+	61	3.5+
Scrub	2	1	0.9−	0	0 <sup>d</sup>	2	1.9	1	0.7−
Wetlands	1	0	0	0	0	2	1.9	1	0.7

<sup>a</sup> Excluding non-forest types.  
<sup>b</sup> Tracks of hares, porcupines, squirrels, and small mammals combined.  
<sup>c</sup> 95% CI = % prey trails ± indicated value; + = preference − = avoidance at  $P < 0.05$  (Z-test).  
<sup>d</sup> No CI possible when type is not used.

Table 7. Distribution of prey tracks/day in snow by understory type,<sup>a</sup> south-central Maine, 1985–86.

Understory type	Transect (%)	Hare		Porcupine		Squirrel		All <sup>b</sup>	
		%	CI <sup>c</sup>	%	CI <sup>c</sup>	%	CI <sup>c</sup>	%	CI <sup>c</sup>
Open	21	11	3.0–	9	10.1–	17	5.2	15	2.5–
Deciduous									
Sparse	17	5	2.1–	28	15.9	11	4.4–	9	2.0–
Dense	3	3	1.6	3	6.0	1	1.4–	2	0.9–
Coniferous									
Sparse	33	36	4.6	13	11.9–	40	6.8+	36	3.4
Dense	4	21	3.9+	8	9.6	7	3.6	14	2.5+
Mixed									
Sparse	20	18	3.7	39	17.3+	23	5.9	19	2.8
Dense	2	6	2.3+	0	0 <sup>d</sup>	0	0	4	1.4+

<sup>a</sup> Excluding non-forest types.  
<sup>b</sup> Tracks of hares, porcupines, squirrels, and small mammals combined.  
<sup>c</sup> 95% CI = % prey trails ± indicated value; + = preference, – = avoidance at *P* < 0.05 (Z-test).  
<sup>d</sup> No CI possible when type is not used.

obtained apples by climbing trees and by digging in snow. Carrion was not commonly encountered along fisher trails, although 1 fisher uncovered and chewed on the dried leg of a raccoon. On 3 occasions fishers passed by carcasses of porcupines without eating them. Although we found 1 moose and 3 deer carcasses, only 1 deer carcass was visited by fishers.

DISCUSSION

Because of the diversity of the fisher’s diet, it was not surprising that we found little evidence of active fishers selecting for particular forest types. The distribution of tracks along transects suggested that at least some of the 4 major groups of mammalian prey (hares, porcupines, squirrels, and small mammals) were present in all forested habitats. The only indication of preferential use of habitats by active fishers during winter was their obvious change in behavior when they encountered dense patches of hare tracks. Although we could not quantify this

preference, fisher behavior clearly indicated that these were important foraging areas.

Fishers did not encounter tracks of any prey species more frequently than did random transects, which indicated that fishers did not search for any particular food (with the possible exception of hares). It is difficult to explain why fishers encountered porcupine trails less than was expected, because porcupine hair and quills were common in fisher scats. Although porcupines were rarely found in areas with dense undergrowth, they may have been especially vulnerable to fisher predation when travelling through these areas. We found no indication that fishers searched for porcupines or investigated porcupine dens, as noted by Powell (1977). Coulter (1966) found porcupine remains in scats of male and female fishers with similar frequencies, and Coulter (1966) and Powell (1977) observed captive female fishers killing porcupines. However, quills were more common in carcasses of males than females (Rego 1984,

Table 8. Frequency of encountering prey trails in snow on fisher trails and transects in south-central Maine, 1985–86.

Species	Fisher trails		Transects		<i>t</i> <sup>b</sup>	<i>P</i>
	$\bar{x}$ <sup>a</sup>	SD	$\bar{x}$ <sup>a</sup>	SD		
Hare	0.1446	0.1314	0.1070	0.0637	1.1658	0.25
Porcupine	0.0015	0.0070	0.0167	0.0311	–3.4545	<0.01
Squirrel	0.0856	0.0642	0.0790	0.0276	0.4247	0.67
Small mammal <sup>c</sup>	0.0433	0.0477	0.0461	0.0290	–0.2320	0.82
All prey <sup>d</sup>	0.2038	0.1116	0.1583	0.0475	1.6743	0.10

<sup>a</sup> Arcsine transformation of tracks/day/km.  
<sup>b</sup> *t*-test comparing fisher trails and transects; df = 72.  
<sup>c</sup> Mice, voles, and shrews.  
<sup>d</sup> Hares, porcupines, squirrels, small mammals, and unknown small mammals.

Table 9. Occurrence of foods in 69 fisher scats from south-central Maine during winter, 1984–87.

Food type	Occurrence		Predominant food <sup>a</sup>	
	n	%	n	%
Fruits	25	37	20	29
Apple	23	34	19	28
Winterberry ( <i>Ilex verticillata</i> )	2	3	1	1
Squirrels	17	25	15	22
Gray squirrel	11	16	10	15
Flying squirrel	4	6	3	4
Red squirrel	2	3	2	3
Porcupine	14	21	6	9
Small mammals	15	22	4	6
Shrews	4	6	2	3
Voles	4	6	0	0
Mice	2	3	0	0
Unknown small mammal	5	7	2	3
Snowshoe hare	12	18	10	15
Birds <sup>b</sup>	9	13	4	6
White-tailed deer ( <i>Odocoileus virginianus</i> )	5	7	2	3
Other <sup>c</sup>	21	31	7	10

<sup>a</sup> Species composed the greatest percent by volume of each scat.  
<sup>b</sup> Mainly domestic chickens and ruffed grouse (*Bonasa umbellus*).  
<sup>c</sup> Raccoon, skunk (*Mephitis mephitis*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), miscellaneous matter, or unknown.

Douglas and Strickland 1987), and in our study only males were found with fresh quills, suggesting that males may kill porcupines more frequently than do females.

Fishers preferred coniferous trees for resting sites during much of the year. Although single coniferous trees within deciduous stands were used occasionally, fishers usually chose sites that were surrounded by other coniferous trees. This might have been because coniferous trees provided more shade or concealment. Fishers did not need large blocks of coniferous forest, however, as clumps <0.5 ha were often used.

Differences between habitat use patterns indicated by aerial locations (which probably included resting and active animals) and by resting sites suggested use of forest types by active fishers. During spring and fall there were no differences, indicating that habitat use patterns were similar for resting and active fishers or that most aerial locations were of resting fishers. During summer and winter there were differences, which suggested that active and resting fishers used different habitats. During summer, fishers rested in coniferous stands more often than was expected, but aerial locations did not show this

preference. Thus, active fishers probably used a wider variety of forest types than did resting fishers. During winter the situation was reversed. Aerial locations showed a preference for coniferous stands but not mixed stands, while resting sites showed a preference for mixed stands but not coniferous stands. The preference for coniferous types shown by aerial locations probably was due to fishers hunting in hare patches, which were not adequately sampled by snow tracking.

Hares in Maine preferred areas with dense undergrowth in winter, but this preference was less pronounced during summer, particularly in areas with sufficient deciduous understories (Litvaitis et al. 1985). A greater diversity of food types, including a wide variety of fruits, was available to fishers during summer. Some kind of food was likely to be found in most forest types, so fishers probably hunted in a variety of types during summer.

Fishers in our study ate more apples and less carrion than those in other areas (Coulter 1966, Kelly 1977, Powell 1982), probably because of the abundance of apple trees and the relative scarcity of carrion (a result of mild winters). The fishers' preference for apples did not cause them to prefer deciduous stands because apples were common around abandoned farms, which usually supported mixed second-growth forest.

Although snow conditions did not seem to affect fisher habitat use in our study, fishers in more northern areas may be restricted to habitats where snow conditions are most favorable (Leonard 1980, Raine 1983). If snow cover limits fisher populations by restricting fisher movements, this might favor pine marten (*Martes americana*), by reducing competition (deVos 1952, Clem 1977, Raine 1983). The diversity of habitats used by fishers in our study suggests that fishers might be better adapted to deciduous and transitional habitats, rather than northern coniferous forest. This conclusion is supported by Hagemeyer's (1956) reconstruction of the species' original range, which showed fishers inhabiting more southern areas and pine marten ranging farther north. Fishers were abundant and marten were rare in our study area and throughout southern Maine; fishers were less abundant and marten were common in the spruce-fir forests of northern Maine, where snow accumulations were deepest (Me. Dep. Inland Fish. Wildl. 1986).



## MANAGEMENT IMPLICATIONS

Allen's (1983) habitat suitability index model assumes that optimum fisher habitat is mature coniferous forest. This might be true in areas where deep snow restricts fisher movements in habitats with little overhead cover. However, given the diversity of the fisher's diet and the productivity of the fisher population in south-central Maine (as indicated by the fur harvest), we suggest that optimum fisher habitat in the southern part of the species' range probably consists of a diversity of forest types with high interspersed. Quality of habitat for fishers in these areas probably declines when stand composition exceeds 75% conifers. Mature hardwoods may be required for natal dens and resting sites. Small ( $\leq 5$  ha) openings that reduce canopy closure to 50% probably do not reduce habitat quality. Rather, such openings help maintain forest diversity and the abundance of a variety of prey species.

Fishers in south-central Maine tolerated a fairly high degree of human activity, including low-density housing, farms, roads, small clearcuts, gravel pits, and intense trapping pressure. This probably was because of the extent and diversity of the forest in the area and because fisher movements were not restricted by large areas of open or developed land. During recent years, the amount of forest that was cleared was balanced by farmland reverting to forest (Vonk 1975). The pattern of small woodlot management in the area probably benefitted fishers by maintaining forest diversity without creating large openings. This is unlikely to continue, however, because more forest is being converted to housing. Continued monitoring will be necessary to determine the effects of increased human activity.

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## WINTER FOODS OF FISHERS DURING A SNOWSHOE HARE DECLINE

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**Abstract:** I studied the diets of fishers (*Martes pennanti*) in Minnesota during 8 winters when the snowshoe hare (*Lepus americanus*) population declined. Fishers consumed less hare as the hare population declined, but fisher fat deposits and reproduction did not decrease. Fisher numbers in Minnesota are unlikely to track hare cycles and further restrictions on trapping may not be necessary to counteract effects of the hare decline.

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Many fisher populations rely on snowshoe hare as food (Clem 1977, Brown and Will 1979, Arthur 1987). Bulmer (1974, 1975) examined records of fur sales in Canada and concluded that population fluctuations of fishers were linked to hare cycles. Population models indicated fisher numbers in Michigan would fluctuate with hare cycles (Powell 1979), but not decline to extinction (Powell 1980). Powell (1979) suggested that the models have “implications for fisher populations anywhere” and recommended management strategies based on them. However, long-term studies have not documented the effects of changing hare populations on fisher condition or population characteristics, and Powell (1980) noted that “there is no evidence concerning whether fishers switch between prey in response to changes in prey density.” Other northern predators exhibit functional and numerical responses to hare cycles. When hare numbers decreased in Alberta, lynx (*Felix lynx*) consumed less hare and became leaner (Brand and Keith 1979), kittens starved, yearlings conceived less often (Brand et al. 1976), and litter size among adults decreased (Brand and Keith 1979). In Alberta, breeding by yearling female coyotes (*Canis latrans*) and mean litter size of adult

females decreased when hare numbers were low (Todd et al. 1981). In Ontario, 1-year-old female martens (*Martes americana*) delayed breeding 1 year when prey, including hares, declined in abundance, ovulation rates of 2-year-old females decreased, and many litters apparently died in utero or as neonates (Thompson and Colgan 1987). Also, the number of juveniles/female  $\geq 2$  years and the percentage of juveniles in the marten harvest decreased as prey populations declined. I describe the diet of fishers in Minnesota during 8 winters when the hare population declined, and relate it to fluctuations in prey availability, fisher fat deposits and reproduction, and to the age structure of the fisher harvest.

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## METHODS

Skinned fisher carcasses were collected from trappers and fur buyers in northern Minnesota during the 1 December–31 January trapping