Fisher

Martes pennanti

Original prepared by Mike Badry[1]

Species Information

Taxonomy

Fishers (*Martes pennanti*) belong to the family Mustelidae (weasels). Fishers are considered to be a single undifferentiated species throughout their range (Powell 1993). Fishers are closely related to the other six members of the genus *Martes*: Eurasian Martens (*M. martes*), American Martens (*M. americana*), Yellow-throated Martens (*M. flavigula*), Japanese Martens (*M. melampus*), Sables (*M. zibellina*), and Stone Martens (*M. foina*). Fishers are sympatric throughout much of their range with American martens (Hagmeier 1956; Krohn et al. 1995), which are the only other *Martes* species found in North America.

Description

Fishers have long, thin bodies that are characteristic of most mustelids. Fishers have dense, long, luxurious, chocolate-brown coloured fur, with considerable grizzling patterns around the shoulders and back. Their tails are furred and make up about one-third of their total body length. Fishers have pointed faces, rounded ears, and short legs (Douglas and Strickland 1987). In British Columbia, adult females weigh on average 2.6 kg whereas males weigh 4.8 kg (R.D. Weir, unpubl. data). The average body length, excluding the tail, is 51 cm for females and 60 cm for males (Douglas and Strickland 1987). Fishers can be differentiated from American Martens by their larger body size (approximately 2–3 times larger), darker colouring, and shorter ears.

Distribution

Global

In North America, Fishers occur south of 60° N. They are distributed across the boreal forests and in southerly projections of forested habitats in the Appalachian Mountains and Western Cordillera (Douglas and Strickland 1987; Proulx et al. 2003). Fishers occur in most provinces and territories in Canada, except Newfoundland and Labrador, Nunuvut, and Prince Edward Island (Proulx et al. 2003).

The distribution of fishers in North America has probably been considerably reduced since pre-European contact (ca. 1600; Proulx et al. 2003). The current distribution of fishers has declined primarily in areas south of the Great Lakes region, but has also diminished in some areas of southeastern Ontario and Quebec, the Prairie Provinces, and in the western United States (Gibilisco 1994). The fisher has been extirpated from most of its former range in the western United States (Carroll et al. 1999).

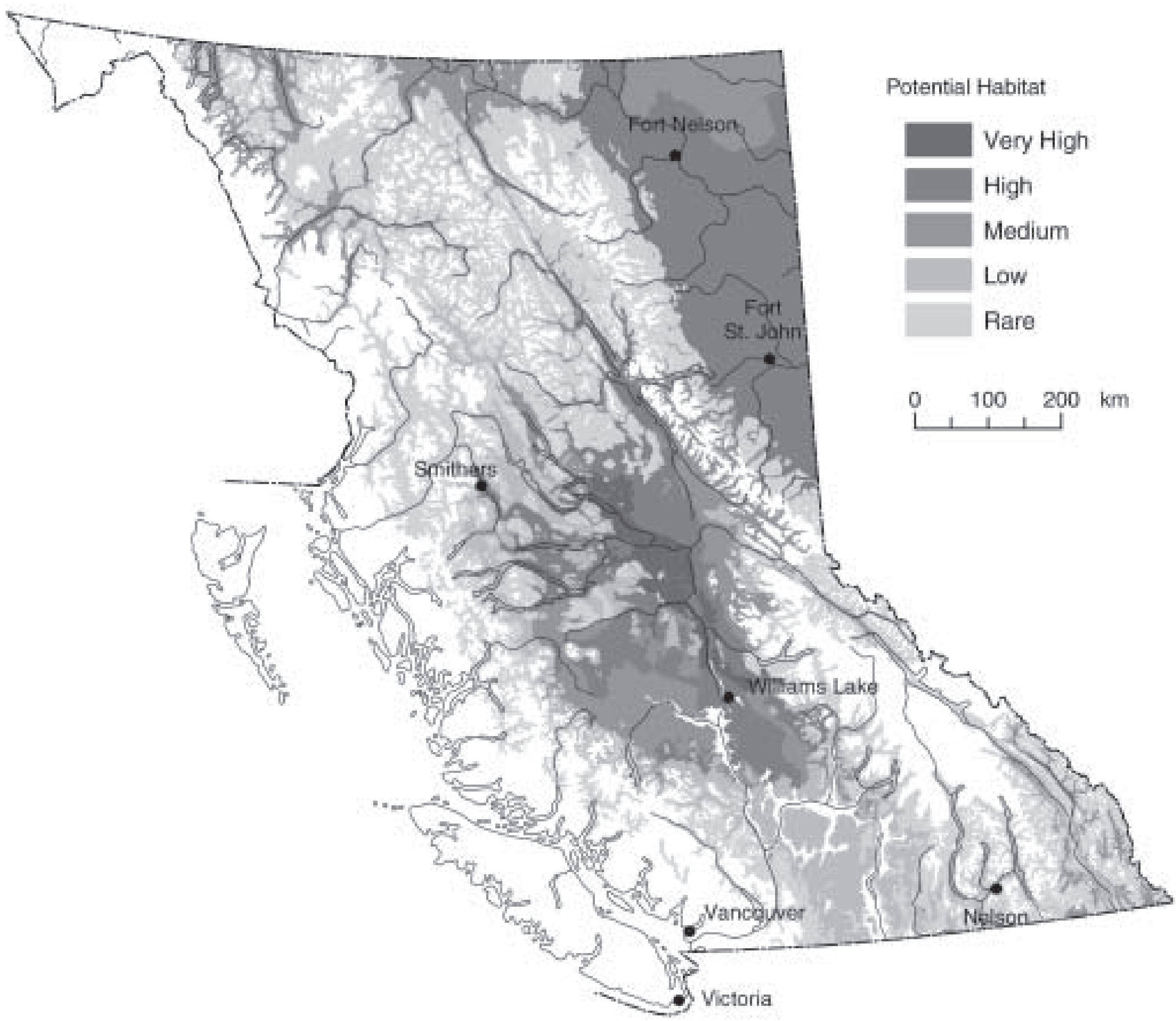
British Columbia

Although fisher occur throughout British Columbia, they are rare in coastal ecosystems. Fishers are currently believed to primarily occur in the Boreal Plains, Sub-Boreal Interior, Central Interior, and Taiga Plains ecoprovinces (Weir 2003). Fisher populations probably have very limited distribution in some portions of the Coast and Mountains, Southern Interior Mountains, Southern Interior, and Northern Boreal Mountains ecoprovinces and have likely disappeared from the Cascade and Okanagan Mountain ranges of the southern interior and in the Columbia and Rocky Mountain ranges south of Kinbasket Reservoir.

1 Account largely adapted from Weir 2003.

Fisher

(Martes pennanti)



Note: This map represents a broad view of the distribution of potential habitat used by this species. The map is based on several ecosystem classifications (Ecoregion, Biogeoclimatic and Broad Ecosystem Inventory) as well as current knowledge of the species' habitat preferences. This species may or may not occur in all areas indicated.

A reintroduction program of 61 fishers was conducted in the southern Columbia Mountains west of Cranbrook, which may have restored a small population of fishers in this region (Fontana et al. 1999).

Forest regions and districts

Coast: Campbell River, North Coast, North Island, Squamish, Sunshine Coast

Northern Interior: Fort Nelson, Fort St. James, Kalum, Mackenzie, Nadina, Peace, Prince George, Skeena Stikine, Vanderhoof

Southern Interior: 100 Mile House, Arrow Boundary, Cascades, Central Cariboo, Chilcotin, Columbia, Headwaters, Kamloops, Kootenay Lake, Okanagan Shuswap, Quesnel, Rocky Mountain

Ecoprovinces and ecosections

BOP: all

CEI: all

COM: CPR, CRU, KIM, MEM, NAB, NAM

NBM: CAR, EMR, HYH, KEM, LIP, MUF, NOM, SBP, STP, TEB, TEP, THH, TUR, WMR

SBI: all

SIM: BBT, BOV, CAM, CCM, ELV, EPM, FLV, FRR, MCR, NKM, NPK, QUH, SFH, SHH, SPM, UCV, UFT

SOI: GUU, HOR, LPR, NIB, NOH, NTU, OKR, PAR, SCR, SOH, SHB, TRU

TAP: all

Biogeoclimatic units

BWBS, CWH, ESSF, ICH, MH, MS, SBPS, SBS, SWB (all possible subzones/variants)

IDF: dk3, dk4, dm1, dm2, dw, mw1, mw2, ww, ww2, xm

Broad ecosystem units

Broad ecosystem units of high value are IH, SD, RR, SF (interior locations only), and WR. Those of medium value are BA, BP, DF, DL, ER, HB, IS, and SL.

Elevation

Fishers tend to inhabit low to mid-elevations, up to 2500 m, and are not found at high elevations. Powell and Zielinski (1994) report that the majority of fishers are found below 1000 m and Banci (1989) indicates that fishers occur in middle range elevations. Fishers are likely confined to low elevations during periods of heavy snow (Powell and Zielinski 1994) and changes in elevation between seasons do not occur (Banci 1989).

Life History

Diet and foraging behaviour

Fishers are generalist predators and typically eat any animal they can catch and kill, although they may specialize on porcupines (*Erethizon dorsatum*) and snowshoe hares (*Lepus americanus*) in some areas (Powell 1993). Other reported foods include deer (*Odocoileus* spp., primarily as carrion), squirrels (*Tamiasciurus* and *Glaucomys* spp.), microtines, shrews (*Sorex* species), birds (mostly passerine and galliform), American martens, berries and other vegetation, and even fish and snakes (Coulter 1966; Clem 1977; Kelly 1977; Kuehn 1989; Arthur et al. 1989a; Giuliano et al. 1989; Martin 1994). Most foraging in winter occurs above the snow layer, and as such snow conditions likely influence foraging and distribution patterns. Summer foraging is strongly associated with coarse woody debris (CWD). Primary prey species are associated with abundant CWD and understorey shrub cover.

Diet is affected by several factors including prey availability, abundance, and size. Fishers are able to switch foods when populations of their primary prey fluctuate, permitting them to compensate for changes in prey availability.

Reproduction

Fishers have a reproductive system that results in a low reproductive output relative to their lifespan. Females produce at most one litter per year after they have reached 2 years of age (Douglas and Strickland 1987). Fishers are polygamous breeders, copulating with multiple conspecifics in early April.

Female fishers have an oestrus period lasting 2–8 days approximately 3–9 days following parturition (Hall 1942). A second oestrus cycle may occur within 10 days of the first cycle (Powell 1993).

Female fishers reproduce by delayed implantation (i.e., fertilized eggs lie dormant for approximately 10 months until implantation occurs; Douglas and Strickland 1987). This strategy is fairly common among mustelids (Mead 1994). Active development of the fetuses begins in middle to late February and lasts about 40 days (Frost et al. 1997).

The date of parturition varies throughout the range of fishers, but generally occurs between February and early April (Douglas and Strickland 1987). Reported parturition dates for fishers in British Columbia were between 23 March and 10 April (Hall 1942; Weir 2000). The mean date of parturition of radio-tagged fishers in the Williston region was 6 April (Weir 2000). Captive fishers in the East Kootenay region gave birth to litters between 17 March and 4 April (Fontana et al. 1999).

Fishers typically give birth to between one and three kits in late winter (Powell 1993), with a mean litter size of 2.7 kits (Frost and Krohn 1997). Fontana et al. (1999) recorded the sizes of 10 litters of captive females in British Columbia as ranging between 1 and 4 kits, with a mean of 2.6 kits. Actual reproduction in wild animals may be slightly lower; in Idaho, Jones (1991) estimated the average litter size of four reproductive fishers from placental scars to be 1.5 kits. Estimates from data from fishers harvested in British Columbia in the early 1990s indicated that the mean maximum number of kits per adult female was 2.3 (SE = 0.15; $n = 86$) during this time.

Female fishers typically give birth to their kits in natal dens. Newborn fishers typically weigh between 40 and 50 g and are completely dependent upon their mother for care (Powell and Zielinski 1994). Fisher kits are born with their eyes closed and they remain this way until 7–8 weeks of age. The mother supplies milk to her kits until they reach 8–10 weeks, after which she begins to provide them with solid food (Powell 1993). Fisher kits become mobile at 10–12 weeks, at which time they begin to leave their dens with their mothers (Paragi 1990). Kits travel with their mothers as they mature, presumably learning how to hunt prey and survive on their own. In Maine, kits were found to disperse from their natal home range in their first autumn (Arthur et al. 1993). However, data from the Williston region indicate that dispersal can occur later and successful establishment of home ranges may not occur until fishers are 2 years of age (Weir and Corbould, unpubl. data).

Site fidelity

Fishers are not widely reported to exhibit strong site fidelity, except for females with natal or maternal dens. On average, female fishers in Maine discontinued using maternal dens 71 days following parturition (Paragi et al. 1996). Female fishers may use between 1 and 5 maternal dens following abandonment of the original natal den (Paragi et al. 1996). Observations of natal dens being reused in subsequent years by fishers have been made in both the Williston and East Cariboo regions of British Columbia (Weir 1995, 2000).

Home range

Fishers are solitary and, other than mothers raising their young, they usually only interact with conspecifics during mating and territorial defence (Powell 1993). Fishers are aggressive and conspecific interactions may occasionally be fatal. The asociality of fishers is also exhibited in their spatial organization. Fishers tend to have intrasexually exclusive home ranges that they maintain throughout their lives. This is a common spacing pattern among mustelids (Powell 1979), in which home ranges of members of the same sex may overlap (Kelly 1977), but this is extremely rare among fishers (Arthur et al. 1989b).

Reported home range areas for fishers range from 4 to 32 km^2 for females and 19–79 km^2 for males. Powell (1994b) summarized the reported sizes of home ranges of fishers from across North America and derived a mean home range size of 38 km^2 for males and 15 km^2 for females. Estimates of home range sizes from Idaho and Montana suggest that the home range sizes of fishers are larger in western regions than in eastern and southern areas possibly because of lower densities of prey (Idaho, Jones 1991; Montana, Heinemeyer 1993). However, Badry et al. (1997) found that translocated fishers in

Alberta had home ranges of 24.3 km² and 14.9 km² for males and females, respectively, which were similar to home range sizes of fishers in eastern North America.

Weir et al. (in prep.) described the size and spatial arrangement of annual and seasonal home ranges for 17 radio-tagged resident fishers in two areas of central British Columbia. The annual home ranges of female fishers ($\bar{x}$ = 35.4 km², SE = 4.6, n = 11) were significantly smaller than those of males ($\bar{x}$ = 137.1 km², SE = 51.0, n = 3). Minor overlap was observed among home ranges of fishers of the same sex, but there was considerable overlap among home ranges of males and females. Home ranges that they observed in central British Columbia were substantially larger than those reported elsewhere in North America, particularly for males. Weir et al. (in prep.) hypothesized that the sizes of home ranges of fishers were relatively large because the density of resources in their study areas may have been lower than elsewhere. They also speculated that home ranges of fishers in their study areas were widely dispersed and occurred at low densities because suitable fisher habitat was not found uniformly across the landscape.

It is unclear what factors affect the size of home ranges in fishers, although it is likely that the abundance and distribution of resources play a critical role in determining home range size. Fluctuating prey densities, varying habitat suitability, and potential mating opportunities are all probably important factors that affect size of the home range. There is likely a lower density at which these resources become limiting which would result in abandonment of the home range (Powell 1994b).

Movements and dispersal

Very little is known about dispersal in fishers because few studies have been able to document this process. In eastern portions of their range, researchers have reported that fishers disperse from their natal home ranges during their first winter and establish home ranges in unoccupied habitats soon afterward (Arthur et al. 1993; Powell 1993). Information from the Williston region suggests that home range establishment may not necessarily occur at this time and may be delayed until fishers reach 2 years of age (R.D. Weir, unpubl. data).

Some evidence suggests that fishers may have poor dispersal capability. Arthur et al. (1993) observed that dispersing juveniles in Maine did not typically establish home ranges more than 11 km from their natal home ranges. A juvenile male fisher in the Williston region moved 20 km from its initial capture location to its eventual home range (Weir 1999). The low degree of relatedness among fisher populations across Canada, and in particular the East Cariboo and Omineca regions of British Columbia, as identified by Kyle et al. (2001), supports this hypothesis of low dispersal capability.

Despite the relatively short distances over which fishers have been documented to successfully disperse, fishers appear to be capable of moving widely through the landscape. A fisher with a radio-collar was photographed using a wildlife overpass in Banff National Park; over 200 km from the nearest radio-telemetry study (T. Clevenger, pers. comm.). A radio-tagged juvenile fisher in the Williston region travelled at least 132 km and covered over 1200 km² before it died 77 km from where it was first captured (Weir 1999). Weir and Harestad (1997) noted that translocated fishers in central British Columbia wandered widely throughout the landscape following release and covered areas of more than 700 km² while transient. They also observed that major rivers and other topographic features were not barriers to movements throughout the landscape.

The apparent contradiction between short successful dispersal distances and considerable movement potential of fishers may be because effective dispersal is dependent upon many factors in addition to the ability to move through the landscape. Suitable habitat and prey, avoidance of predators and other mortality agents, and the presence of conspecifics can all act in concert to affect successful dispersal.

The process of dispersal is integral to the persistence of fisher populations because fisher populations are inherently unstable (Powell 1994b) and are probably characterized by periods of local extinction and recolonization (Powell 1993). Thus, the ability of individuals to successfully disperse to unoccupied habitats is important for population persistence. Arthur et al. (1993) speculated that the short distances over which fishers dispersed in Maine could limit the ability of the species to recolonize areas where fishers have been extirpated. This relationship between recolonization and dispersal ability may hold true in British Columbia, but information on this is lacking.

Fishers move about their home ranges in their day-to-day activities of acquiring resources. With the exception of females maintaining natal or maternal dens, fishers do not base their activities from any one central point in their home range (Powell 1993). Fishers can typically cross their home range in 16 hours and travel up to 5–6 km/day (Arthur and Krohn 1991), although transient individuals have been observed moving up to 53 km in <3 days (Weir and Harestad 1997). Early snow-tracking studies suggested that fishers follow circuits of up to 96 km as they wander through their home range, although their movements may not necessarily follow such predictable routes (de Vos 1952). Arthur and Krohn (1991) noted that adult male fishers moved more widely during spring than any other season, presumably to locate potential mates.

Fishers typically have two or three periods of activity during the day (Powell 1993). In Maine, fishers were reported to have peaks in activity primarily in the early morning before sunrise and in the evening shortly after sunset (Arthur and Krohn 1991). Approximately half of all radio-locations of fishers in the Williston region indicated that fishers were active, but there was no consistent trend in the timing of activity (R.D. Weir, unpubl. data). Reproductive female fishers with kits were more active than non-reproductive females despite nursing kits each day (Arthur and Krohn 1991; R.D. Weir, unpubl. data). Both cold temperatures and deep snow probably reduce the activity of fishers (Powell 1993; R.D. Weir, unpubl. data).

Deep, soft snow may also inhibit the movements of fishers during winter. Fishers are reported to modify their small-scale movements within stands to avoid areas with less-supportive snow (Leonard 1980; Raine 1983). Weir (1995) suggested that fishers in the East Cariboo region of central British Columbia used patches with large trees because the overstorey closure afforded by these trees may have increased snow interception.

Habitat

Structural stage

Fishers forage within many structural stages. Structural stages 1a (non-vegetated) through 3b (tall shrub) are not used during winter but may be used in other seasons providing sufficient forage and security cover is present. Most habitat use is associated with structural stages 6 (mature forest) and 7 (old forest) where structural characteristics of older forests are most developed. Resting and maternal denning habitat is typically associated with structural stages 6 and 7, and key features are availability of CWD, large wildlife trees, and canopy cover in winter. Fisher will forage in a wider range of structural stages (particularly in summer) and habitat use may be influenced by population cycles of major prey species.

Important habitats and habitat features

In western coniferous-dominated forests, fishers appear to have affinities to specific habitat features, many of them found primarily in late-successional forests (Jones and Garton 1994; Weir 1995). Aspects of forest structure are likely more important determinants of distribution and habitat use than are forest types.

In British Columbia, preferred habitat resembles that found in SBS, SWB, and BWBS biogeoclimatic zones and more specifically riparian and dense wetland forest habitats within those zones. Fishers generally stay in or near forests with ^{3}30% canopy closure with a productive understorey that supports a variety of small and medium-sized prey species. The presence of suitable resting and maternal den sites is also important as is riparian-riparian and riparian-upland connectivity.

Resting

Fishers use rest sites for a variety of purposes, including refuge from potential predators and thermoregulatory cover (Kilpatrick and Rego 1994). Fishers have been reported to use a wide variety of structures as rest sites, including tree branches, tree cavities, in or under logs (hollow or solid), under root wads, in willow (*Salix* spp.) thickets, in ground burrows, and in rock falls (Raine 1981; Arthur et al. 1989a; Jones 1991; Powell 1993; Kilpatrick and Rego 1994; Gilbert et al. 1997).

Weir et al. (2003) identified four distinct types of structures used for resting by fishers in British Columbia: branch, cavity, CWD, and ground sites. Branch rest structures were arboreal sites that typically involved abnormal growths (i.e., brooms) on spruce trees caused by spruce broom rust (*Chrysomyxa arctostaphyli*) or on subalpine fir trees caused by fir broom rust (*Melampsorella caryophyllacearum*). Occasionally branch rest sites associated with exposed large limbs of black cottonwood (*Populus balsamifera trichocarpa*) and spruce (*Picea* spp.) trees were used. Cavity rest structures were chambers in decayed heartwood of the main bole of black cottonwood, aspen, or Douglas-fir (*Pseudotsuga menziesii*) trees; cavities were accessed through branch-hole entrances into heart-rot (black cottonwood, aspen [*Populus tremuloides*], or Douglas-fir trees) or excavations of primary cavity nesting birds (aspen trees only). Coarse woody debris rest structures were located inside, amongst, or under pieces of CWD. The source of CWD for these sites was natural tree mortality, logging residue, or human-made piling. CWD rest structures were usually comprised of a single large (>35 cm diameter) piece of debris, but occasionally involved several pieces of smaller diameter logging residue. Ground rest structures were those that involved large diameter pieces of loosely arranged colluvium (e.g., rock piles) or pre-excavated burrows into the soil. Weir et al. (2003) recorded fishers using branch rest structures most frequently (57.0%), followed by cavity (19.8%), CWD (18.6%), and ground (4.6%) rest structures.

The selection of rest sites by fishers may be mediated by ambient temperature. Weir et al. (2003) noted fishers used subnivean CWD rest structures when ambient temperatures were significantly colder than when they used branch and cavity structures. The thermal attributes of the four types of rest sites used by fishers in their study likely affected their respective selection and may help explain the patterns that they observed. Taylor and Buskirk (1994) measured and calculated the thermal properties of branch, cavity, and CWD sites in high-elevation forests of southern Wyoming. They found that CWD sites provided the warmest microenvironments during periods of cold temperatures (<–5°C), deep snowpack (>15 cm), and high wind speed. Branch or cavity sites were warmer during all other combinations of ambient temperature, snowpack, and wind (Taylor and Buskirk 1994). Although it is unlikely that fishers in British Columbia encounter temperatures that are near their estimated lower critical temperature for resting, they likely select rest structures that are the most energetically favourable to help maximize their fitness. Fishers in British Columbia exclusively used subnivean CWD structures for the energetic benefits that they confer relative to other structures when temperature were below –15°C (Weir et al. 2003). Fishers probably use branch and cavity structures for resting during most of the year because these sites provide an adequate thermal environment for most combinations of ambient temperature and wind speed.

Reasons for selecting specific rest structures probably change seasonally and thermoregulation is likely not the only factor that affects the selection of rest sites by fishers. Several authors have suggested that fishers rest close to food sources (de Vos 1952; Coulter 1966; Powell 1993). There are more suitable resting sites in trees than on the ground (Martin and Barrett 1991); hence, fishers may select tree sites because of their relative availability. Additionally, Raphael and Jones (1997) speculated that arboreal structures offer greater protection from predators than do ground sites. Because of their elevated position, tree sites may also enhance olfactory or visual discovery of approaching predators. Similarly, elevated sites may improve detection of potential prey, while providing areas for avoiding predators. Thus, in the absence of restrictive thermoregulatory demands, fishers probably select structures based upon these other factors.

Breeding

Female fishers appear to have very specific requirements for structures in which they rear their kits. Natal (i.e., whelping) and maternal (i.e., rearing) dens of fishers are typically found in cavities, primarily in deciduous trees (Powell 1993; Weir 2000). Leonard (1980) hypothesized that dens were situated in tree cavities because they provide thermal benefits and are more defendable. Female fishers use between one and five maternal dens following abandonment of the original natal den (Paragi et al. 1996). In eastern parts of their range, fishers have been documented whelping in a variety of hardwood trees (Maine: median diameter = 45 cm, Paragi et al. 1996; New England: $\bar{x}$ = 66 cm, Powell et al. 1997; Wisconsin: $\bar{x}$ = 60.9 cm, Gilbert et al. 1997). In contrast, recent work by Aubry et al. (2001) has identified fishers in southwestern Oregon using cavities and witches' brooms in coniferous trees (Douglas-fir, incense cedar [*Calocedrus decurrens*], grand fir [*Abies grandis*], western white pine [*Pinus monticola*], and sugar pine [*Pinus lambertiana*]) and logs as natal and maternal dens.

In British Columbia, fishers have been recorded whelping in trees that are atypically large and uncommon across the landscape. Researchers have identified 11 natal and eight maternal dens of radio-tagged fishers, all of which were located in large diameter ($\bar{x}$ = 105.4 cm), declining black cottonwood or balsam poplar (*Populus balsamifera balsamifera*) trees (R.D. Weir, unpubl. data). Den cavities in these large trees were, on average, 15 m above ground (R.D. Weir, unpubl. data).

Elements with these traits may be rare across the landscape, as indicated by observation of natal dens being reused by fishers in the both the Williston and East Cariboo regions (Weir 1995, 2000). Weir (1995) found that 98% of random points in his study area in the East Cariboo had either no cottonwood trees or ones that were smaller than the minimum diameter of any natal or maternal den trees. Thus, suitable cottonwood trees may be an important component in the selection of a home range by female fishers (Weir 1995). The reasons that fishers select this type of tree for whelping is likely related to the decay characteristics of deciduous trees, which produce heart rot and cavities much earlier and at smaller diameters than coniferous trees. The cottonwood trees that fishers in British Columbia use may be atypically large because they grow faster than eastern deciduous trees and rot earlier.

All of the natal and maternal dens identified in British Columbia consisted of holes through the hard outer sapwood into cavities in the inner heartwood (R.D. Weir, unpubl. data). Black cottonwood trees are prone to decay of the heartwood at an early age (Maini 1968), but data from British Columbia suggest that cottonwood trees may be suitable for use by fishers for rearing kits when the bole at the cavity height is >54 cm diameter (R.D. Weir, unpubl. data). Although the relationship between dbh and dbh of the den is unclear, it appears that cottonwood trees need to be >88 cm dbh; for the cavity to be used by fishers, cavity entrances may need to be >5 m above ground (R.D. Weir, unpubl. data). Thus, for fishers to use black cottonwood trees for natal or maternal dens, the trees may need to have heart rot and a bole diameter >54 cm at 5 m above ground.

Foraging

Fishers require the presence of "available" prey and adequate security cover to use habitats for foraging. Availability of prey is affected by not only the abundance of the prey, but also its vulnerability to predation (Buskirk and Powell 1994). Vulnerability is affected by the presence of escape cover for the prey, which can include such features as snow cover and highly complex vegetative structure. Fishers rarely use open areas for foraging (Raine 1981), and when crossing them, they usually run (Powell 1981). Sufficient overhead cover in a foraging habitat can be provided by tree or shrub cover (Weir 1995).

Suitable combinations of available prey and adequate security cover likely occur in a variety of habitat types, and thus, fishers have been reported to use a wide array of habitats for foraging. Researchers have documented fishers using deciduous forests for hunting porcupines (Powell 1994a), riparian zones for small mammals (Kelly 1977), and densely regenerating coniferous habitats for hunting snowshoe hares (R.D. Weir, pers. comm.).

Regardless of prey species, foraging by fishers is believed to involve two components: locating patches of habitat with prey and searching for prey items within these patches (Powell 1993). Fishers appear to have a cognitive map of where suitable patches of prey may be within their home range and visit these areas to hunt for food (Powell 1994a). The characteristics of these patches are likely related to the type of prey that use them; Powell (1994b) noted that fishers hunted for snowshoe hares in patches of dense lowland conifers and for porcupine dens in open upland habitats. Fishers use several very different strategies when searching for prey within patches, depending on the prey being pursued. When searching for high-density prey in complex structure, fishers hunt using frequent changes in direction, presumably to increase chance encounters with prey (Powell 1993). When using habitats with relatively low densities of prey, fishers travel in more-or-less straight lines but will deviate from these routes to opportunistically capture prey (Powell 1993). Unlike the American Marten, fishers are somewhat limited to foraging on the snow surface during winter and are relatively ineffective at catching prey beneath the snow (de Vos 1952; Powell 1993). It is unclear whether the foraging strategies that fishers use for different prey are dependent upon the prey species' respective vulnerability, abundance, or both.

Conservation and Management

Status

Fishers are on the provincial *Red List* in British Columbia. Its status in Canada has not been evaluated (COSEWIC 2002). (See Summary of ABI status in BC and adjacent jurisdictions at bottom of page.)

Trends

Population trends

The range reduction in the eastern part of the fishers range observed in the early 1900s has been attributed to wide-scale habitat alterations and overtrapping (Douglas and Strickland 1987). Fisher populations are believed to be stable or expanding in the central and eastern portions of its range (Proulx et al. 2003), likely because of reforestation of abandoned agricultural lands, trapping restrictions, and several reintroduction programs.

Very little is known about population trends of fishers in British Columbia and what little is known has been derived from harvest statistics. The harvest of fishers in the province has fluctuated widely since 1919. Generally, the annual harvest of fishers decreased during the 1970s and 1980s. In 1973–1974, 1747 fishers were harvested, while in 1990–1991 only 93 fishers were harvested. The mean annual harvest of fishers in British Columbia over the past eight trapping seasons was 276 fishers (SE = 17, range: 206–348). However, harvest information can be biased and dependent upon many other factors in addition to population size, such as trapper effort (which is affected by fur prices, economic alternatives, and access) and vulnerability to trapping (Banci 1989; Strickland 1994).

Summary of ABI status in BC and adjacent jurisdictions (NatureServe Explorer 2002)

AB	AK	BC	ID	MT	NWT	OR	YK	WA	Canada	Global
S4	S?	S2	S1	S2	S?	S2	S?	SH	N5	G5

The Ministry of Environment collected 329 fisher carcasses from British Columbia between 1988 and 1993 to assess the harvest rate and population trends of fishers. Age, sex composition, and date of the harvest were determined from these carcasses. The harvest ratio during this survey was 1.34 juveniles per adult and 1.36 females per male. The low juvenile to adult female ratio in the harvest, in combination with a relatively low fecundity rate, suggests that the fisher population in British Columbia may have been declining in the early 1990s, despite a province-wide closure of the trapping season. Notwithstanding this possible decline, harvests of fishers since 1994 have remained relatively stable (about 275 fishers/yr). This may be due to the natural recovery of fisher populations following years of decline (Powell 1994b). Insufficient population inventory restricts our ability to assess the rate of decline or growth during the past 10 years.

A population estimate based on empirical data for fishers in British Columbia is lacking. However, a density estimate of one fisher per 146 km² from the Williston region can be extrapolated to other areas based upon habitat capability. The density estimate from the Williston region was derived for an area with 75% "moderately high" (SBSmk) and 25% "moderate" (SBSwk) habitat capability. These ranks are defined as areas that have densities between 51 and 75% (moderately high) and between 26 and 50% (moderate) of the benchmark density (RIC 1999). The benchmark is the highest capability habitat for the species in the province, against which all other habitats for that species are rated. It is used to calibrate the capability ratings by providing "the standard" for comparing and rating each habitat or ecosystem unit. Thus, using the Williston density of one adult fisher per 146 km², the provincial benchmark density for fishers would range between one fisher per 100 km² if the Williston estimate was 75% of the benchmark, and one fisher per 65 km² if the Williston estimate was 51% of the benchmark. Using the area of each habitat capability rank within the extent of occurrence of fishers in British Columbia, the late-winter population estimate for the province extrapolates to between 1113 and 2759 fishers.

Habitat trends

Habitat for fishers in British Columbia has undergone considerable anthropogenic change during the past 100 years. Habitat alterations, primarily through forest harvesting activities, hydroelectric developments, and land clearing, have changed the composition of many landscapes in which fishers occur. Because fishers rely on many of the habitats that are directly affected by these activities, these changes have likely had considerable effect on fisher populations in the province.

Hydroelectric developments have eliminated fisher habitat in several areas of the province. Flooding typically inundates, and thus removes, substantial portions of the riparian habitat that is found within a watershed. In the Williston region for example, the most productive habitats for fishers appear to be the late-successional riparian habitats that occur alongside meandering rivers (Weir and Corbould, unpubl. data). Much of this habitat in the region was removed with the flooding of 1773 km² of the Rocky Mountain Trench during 1968–1970 to create the Williston Reservoir. Almost 700 km² of "moderately high" capability habitat was flooded during the creation of the Ootsa Reservoir on the Nechako River. Similarly, flooding of ~700 km² of valley bottom habitats of the Columbia River likely removed much of the capable habitat for fishers in many areas of the Kootenay region (B. Warkentin, pers. comm.). The removal of these habitats from the land base has probably had highly localized negative effects on fisher populations in these areas.

Other human developments have diminished the quantity of fisher habitat in many areas of the province. Urban and semi-rural development associated with cities and towns in central British Columbia has probably reduced the quantity of habitat for fishers in some small portions of their range. Development of valley bottoms for agricultural operations has occurred extensively along the Nechako, Bulkley, and Fraser rivers. Clearing of land over the past 100 years for these activities has probably been detrimental to fisher populations because it removed most of the structures that fishers need for overhead cover, resting, whelping, and foraging. Development of valley bottom habitats in the Skeena region was thought to have effectively removed much of the suitable habitat for fishers (G. Schultze, pers. comm.).

Forest harvesting has probably had the greatest single effect on habitat quality for fishers throughout the province. During the last 15 years, over 213 000 km² of forested land has been harvested in the four forest regions that support fisher populations in the province. Of this 213 000 km², over 90% was logged using clearcut harvesting systems. Although a substantial portion of this area was probably outside of areas occupied by fishers, modification of late-successional forests into early structural stages through this type of forest harvesting has likely had detrimental effects on the ability of fishers to acquire sufficient resources to survive and reproduce.

Additionally, forests in considerable portions of the Fisher's range in British Columbia are currently experiencing substantial tree mortality caused by outbreaks of the mountain pine beetle (*Dendroctonus ponderosae*) and other insects. In the Prince George Forest Region alone, over 25 000 km² of forests are currently under attack from insects (MOF 2002), an area that is more than the total area that has been logged in the Cariboo, Kamloops, Prince George, and Prince Rupert forest regions combined over the past 15 years. Reduction in overhead cover in these areas may be detrimental to Fishers. However, wide-scale harvesting of these forests as part of salvage operations would likely contribute to a substantial decrease in the availability and suitability of Fisher habitat in the both the short and long term (G. Schultze, R. Wright, pers. comm.).

Threats

Population threats

Trapping has the potential to affect populations of Fishers by changing mortality rates and the reproductive potential of the population. Trapping of adults could exacerbate difficulties in Fishers successfully finding mates, which could potentially reduce the reproductive rates within the population. Trapping mortality may be compensatory for the juvenile cohort at moderate harvest intensities (Krohn et al. 1994), but the rate of harvest at which this mortality becomes additive is unknown. Trapping mortality within the adult cohort is probably additive to natural rates (Strickland 1994). Because Fishers typically do not breed until 2 years of age, maintaining this cohort is very important for population health.

Banci and Proulx (1999) identified Fisher populations as having low to intermediate resiliency to trapping pressure, which means that Fisher populations generally have a moderate capability to recover from a reduction in numbers. However, this assessment was primarily based on information from eastern parts of their range. Information specific to British Columbia suggests that fishers in this province have more limited range or distribution, lower reproductive rates, and larger home ranges than Fishers in other areas. These factors suggest that Fisher populations in British Columbia may have a lower resiliency to trapping than populations elsewhere.

Habitat threats

In an extensive review of the worldwide distribution of *Martes* species, Proulx et al. (2003) identified loss of forested habitat from human development as the main long-term threat to fisher populations throughout its range. For a species like fishers with large spatial requirements, the long-term maintenance of extensive forestlands will be the major conservation challenge (Proulx et al. 2003.) This risk is probably even greater in British Columbia, where the home ranges of fishers are larger and the density lower than in other portions of their range.

Forestry activities can affect the quality of fisher habitat in many respects. First, timber harvesting typically removes many of the features of late-successional forests that fishers rely upon, such as large spruce trees, and replaces them with stands that have fewer structural components and are of lower suitability (Weir 1995). Second, forest harvesting may negatively affect the distribution of the remaining habitat so that fishers have to search more widely to sequester sufficient resources. Third, the concomitant increase in access that occurs with forest harvesting in previously inaccessible areas may increase trapping mortality, possibly diminishing "source" populations.

Prior to logging, many forests likely provided habitat structures that fishers require for resting and reproduction (e.g., large cottonwood trees, CWD, large spruce trees). Forest harvesting, which is targeted primarily at late-successional forests, has likely altered the availability of these resources across spatial scales. The reduced availability of these habitat features has probably resulted in previously occupied landscapes becoming unsuitable for fishers.

The quality of regenerating clearcuts to fishers varies tremendously depending upon the silvicultural systems that are implemented. Fishers use many features of late-successional forests to fulfil several life requisites. Thus, the supply of these features is probably critical to the survival and reproduction of fishers. Forest harvesting activities tend to remove many of these features and the resulting silvicultural management of the regenerating forests suppresses the development and recruitment of these structures in managed areas.

Many attributes that are the result of natural processes of growth, disease, and decay of forested stands appear to be important for providing habitat for fishers. Thus, management of forested land that emphasizes tree growth and suppresses disease, death, and decay of trees may negatively affect the quality of fisher habitat. Monotypic stands that are low in structural and plant diversity probably fulfil few life requisites for fishers because many habitat elements that fishers and their prey are dependent upon are missing in these habitats. Thus, maintaining structurally diverse and productive fisher habitat in logged areas is not only a function of the method and extent of timber harvesting, but also the type of site preparation and subsequent stand tending.

The effects of alterations in habitat quantity and quality on fisher populations probably depend upon the scale and intensity at which the changes have occurred. Because the stand is the dominant scale at which an individual fisher operates within a home range, loss of habitats at this scale or larger will likely preclude use of that area by fishers. Habitat loss at smaller spatial scales likely affects the energetics of individual animals because they have to travel more widely to find food and other resources.

The quality of harvested areas is likely substantially diminished for fishers under typical clearcut and intensive forest management practices. With rotational forestry, many of the features of late-successional forests will be lost and not have the opportunity to regenerate. For example, large coniferous trees that are used by fishers for resting may vanish with short rotations (e.g., <100 yr). The retention of CWD within harvested sites may also be insufficient to supply cold-weather resting sites. Interspersion of deciduous trees for potential resting and den sites may disappear as they are removed during stand tending. Sufficient conifer cover may be present at the later stages of the rotation under intensive forest management.

Reductions in the quality and quantity of habitat for fishers will likely continue to occur in the future in British Columbia. Continued harvesting of late-successional forests using conventional clearcut harvesting at the 15-year average rate of 1422 km^2/yr will likely pose a substantial threat to fisher populations in the central interior of British Columbia.

Legal Protection and Habitat Conservation

Fishers are designated as wildlife in British Columbia under the *Wildlife Act* and cannot be hunted, trapped, or killed unless under license or permit. Fishers are also classified as "furbearers" and as such may be legally trapped under license during open seasons. Currently trapping seasons are open in the Thompson, Cariboo, Skeena, and Omineca/Peace regions between 1 November to 15 February. There is no open season in the Lower Mainland, Okanagan, and Kootenay regions. Furbearing species in British Columbia can only be harvested by qualified personnel on private land or registered traplines (where one individual or group has the exclusive right to harvest furbearers in a specified area). There is no quota on the harvest of fishers in British Columbia.

Fishers in British Columbia occur primarily on Crown land administered by the Ministry of Forests. Within the extent of occurrence of fishers in the province, ~7% lies within 385 protected areas. Many of these are too small to encompass the home range of a fisher; 65 are large enough to encompass the mean home range size of a female fisher (i.e., 35 km^2) and, of these, only 35 are large enough to encompass the mean home range size of a male fisher (i.e., 137 km^2).

Protected areas are generally comprised of low quality habitat for fishers. There is significantly more "nil," "very low," and "low" capability habitat and significantly less "moderate," "moderately high," and "high" capability habitat inside protected areas compared to outside these areas (R.D. Weir, unpubl. data).

Results based code provisions, such as wildlife tree retention areas, coarse woody debris recommendations, old forest retention, landscape level planning, and riparian management, have the potential to address fisher habitat requirements through the retention of large trees, dense canopy closure, and abundant levels of CWD (see following section).

Identified Wildlife Provisions

Sustainable resource management and planning recommendations

The following recommendations should be considered in areas of high management priority for fishers, such as the biogeoclimatic subzones of natural disturbance type (NDT) 3. Fisher populations in NDT3 are the highest in British Columbia because of the abundance of prey, favourable climate, and structurally complex forests with continuous overhead cover. Although the following recommendations have been developed for NDT3 (except for CWH, ICHdw, MSdk, MSdm, and SBSmc subzones) they may also be considered in other areas determined to be of high value to fishers such as the drier interior subzones of NDT2 and more northerly subzones of NDT4. These recommendations are based on the best technical information on the species at this time and some or all of them should be considered for application in localized portions of a planning area where the planning table intends to propose a conservation objective for the species.

- Fishers select resources at several spatial scales; thus it is important to consider management recommendations at all spatial scales including landscape, stand, patch, and feature. Consider the following recommendations:
- Maintain sufficient suitable habitat to support healthy populations of fishers. Areas managed for fisher should contain 30–45% mature and old forest, depending on the diversity of habitat available and prey abundance, and be suitable for fishers. Suitable habitat is characterized by shrub cover, coniferous canopy cover, sub-hygric or wetter moisture regime, patches of large, declining trees (particularly black cottonwood), and greater than average amounts of CWD for the zone.
- Maximize landscape connectivity through the use of corridors of mature and old seral forests. Ideally, connectivity should be centred on stream systems and can be achieved by maintaining large (e.g., 100 m where ecologically appropriate) riparian buffers on either side of streams (S1–S6), focusing on riparian areas that contain suitable habitat features to support fishers.
- The distribution of cutblock sizes should focus on the small and large sizes of the patch size recommendations described in the *Guide to Landscape Unit Planning*. Fishers will use small cutblocks but also require larger habitat areas. Over the long term, larger cutblocks will develop into these larger habitat areas.
- Maintain important structural attributes and natural structural complexity of forests.
- Maintain stands that provide sufficient snow interception, security, foraging, and resting cover. Silvicultural prescriptions should avoid producing stands in the herb structural stage with no CWD and strive to conserve stands with greater than average CWD and >30% closure of the coniferous canopy.

- Retain patches with a high degree of structure. Fishers use patches within otherwise unsuitable stands that provide sufficient habitat for security cover, foraging, snow interception, resting, and whelping. If it is not possible to conserve stands with the features listed above, conservation of patches within these stands should be maintained. Proposed structural variables within these retention areas include relatively high volume of CWD, large diameter (>20 cm) and elevated CWD, increased canopy and high shrub closure, and increased stocking of trees (including large diameter (>40 cm dbh) and trees containing rust brooms). If the stand that is created or otherwise altered has structural features that are less than any of the desired levels, patches with more structure should be retained.
- Retain important habitat features across the landscape.
- When using wildlife tree or old forest retention to provide denning opportunities for fishers, use Table 1 to select suitable sites.
- It is recommended that salvage does not occur in WTR areas and OGMAs established to provide habitat for this species. In addition these areas should be designed to include as many suitable wildlife trees as possible and that they should be maintained over the long-term (>80 yr).
- Ensure recruitment of suitable den sites. The availability of suitable maternal and resting den sites may be limiting factors for fisher populations.
- Maintain natural levels, decay and size characteristics as well as dispersion of CWD.

Wildlife habitat area

Goal

Maintain resting and maternal den sites.

Feature

Establish WHAs at suitable resting or maternal den sites where riparian and riparian-associated habitats contain an abundance of the specific habitat attributes described above (e.g., large declining cottonwoods), and are not included within riparian reserve zones.

Size

Generally between 2 and 60 ha but will ultimately be based on the extent of appropriate habitats.

Design

When selecting WHA boundaries, maximize the inclusion of important habitat features such as large cottonwoods and riparian habitats. Ensure suitable den sites are sufficiently buffered.

Table 1. Preferred wildlife tree retention area and old growth management area (OGMA) characteristics for fishers

Attribute	Characteristics
Size (ha)	≥2 ha
WTR location	Riparian and riparian-associated habitats
Tree features	Presence of cavities, particularly those created from broken branches and primary excavators. Large cottonwoods with cavities (>75 cm), trees with broom rust or witches broom (>40 cm dbh), and trees with heart rot and a bole diameter >54 cm at 5 m above ground.
Tree species	Cottonwood, fir, spruce, or balsam poplar
Tree size (dbh*)	>75 cm cottonwood or fir, >40 cm spruce (minimum 25 cm). Without trees with the preferred dbh, retain the largest available in the stand for recruitment.
Decay class	2 or 3 preferred, 2–6 acceptable
Structural features	Presence of large diameter (>65 cm dbh) , elevated pieces of CWD; CWD in decay classes 2–6; declining cottonwoods (>87 cm dbh)

General wildlife measures

Goals

1. Maintain mature and old cottonwood and large diameter fir and spruce along riparian and riparian-associated habitats.
2. Maintain connectivity between riparian and upland habitats.
3. Maintain important structural attributes for fishers and prey species (i.e., CWD, wildlife trees, cottonwood, and large fir and spruce).

Measures

Access

- Do not develop roads. Where there is no alternative to road development, close road during critical times and rehabilitate.

Harvesting and silviculture

- Do not harvest or salvage.

Pesticides

- Do not use pesticides.

Additional Management Considerations

Reduce incidental harvest of fishers in marten traps (i.e., specially designed traps that exclude fishers, changes to trapping timing).

Refuges have been suggested as an option for population management of fishers (Strickland 1994). Refuges are untrapped areas within fisher populations that act as source populations for trapped areas, and also as insurance against population reductions (Banci 1989). For example, persistence of fisher populations in the Omineca region has been largely attributed to untrapped traplines providing dispersing individuals into actively trapped areas (G. Watts, pers. comm.). Explicitly establishing refuges across the range of fishers in British Columbia would involve considerable co-operation among registered trapline owners and regulatory agencies (MWLAP, MOF).

Information Needs

1. Information on reproduction and trends including conception rates, litter sizes, survival to dispersal, and net recruitment to be able to better predict the ability of fishers in British Columbia to respond to changes in harvest and habitat change.
2. Threshold densities at which fishers can no long acquire sufficient resources at different spatial scales.
3. Reasons for the reuse of structures for whelping and resting remain unclear. Future effort should be directed towards continuing to assess reuse of natal dens and to determining if the availability of suitable den sites is limited across the landscape.

Cross References

Wolverine

References Cited

Arthur, S.M., W.B. Krohn, and J.R. Gilbert. 1989a. Habitat use and diet of fishers. J. Wildl. Manage. 53:680–688.

______. 1989b. Home range characteristics of adult fishers. J. Wildl. Manage. 53:674–679.

______. 1991. Activity patterns, movements, and reproductive ecology of fishers in southcentral Maine. J. Mammal. 72:379–385.

Arthur, S.M., T.F. Paragi, and W.B. Krohn. 1993. Dispersal of juvenile fisher in Maine. J. Wildl. Manage. 57:686–674.

Aubry, K.B., C.M. Raley, T.J. Catton, and G.W. Tomb. 2001. Ecological characteristics of fishers in southwestern Oregon: annual report 2000. U.S. Dep. Agric. For. Serv., Pac. Northwest Res. Stn., Olympia, Wash. 10 p.

Badry, M.J., G. Proulx, and P.M. Woodward. 1997. Home-range and habitat use by fishers translocated to the aspen parkland of Alberta. *In Martes*: Taxonomy, ecology, techniques, and management. G. Proulx, H.N. Bryant, and P.M. Woodward (editors). Prov. Mus. Alberta, Edmonton, Alta., pp. 233–251.

Banci, V. 1989. A fisher management strategy for British Columbia. B.C. Min. Environ., Wildl. Br., Victoria, B.C. Wildl. Bull. B-63.

Banci, V. and G. Proulx. 1999. Resiliency of furbearers to trapping in Canada. *In* Mammal trapping. G. Proulx (editor). Alpha Wildl. Res. and Manage., Sherwood Park, Alta., pp. 175–204.

B.C. Ministry of Forests (MOF). 2002. Annual performance report for fiscal year ending March 31, 2001. Victoria, B.C.

Buskirk, S.W. and R.A. Powell. 1994. Habitat ecology of fishers and American martens. *In* Martens, sables, and fishers: Biology and conservation. S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell (editors). Cornell Univ. Press, New York, N.Y., pp. 283–296.

Carroll, C., W.J. Zielinski, and R.F. Noss. 1999. Using presence-absence data to build and test spatial habitat models for the fisher in the Klamath region, USA. Conserv. Biol. 13:1344–1359.

Clem, M.K. 1977. Food habits, weight changes and habitat use of fisher (*Martes pennanti*) during winter. Ms.Thesis. Univ. Guelph, Guelph, Ont.

Committee on the Status of Endangered Wildlife in Canada (COSEWIC). 2002. Canadian species at risk. Available from: http://www.speciesatrisk.gc.ca

Coulter, M.W. 1966. Ecology and management of fishers in Maine. PhD Dissertation. Syracuse Univ., Syracuse, N.Y.

de Vos, A. 1952. Ecology and management of fisher and marten in Ontario. Ont. Dep. Lands and For., Toronto, Ont. Tech. Bull. Wildl. Serv. No. 1.

Douglas, C.W. and M.A. Strickland. 1987. Fisher. *In* Wild furbearer management and conservation in North America. M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch (editors). Ont. Trappers Assoc., North Bay, Ont., pp. 511–529.

Fontana, A., I.E. Teske, K. Pritchard, and M. Evans. 1999. East Kootenay fisher reintroduction program. Report prepared for B.C. Min. Environ., Lands and Parks, Cranbrook, B.C. 29 p.

Frost, H.C. and W.B. Krohn. 1997. Factors affecting the reproductive success of captive female fishers. *In Martes*: Taxonomy, ecology, techniques, and management. G. Proulx, H.N. Bryant, and P.M. Woodward (editors). Prov. Mus. Alberta, Edmonton, Alta., pp. 100–109.

Frost, H.C., W.B. Krohn, and C.R. Wallace. 1997. Age-specific reproductive characteristics in fishers. J. Mammal. 78:598–612.

Gibilisco, C.J. 1994. Distributional dynamics of modern *Martes* in North America. *In* Martens, sables, and fishers: Biology and conservation. S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell (editors). Cornell Univ. Press, New York, N.Y., pp. 59–71.

Gilbert, J.H., J.L. Wright, D.J. Lauten, and J.R. Probst. 1997. Den and rest-site characteristics of American marten and fisher in northern Wisconsin. *In Martes*: Taxonomy, ecology, techniques, and management. G. Proulx, H.N. Bryant, and P.M. Woodward (editors). Prov. Mus. Alberta, Edmonton, Alta., pp. 135–145.

Giuliano, W.M., J.A. Litvatis, and C.L. Stevens. 1989. Prey selection in relation to sexual dimorphism of fishers (*Martes pennanti*) in New Hampshire. J. Mammal. 70:639–641.

Hagmeier, E.M. 1956. Distribution of marten and fisher in North America. Can. Field-Nat. 70:149–168.

Hall, E.R. 1942. Gestation period in the fisher with recommendations for the animal's protection in California. Calif. Fish and Game 28:143–147.

Heinemeyer, K.S. 1993. Temporal dynamics in the movements, habitat use, activity, and spacing of reintroduced fishers in northwestern Montana. MSc. Thesis. Univ. Montana, Missoula, Mont.

Jones, J.L. 1991. Habitat use of fisher in northcentral Idaho. Thesis. Univ. Idaho, Moscow, Idaho.

Jones, J.L. and E.O. Garton. 1994. Selection of successional stages by fishers in north-central Idaho. *In* Martens, sables, and fishers: Biology and conservation. S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell (editors). Cornell Univ. Press, New York, N.Y., pp. 377–388.

Kelly, G.M. 1977. Fisher (*Martes pennanti*) biology in the White Mountain National Forest and adjacent areas.PhD Dissertation. Univ. Massachusetts, Amherst, Mass.

Kilpatrick, H.J. and P.W. Rego. 1994. Influence of season, sex, and site availability on fisher (*Martes pennanti*) rest-site selection in the central hardwood forest. Can. J. Zool. 72:1416–1419.

Krohn, W.B., S.M. Arthur, and T.F. Paragi. 1994. Mortality and vulnerability of a heavily-trapped fisher population. *In* Martens, sables, and fishers: Biology and conservation. S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell (editors). Cornell Univ. Press, New York, N.Y., pp. 137–146.

Krohn, W.B., K.D. Elowe, and R.B. Boone. 1995. Relations among fishers, snow, and martens: Development and evaluation of two hypotheses. For. Chron. 71:97–105.

Kuehn, D.W. 1989. Winter foods of fishers during a snowshoe hare decline. J. Wildl. Manage. 53:688–692.

Kyle, C.J., J.F. Robitaille, and C. Strobeck. 2001. Genetic variation and structure of fisher (*Martes pennanti*) populations across North America. Mol. Ecol. 10:2341–2347.

Leonard, R.D. 1980. The winter activity and movements, winter diet, and breeding biology of the fisher (*Martes pennanti*) in southeastern Manitoba. MScThesis. Univ. Manitoba, Winnipeg, Man.

Maini, J.S. 1968. Silvics and ecology of *Populus* in Canada. *In* Growth and utilization of poplars in Canada. J.S. Maini and J.H. Crayford (editors). Dep. For. and Rural Dev., Ottawa, Ont., pp. 21–69.

Martin, S.K. 1994. Feeding ecology of American martens and fishers. *In* Martens, sables, and fishers: Biology and conservation. S.W. Buskirk, A.S. Harestad, G. Raphael, and R.A. Powell (editors). Cornell Univ. Press, New York, N.Y., pp. 297–315.

Mead, R.A. 1994. Reproduction in *Martes*. *In* Martens, sables, and fishers: Biology and conservation. S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell (editors). Cornell Univ. Press, New York, N.Y., pp. 404–422.

Mead, S.K. and R.H. Barrett. 1991. Resting site selection by marten at Sagehen Creek, California. Northwest. Nat. 72:37–42.

NatureServe Explorer. 2002. An online encyclopedia of life [Web application]. Version 1.6. Arlington, Va. Available from: http://www.natureserve.org/explorer

Paragi, T.F. 1990. Reproductive biology of female fishers in southcentral Maine. MSc.Thesis. Univ. Maine, Orono, Maine.

Paragi, T.F., S.M. Arthur, and W.B. Krohn. 1996. Importance of tree cavities as natal dens for fishers. North. J. Appl. For. 13:79–83.

Powell, R.A. 1979. Mustelid spacing patterns: Variations on a theme by *Mustela*. Zeitschrift fur Tierpsychologie 50:153–165.

_____. 1981. Hunting behavior and food requirements of the fisher (*Martes pennanti*). *In* Proc. Worldwide Furbearer Conf. J.A. Chapman and D. Pursley (editors). II. Frostburg, Md., pp. 883–917.

_____. 1993. The fisher: life history, ecology, and behavior. 2nd ed. Univ. Minnesota Press, Minneapolis, Minn.

_____. 1994a. Effects of scale on habitat selection and foraging behavior of fishers in winter. J. Mammal. 75:349–356.

_____. 1994b. Structure and spacing of *Martes* populations. *In* Martens, sables, and fishers: biology and conservation. S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell (editors). Cornell Univ. Press, Ithaca, N.Y., pp. 101–121.

Powell, R.A. and W.J. Zielinski. 1994. Chapter 3: Fisher. *In* The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, J. Lyon, and W.J. Zielinski (technical editors). U.S. Dep. Agric. For. Serv., Rocky Mt. Forest and Range Exp. Stn., Fort Collins, Colo., pp. 38–72.

Powell, S.M., E.C. York, J.J. Scanlon, and T.K. Fuller. 1997. Fisher maternal den sites in central New England. *In Martes*: Taxonomy, ecology, techniques, and management. G. Proulx, H.N. Bryant, and P.M. Woodward (editors). Prov. Mus. Alberta, Edmonton, Alta., pp. 265–278.

Proulx, G., K.B. Aubry, J.D.S. Birks, S.W. Buskirk, C. Fortin, H.C. Frost, W.B. Krohn, L. Mayo, V. Monakov, D.C. Payer, M. Santos-Reis, R.D. Weir, and W.J. Zielinski. 2003. World distribution and status of the genus *Martes*. *In* Proc. 3rd Int. *Martes* Symp. Ecology and management of *Martes* in human altered landscapes. D.J. Harrison, A.K. Fuller, and G. Proulx (editors). Under review.

Raine, R.M. 1981. Winter food habits, responses to snow cover and movements of fisher (*Martes pennanti*) and marten (*Martes americana*) in southeastern Manitoba. MSc.Thesis. Univ. Manitoba, Winnipeg, Man.

_____. 1983. Winter habitat use and responses to snow cover of fisher (*Martes pennanti*) and marten (*Martes americana*) in southeastern Manitoba. Can. J. Zool. 61:25–34.

Raphael, M.G. and L.L.C. Jones. 1997. Characteristics of resting and denning sites of American martens in central Oregon and western Washington. *In Martes*: Taxonomy, ecology, techniques, and management. G. Proulx, H.N. Bryant, and P.M. Woodward (editors). Prov. Mus. Alberta, Edmonton, Alta., pp. 146–165.

Resources Inventory Committee (RIC). 1999. British Columbia wildlife habitat ratings standards. Victoria, B.C.

Strickland, M.A. 1994. Harvest management of fishers and American martens. *In* Martens, sables, and fishers: Biology and conservation. S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell (editors). Cornell Univ. Press, New York, N.Y., pp. 149–164.

Taylor, S.L. and S.W. Buskirk. 1994. Forest microenvironments and resting energetics of the American marten *Martes americana*. Ecography 17:249–256.

Weir, R.D. 1995. Diet, spatial organization, and habitat relationships of fishers in south-central British Columbia. Thesis. Simon Fraser Univ., B.C.

______. 1999. Inventory of fishers in the sub-boreal forests of north-central British Columbia: Year III (1998/99) - Radiotelemetry monitoring. Peace/ Williston Fish and Wildl. Compensation Prog., Prince George, B.C. Rep. No. 206. 39 p.

______. 2000. Ecology of fishers in the sub-boreal forests of north-central British Columbia: Year IV (1999/2000) - Radiotelemetry monitoring and habitat sampling. Peace/Williston Fish and Wildl. Compensation Prog., Prince George, B.C. Rep. No. 222. 38 p.

______. 2003. Status of the fisher in British Columbia. B.C. Min. Water, Land and Air Prot. and B.C. Min. Sustainable Resour. Manage., Victoria, B.C. Wildl. Bull. No. B-105.

Weir, R.D., F.B. Corbould, and A.S. Harestad. 2003. Effect of ambient temperature on the selection of rest structures by fishers. *In* Proc. 3rd Int. *Martes* Symp. Ecology and management of *Martes* in human altered landscapes. D.J. Harrison, A.K. Fuller, and G. Proulx (editors). Under review.

Weir, R.D. and A.S. Harestad. 1997. Landscape-level selectivity by fishers in south-central British Columbia. *In Martes*: Taxonomy, ecology, techniques, and management. G. Proulx, H.N. Bryant, and P.M. Woodward (editors). Prov. Mus. Alberta, Edmonton, Alta., pp. 252–264.

Weir, R.D., A.S. Harestad, and F.B. Corbould. In prep. Home ranges and spatial organization of fishers in central British Columbia.

Personal Communications

Clevenger, T. 2002. Warden Service, Banff National Park, Banff, Alta.

Schultze, G. 2002.Ecosystems Section, Min. Water, Land and Air Protection, Terrace, B.C.

Warkentin, B. 2002.Fish and Wildlife Science and Allocation Section, Min. Water, Land and Air Protection, Cranbrook, B.C.

Watts, G. 2002. Fish and Wildlife Science and Allocation Section, Min. Water, Land and Air Protection, Prince George, B.C.

Weir, R.D. 2002. Artemis Wildlife Consultants, Armstrong, B.C.

Wright, R. 2002. Ecosystems Section, Min. Water, Land and Air Protection, Williams Lake, B.C.