STATUS OF THE FISHER IN BRITISH COLUMBIA

by

R.D. Weir, R.P.Bio.

BRITISH COLUMBIA

B.C. Ministry of Water, Land and Air Protection
Biodiversity Branch
Victoria BC

B.C. Ministry of Sustainable Resource Management
Conservation Data Centre
Victoria BC

Wildlife Bulletin No. B-105

March 2003

Wildlife Bulletins

Wildlife Bulletins can contain preliminary data, so conclusions based on these may be subject to change. Bulletins receive some review and may be cited in publications. Copies may be obtained, depending upon supply, from the Ministry of Water, Land and Air Protection, Biodiversity Branch, Victoria, BC.

National Library of Canada Cataloguing in Publication Data

Weir, R. D.

Status of the Fisher in British Columbia.

(Wildlife bulletin (British Columbia. Biodiversity Branch) ;no. B-105)

Cover title.
Co-published by Ministry of Sustainable Resource Management, Conservation Data Centre.
Also available on the Internet.
Includes bibliographical references: p.
ISBN 0-7726-4925-1

1. Fisher (Mammal) - British Columbia. 2. Fisher (Mammal) - Monitoring - British Columbia. I. British Columbia. Biodiversity Branch. II. British Columbia. Conservation Data Centre. III. Title.

QL737.C25W44 2003333.95'97665 C2003-960053-X

This publication is available at http://wlapwww.gov.bc.ca/wld/documents/statusrpts/b105.pdf

This publication is also available at http://wlapwww.gov.bc.ca/wld/documents/statusrpts/b105.pdf

Citation

Weir, R.D. 2003. Status of the Fisher in British Columbia. B.C. Minist. Sustainable Resour. Manage., Conservation Data Centre, and Minist. Water, Land and Air Protection, BiodiversityBranch, Victoria, BC. Wildl. Bull. No. B-105. 38pp.

DISCLAIMER

"In cases where a Wildlife Working Report or Bulletin is also a species' status report, it may contain a status recommendation from the author. The Province, in consultation with experts, will determine the official conservation status and consider official legal designation. The data contained in the status report will be considered during those processes."

SUMMARY

Fishers (*Martes pennanti*) are medium-sized terrestrial carnivores of the Mustelidae family that inhabit forested regions of central and northeastern British Columbia. Although the extent of occurrence of Fishers in the province is widespread, the area of occupancy within this range is probably limited.

Fishers have a low reproductive output relative to their lifespan, with adult females typically giving birth to between one and three kits in late winter. Survival of the offspring to the age of dispersal is low and further decreases the effective reproductive output. Natural mortalities within Fisher populations come from a variety of sources, but Fishers have few natural predators, probably because their speed and agility make it difficult for other predators to catch and prey upon them. Humans are the major source of mortality in most studied Fisher populations, primarily from fur trapping. It is unclear as to whether the rate of recruitment into the Fisher population in British Columbia is sufficient to balance the mortality rate, although this balance probably varies both spatially and temporally.

Fishers have intrasexually exclusive home ranges, wherein home ranges of individuals of the same sex overlap very little. Home ranges of Fishers in British Columbia are substantially larger than those reported elsewhere in North America, particularly for males, which contributes to the low density observed in the province. Additionally, the distance over which Fishers can successfully disperse may be quite limited, 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.

In conifer-dominated forests of western North America, Fishers appear to have close affinities to specific habitat features, many of them found in late-successional forests. Fishers do not appear to be limited to a fixed array of habitats, although some generalities seem to exist. Early structural stages typically lack sufficient overhead cover to be used by Fishers, particularly during winter, and Fishers generally avoid these habitats. Fishers in British Columbia also show a strong affinity for forested riparian zones, probably because the density of many of the late-successional habitat features that Fishers have been reported to use may be higher in these areas.

Fishers appear to have specific requirements for sites used for resting and rearing young. Fishers in British Columbia have been documented using four distinct types of structures: branch; cavity; coarse woody debris (CWD); and ground sites. The selection of these rest sites by Fishers may be mediated by ambient temperature. Female Fishers also appear to have very stringent requirements for structures in which they rear their kits. In British Columbia, Fishers have been recorded whelping exclusively in large-diameter, declining black cottonwood (*Populus balsamifera spp. trichocarpa*) or balsam poplar (*P. b. spp. balsamifera*) trees, which are atypical and uncommon across the landscape.

Fishers appear to be more flexible in their requirements for habitats in which they forage. These habitats appear to require the presence of catchable prey and adequate security cover to be used by Fishers for foraging. 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. Regardless of species of prey, foraging by Fishers is believed to involve two components: locating patches of habitat with prey; and searching for prey items within these patches. This foraging strategy has implications for the effects of habitat disturbance on their foraging efficiency.

The current extent of occurrence of Fishers in British Columbia is approximately 400 000 km^2, although the proportion of this area that is occupied by Fishers is unknown. Densities of Fishers in British Columbia may be considerably lower than in eastern regions and are estimated to be between 1 Fisher per 65 km^2 and 1 Fisher per 100 km^2 in the highest quality habitats in the province. Using the area of each habitat capability rank within the extent of occurrence of Fishers in British Columbia, the late-winter population for the province is estimated to be between 1113 and 2759 Fishers. With this method, it is expected that 40 to 116 adult Fishers may occur within protected areas in British Columbia at the end of March each year.

Very little is known about the population trends of Fishers in British Columbia and most of the informa-

tion that we have is derived from harvest statistics. Unfortunately, harvest information can be quite biased and dependent upon many other factors in addition to population size and trends, such as trapper effort (which is affected by fur prices, economic alternatives, and access) and vulnerability of animals to trapping. The low juvenile-to-mother ratio in the harvest, in combination with the relatively low fecundity rate of Fishers, 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 per year), which may be due to the natural recovery of Fisher populations following years of decline.

The primary threats to Fisher populations in British Columbia are likely anthropogenic, occurring through changes to habitats from development of forested land and changes in survival rates caused by trapping.

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. Given the apparent reliance of Fishers upon forests with late-successional attributes, disturbance of these ecosystems has likely had detrimental effects on populations.

Forest harvesting has probably had the greatest single effect on habitat quality for Fishers throughout the province. 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 (*Picea spp.*) trees, and replaces them with stands that have fewer structural components and are of lower suitability. 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. The effects of alterations in habitat quantity and quality on Fisher populations are probably dependent upon the scale and intensity at which the changes have occurred. The threats to Fisher habitat are likely to continue to grow because forest harvest will continue. 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.

Fishers are also trapped for their pelts on registered traplines throughout the Thompson, Cariboo, Omineca/Peace, and Skeena Ministry of Water, Land and Air Protection (MWLAP) regions. A portion of the harvest of juvenile Fishers may be compensatory to natural mortality; however, trapping mortality within the adult cohort is likely additive. Although it is unclear what effect trapping pressure has on the population dynamics of Fishers in British Columbia, trapping has likely contributed to their current status.

Several potential alternatives for the management of Fishers and their habitat are presented. Options for management of Fisher habitat come primarily from changes to forest development plans and silvicultural prescriptions. Management of Fisher harvests is the joint responsibility of individual trapline owners and MWLAP, which has the power to set trapping season dates, gear restrictions, and quotas. Several options for changes in the management of the Fisher harvest are presented.

Many factors hamper an accurate assessment of the status of Fishers in British Columbia. The number of known occurrences of the species in the province is unclear, but it is likely that at least four subpopulations exist. Insufficient population monitoring means that population trends cannot be adequately determined. However, a low total population size (estimated to be between 1000 and 3000 at the end of winter), continued exploitation of the species, and persistent degradation of the habitats that they seem to require, all contribute to their vulnerability. Therefore, it is recommended that Fisher populations in British Columbia be ranked as S2/S3.

ACKNOWLEDGEMENTS

Much of the information included in this report comes from published and unpublished results of several studies conducted on Fishers in British Columbia. Fraser Corbould and the Peace/Williston Fish and Wildlife Compensation Program implemented a large-scale research project examining Fisher ecology in north-central British Columbia from 1996 to 2000. Irene Teske and Anna Fontana of the Wildlife Branch (Ministry of Environment, Lands and Parks) completed a reintroduction program in the East Kootenay region in 1996-1999. Finally, Randy Wright and Darryl Hebert (Wildlife Branch, Ministry of Environment) began the first telemetry study of Fishers in the Cariboo in 1990, and Richard Weir completed this research as part of his graduate studies at Simon Fraser University. Mike Badry generously provided information on provincial and national harvests of Fishers. Provincial wildlife biologists and technicians from Ministry of Water, Land and Air Protection regions provided very helpful information on Fisher populations and habitat trends for their respective areas. Chris Kyle provided unpublished results of genetics work on Fishers that he completed as part of his doctoral dissertation at the University of Alberta. The quality of this report was greatly enhanced by helpful comments from Mike Badry, David Hatler, Eric Lofroth, Kari Nelson, and Don Reid.

Publication of this species status report was made possible through the funding assistance of Forest Innovation Investment, MSRM and MWLAP.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

Fishers (*Martes pennanti*) are medium-sized carnivores of the Mustelidae (weasel) family that occur in much of the temperate and boreal forests of North America. Fishers tend to be associated with forests wherever they occur, including the extensive hardwood forests of New England and eastern Canada, the boreal coniferous forests of Canada, and the montane coniferous forests of the western United States (Powell 1993).

The status of Fishers across their range has fluctuated widely in both space and time over the past 150 years. In the early 1900s, mortality associated with over-trapping and predator poisoning, and broad habitat changes contributed to a substantial decline in Fisher populations in northeastern United States and eastern Canada (Douglas and Strickland 1987). Reforestation of abandoned agricultural land and application of population management techniques later led to considerable recovery of Fisher populations in many of these areas (Powell and Zielinski 1994). In the western United States, the status of Fishers probably declined over the past 150 years; populations were likely never as abundant as in the east and forest development may have reduced or eliminated suitable habitat for Fishers in some areas (e.g., Washington; Aubry and Houston 1992). Although their populations have been exposed to fur harvest pressure during the past 150 years, the status of Fisher populations in boreal forests has probably not changed considerably, because, until recently, these areas were not exposed to the same broad-scale habitat changes resulting from forestry operations as elsewhere. The same may hold true in British Columbia, where most Fisher populations probably were not exposed to substantial changes in habitat and trapping pressure until the past 50 years.

The purpose of this report is to synthesize information about Fishers specific to British Columbia. This document outlines the biology, habitat requirements, distribution, limiting factors, and current status of Fishers in British Columbia based upon information from published literature, government biologists and technicians, members of the trapping community, and unpublished reports. The broad objective is to determine the status of the species in the province and to develop habitat and population management recommendations to ensure the persistence of the species into the future.

2 SPECIES INFORMATION

2.1 Name and Classification

Fishers (*Martes pennanti* Erxleben 1777; Family Mustelidae) are rather inappropriately named animals, as they do not actually fish. It is believed that the current name is derived from a similarity between Fishers and polecats, which were sometimes called fitchets (Powell 1993). Other names for Fishers are Pennant's Marten, pékan (French), wejack, Fisher cat, and pescador (Spanish). Aboriginal names for the species include tha cho (Chippewayan), otchoek (Cree), uskool (Wabanaki), otschilik (Ojibwa), and tcintu'pus (Secwepemc; Teit 1975; Powell 1993).

Taxonomists once believed that Fishers comprised several subspecies, but Fishers are now considered to be a single, undifferentiated species throughout their range (Powell 1993). The Fisher is closely related to the other six members of the genus *Martes:* Eurasian Marten (*M. martes*); American Marten (*M. americana*); Yellow-throated Marten (*M. flavigula*); Japanese Marten (*M. melampus*); Sable (*M. zibellina*); and Stone Marten (*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.

2.2 Description

Fishers have long, thin bodies, which are characteristic of most Mustelids. Fishers have dense coats and well-furred tails that make up about one-third of their total body length, pointed faces, rounded ears, and short legs (Douglas and Strickland 1987). Their fur is long, luxurious, and chocolate-brown in colour, with considerable grizzling patterns around the shoulders and back. Fishers are sexually dimorphic and range in average body mass from 2.6 kg for females to 4.8 kg for males in British Columbia (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 two to three times larger), darker colouring, and shorter ears.

3 GENERAL BIOLOGY

Prior to 1990, most of our understanding of Fisher ecology was based on research conducted in eastern North America. However, three projects focussing on Fishers were conducted in British Columbia during the past 10 years, providing information on the species that is more specific to the province (Figure 1). The first research study was conducted in the dry-warm subzone of the Sub-Boreal Spruce biogeoclimatic zone to the northeast of Williams Lake (East Cariboo; Weir 1995a). The second involved Fishers translocated from the Cariboo region into unoccupied habitats of the Interior Douglas-fir and Montane Spruce zones to the southwest of Cranbrook (East Kootenay; Fontana et al. 1999). The third was conducted in the moist-cool and wet-cool subzones of the Sub-Boreal Spruce (Williston region) and is currently in the data analysis stage (Weir and Corbould in prep.).

3.1 Reproduction

Fishers have a reproductive system that results in a low reproductive output relative to their lifespan. Female Fishers are not capable of breeding until 12 months of age and produce at most one litter per year after they have reached two years of age (Douglas and Strickland 1987). Many authors report that female Fishers are capable of breeding every year starting at the age of one (Hall 1942; Douglas and Strickland 1987), but Frost et al. (1997) found that a proportion of female Fishers did not enter oestrus until their second year. Fishers generally have a short lifespan with relatively low survivorship from year to year. Fisher populations are composed primarily of young cohorts (Powell 1994a) and the upper limit of their life expectancy is about 10 years (Powell 1993), although a Fisher harvested in British Columbia had reached 12 years of age (R.D. Weir, unpubl. data). Although capture vulnerability differs among age and sex classes, a sample of carcasses harvested by trappers in the late 1980s and early 1990s and collected by the B.C. Ministry of Environment indicated that 95 percent of Fishers harvested in British Columbia were under the age of five

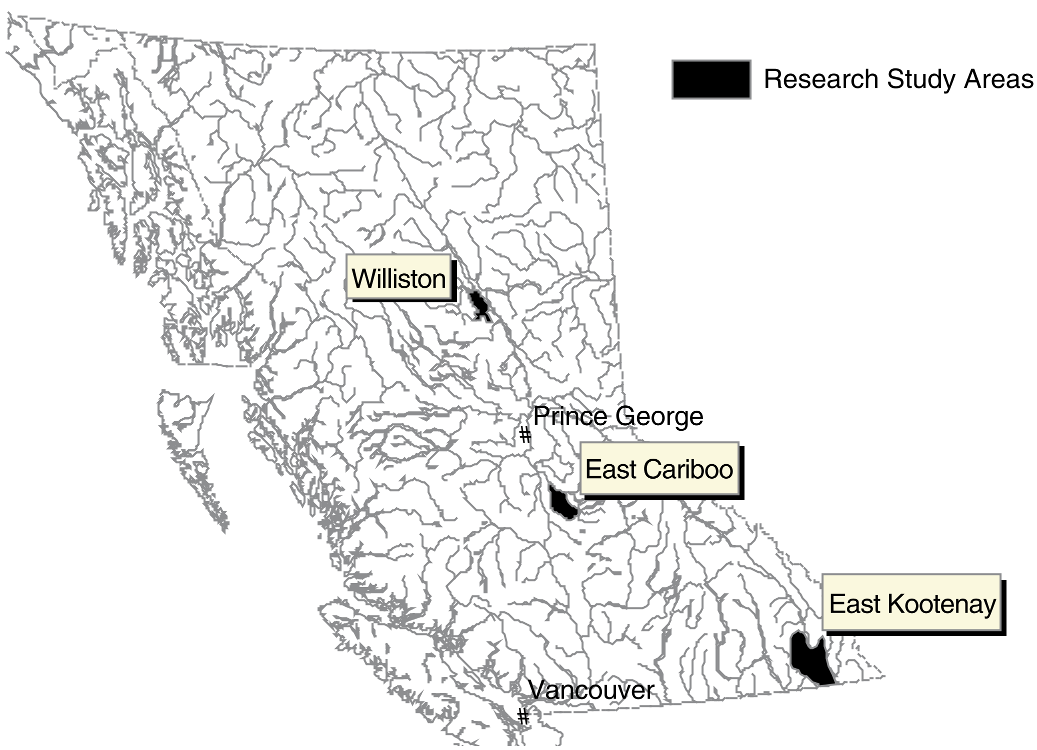

Figure 1. Locations of Fisher studies that have been done in British Columbia. Much of the information about Fishers included in this status report comes from these three studies.

(Figure 2). Thus, generation time can be as short as two years, but is most likely between three and four years. Fishers are polygamous breeders, copulating with multiple conspecifics in early April. Fishers are likely induced ovulators (Powell 1993), which means that successful reproduction may be dependent upon the presence and/or abundance of sexually proficient males (which may be related to age, see Section 3.1.1).

The sex ratio within populations of Fishers is believed to be close to 50:50 (Powell 1994a), although their spatial organization suggests that more females than males should occur in the population (Arthur et al. 1989b). It is difficult to determine the age and sex ratio of Fisher populations because juveniles and adult males are much easier to capture and, therefore, census (Douglas and Strickland 1987). The sex ratio of kits at birth has been reported to be close to 50:50 (Frost and Krohn 1997).

3.1.1 Male reproductive biology

Male Fishers reach sexual maturity at 12 months of age, but probably do not breed successfully until at least two years of age (Douglas and Strickland 1987). This may be a result of the size and conformation of the baculum of young animals (Frost et al. 1997). Males have effective concentrations of sperm for only a short period in March and April, during which time the testes are at their maximal size and testosterone reaches peak levels. The testes begin to regress in May and are dormant until the following December, when they begin to increase in size (Frost et al. 1997).

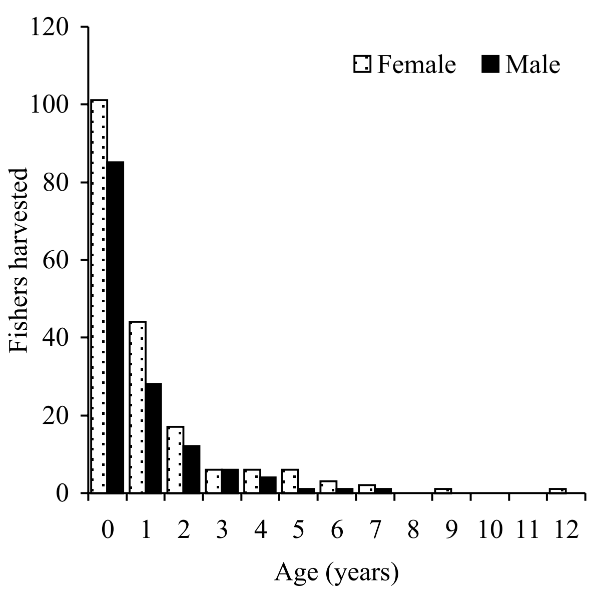

Figure 2. Age structure of Fishers harvested by trappers in British Columbia and collected by the Ministry of Environment, 1988-1993.

3.1.2 Female reproductive biology

Female Fishers have an oestrus period lasting two to eight days, approximately three to nine days following parturition (Hall 1942). A second oestrus cycle may occur within 10 days of the first cycle (Powell 1993). Females are anoestrus between June and March (Frost et al. 1997).

Female Fishers reproduce via delayed implantation, a strategy that is fairly common among mustelids (Mead 1994). During this process, the fertilized eggs develop until they reach the blastocyst stage and then lie dormant in the uteri for approximately 10 months until implantation occurs (Douglas and Strickland 1987). Active development of the foetuses begins in middle to late February and lasts about 40 days (Frost et al. 1997).

The date of parturition varies throughout the Fisher's range, but generally occurs between February and early April (Douglas and Strickland 1987). Reported parturition dates for Fishers in British Columbia are 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).

3.1.3 Litter size

Fishers typically give birth to one to three kits in late winter (Powell 1993), with a mean litter size of 2.7 (Frost and Krohn 1997). Fontana et al. (1999) recorded the sizes of 10 litters of captive females in British Columbia as ranging from one to four 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. As determined from counts of corpora lutea (corpuscles that form in the ovaries after the release of eggs) from Fishers harvested in British Columbia in the early 1990s, the mean maximum number of kits per adult female was 2.3 (SE = 0.15, n = 86) (R.D. Weir, unpubl. data).

Maternal age may affect litter size in Fishers. Frost and Krohn (1997) found a positive correlation between actual litter size and the age of the mother. Although counts of corpora lutea are a poor indicator of actual reproductive output (Crowley et al. 1990), Douglas and Strickland (1987) noted that first-time breeders have smaller numbers of corpora lutea than older animals and that corpora lutea counts of very old females (>8 years) declined.

Survival of kits immediately following birth further affects the effective litter size. In studies of captive animals, 3 of 26 (Fontana et al. 1999) and 15 of 38 (Frost and Krohn 1997) kits died following birth. Frost and Krohn (1997) noted that the average litter size decreased from 2.7 to 2.0 kits within seven days following birth. Aubry et al. (2000) noted that one female in their Oregon study had three kits in her den in May, but only one kit was seen with her during the remainder of the spring and summer. Causes of postnatal death in captivity included improper maternal care, cannibalism, exposure, and low viability of the kits (Frost and Krohn 1997).

Survival to age of dispersal probably further decreases the effective reproductive output. Paragi (1990) estimated that the fall recruitment of Fisher kits in Maine was between 0.7 and 1.3 kits per adult female in the population.

3.1.4 Frequency of reproduction

Adult female Fishers may not produce litters every year. A sample of Fishers harvested in British Columbia between 1998 and 1993 showed that 24% (21 of 86) of the adult females had not ovulated the previous year (R.D. Weir, unpubl. data). Fontana et al. (1999) reported that the pregnancy rates of adult female Fishers live-captured in the Cariboo region and kept in captivity through the whelping season were 43% (1996), 79% (1997), and 25% (1998). In Oregon, Aubry et al. (2000) observed that one adult female in their study was not reproductive for three consecutive years. Field studies in British Columbia also suggest that adult Fishers might not reproduce successfully each year. In the Williston region, adult female Fishers did not reproduce on six occasions during 19 possible reproductive seasons (one adult female during one spring is a reproductive season; Weir and Corbould in prep.).

Several factors may influence the pregnancy rates of females within a population of Fishers. Arthur and Krohn (1991) suggested that stress from cold temperatures or limited food availability may affect pregnancy rates. As a corollary to the second stress factor, pregnancy rates may fluctuate with population cycles of prey species. As well, females that occur in sparsely distributed populations may have lower pregnancy rates because of diminished breeding opportunities associated with low density. Decreased reproduction may occur in older female Fishers as well (e.g., ≥8 years; Douglas and Strickland 1987), so reproductive stagnation may occur in populations with a low turnover rate of old females.

3.2 Growth and Early Development

Female Fishers typically give birth to their kits in natal dens (see Section 4.1.4). Newborn Fishers typically weigh 40-50 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 seven to eight 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). The kits become mobile at 10-12 weeks, at which time they begin to leave their dens with their mothers (Paragi 1990). On average, female Fishers in Maine discontinued using maternal dens 71 days following parturition (Paragi et al. 1996). 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 two years old (Weir and Corbould in prep.).

It is unclear as to whether the rate of recruitment into the Fisher population in British Columbia is sufficient to balance the mortality rate, although this balance probably varies both spatially and temporally. It is likely that in areas with little human-caused disturbance and high-quality habitat, the recruitment rate is greater than the mortality rate (i.e., source population). In areas with high disturbance, mortality may exceed recruitment (i.e., sink population).

3.3 Survival

Natural mortalities within Fisher populations come from a variety of sources. Fishers have few natural predators, although canids (Douglas and Strickland 1987) and large raptors (Buck et al. 1979) occasionally kill Fishers. In Montana, Roy (1991) recorded that Cougars (*Felis concolor*), Coyotes (*Canis latrans*), Wolverines (*Gulo gulo*), Golden Eagles (*Aquila chrysaetos*), and Lynx (*Lynx canadensis*) preyed upon "inexperienced" translocated Fishers. In the East Kootenay region, predatory attacks or starvation caused the death of six translocated Fishers (Fontana et al. 1999). Two radio-tagged juvenile Fishers in the Williston region of north-central British Columbia appeared to have starved to death and three other Fishers were killed by Lynx, Wolverines, or other Fishers (Weir 2000).

Humans are the major source of mortality in most studied populations of Fishers (Powell 1993). In a heavily harvested population in Maine, where fur trapping is not managed on individual traplines, humans caused 94% of the mortalities of radio-tagged Fishers (Krohn et al. 1994). Human-caused mortality is primarily from fur trapping, although hunting and collisions with vehicles on roads also occur (Krohn et al. 1994; Zielinski et al. 1995). In the Williston region, where there was relatively little fur trapping pressure, three of nine study animals that died were killed in traps set for American Martens or minks (*Mustela vison;* Weir and Corbould in prep.).

Few studies have been able to accurately assess individual survival in Fishers, but it is probably dependent upon age and sex. In a large study of Fishers in Maine, adult survival rates were higher than those for juveniles during the non-trapping period (89% and 73%, respectively; Krohn et al. 1994). Adult male Fishers and juveniles of both sexes are much more vulnerable to traps than are adult females (Strickland 1994) and thus have lower survival rates. In Maine, survival rates of radio-tagged Fishers during the trapping season decreased to 38% for juveniles of both sexes, 57% for adult males, and 79% for adult females (Krohn et al. 1994). Five of six radio-tagged juvenile Fishers in the Williston region died before maturing (Weir and Corbould in prep.) Powell and Zielinski (1994) suggested that age-specific survivorship likely fluctuates with prey populations, but survivorship is also probably affected by differential vulnerability to trapping (Douglas and Strickland 1987).

Powell (1994*a*) hypothesized that populations of Martes are inherently unstable and that natural populations will never have characteristic age structures or age-specific survivorship rates. He concluded that, because the intrinsic rates of increase in populations of their prey exceed those for Martes species, population- and age-specific mortalities continually change in natural populations. This continual flux results in an unstable age structure in natural populations, which causes variation in responses to change. Powell (1994*a*) hypothesized that high reproduction and high survivorship in years with abundant prey populations create a disproportionate "pulse" of juvenile cohort that persists into future years. Powell (1994*a*) also hypothesized that instability in populations and age structure might be compounded by competition between *Martes* species and habitat change.

3.4 Physiology and Energetics

Relatively little is known about the physiological limitations of Fishers. Because Fishers have the characteristic long, thin body shape of the weasel family, they have a high surface-to-volume ratio and are exposed to thermal constraints during winter that many other carnivores do not encounter. As evidence for this, Powell (1977) documented that Fishers have metabolic rates that are higher than the average for similarly sized mammals, which he attributed to their body shape. Furthermore, he determined that the lower critical temperature (the temperature at which animals must generate energy to survive) for Fishers while active was –50ºC for males and –30ºC for females. Fishers are able to withstand much lower temperatures if they are resting (–120ºC for males, –60ºC for females; Powell 1977), although they may change their habitat use during periods of extreme cold. Very little is known about the physiological adaptability of Fishers to changes in the abiotic environment. Powell (1977) modelled the energetics of free-ranging Fishers in Michigan and estimated that Fishers need to consume 9-16 mice, 0.5-1 squirrel, or 0.125-0.33 Snowshoe Hare each day to survive during winter.

3.5 Diet

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* spp. and *Glaucomys* spp.), microtines (voles and related species), shrews (*Sorex* spp.), 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).

Several factors may affect the composition of Fishers' diets. The wide distribution of Fishers encompasses many different prey communities and this is reflected in the diversity of their diets. Fishers are also able to alternate their selection of prey species in response to availability (Powell and Brander 1977). This plasticity allows Fishers to switch foods when populations of their primary prey fluctuate, permitting them to compensate for changes in prey availability. The sexual dimorphism of Fishers may also affect the composition of the diet within populations because of food niche separation between sexes.

Weir (1995*a*) identified foods consumed by Fishers in British Columbia in an analysis of 255 stomachs collected from Fisher carcasses submitted by trappers between 1988 and 1993. The Snowshoe Hare was the single most commonly occurring prey species identified, occurring in 83 of the 255 stomachs (32.5%). These prey were followed in frequency by red squirrels (*Tamiasciurus hudsonicus;* 28.2%), southern red-backed voles (*Clethrionomys gapperi;* 20.5%), and Porcupines (16.1%). The number of different prey species in each stomach did not differ among age classes or between sexes of Fishers.

Weir (1995*a*) also examined diet composition by lumping prey species into groups on the basis of similar taxa and lifestyles. Small mammals were the most frequently occurring food group in the Fisher stomachs (217 of 551 food group occurrences; 39.4%), followed by Snowshoe Hares (15.1%), semi-aquatic mammals (13.8%), ungulates (10.5%), mustelids (8.7%), Porcupines (7.4%), and galliform birds (3.3%). Female Fishers exploited the small mammal food group more often than did males, and males consumed other mustelids more than did females. Weir (1995*a*) speculated that these diet differences between the sexes would result in females searching for prey in habitats with abundant small mammals, whereas males should forage in habitats with greater abundance of mid-sized prey. However, the effect of the Snowshoe Hare cycle on prey choice and niche partitioning between males and females is largely unknown, and caution should be exercised in the application of this diet information to periods with low Snowshoe Hare density.

3.6 Spatial Organization

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 maintain intrasexually exclusive home ranges in which home ranges of members of the same sex very rarely overlap (Kelly 1977; Powell 1979; Arthur et al. 1989b).

Powell (1994*a*) 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 (Jones 1991) and Montana (Heinemeyer 1993) suggest that the home ranges of Fishers are larger in western regions than in eastern and southern areas, possibly because of lower densities of prey. Badry et al. (1997), however, found that translocated Fishers in Alberta had home ranges of 24.3 km^2 and 14.9 km^2 for males and females, respectively, which were similar to home range sizes of Fishers in eastern North America.

Weir et al. (in press *a*) 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 km^2, SE = 4.6, n = 11) were significantly smaller than those of males ($\bar{x}$ = 137.1 km^2, SE = 51.0, n = 3). Minor overlap was observed among home ranges of Fishers of the same sex, but there was considerable overlap between 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 press *a*) hypothesized that the home ranges of Fishers in their study areas were larger than elsewhere in North America because the density of resources may have been lower. They also speculated that home ranges 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 Fisher home ranges, 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 home range size. There is likely a lower density at which these resources become limiting, which would result in abandonment of the home range (Powell 1994*a*).

3.6.1 Activity and movements

Fishers move about their home ranges during their day-to-day activities of acquiring resources. With the exception of females maintaining natal or maternal dens, they 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 per day (Arthur and Krohn 1991), although transient individuals have been observed moving up to 53 km in less than three 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 ranges, 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; PWFWCP, 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; PWFWCP, unpubl. data). Cold temperatures and deep snow both probably reduce Fisher activity (Powell 1993; R.D. Weir, unpubl. data).

Deep, soft snow may also inhibit Fisher movements 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*a*) suggested that Fishers in the East Cariboo region of central British Columbia used patches with large trees because the overstory closure afforded by these trees may have increased snow interception.

3.6.2 Dispersal

Very little is known about dispersal in Fishers because few studies have been able to document this process. In the eastern portion of the 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 two years of age (R.D. Weir, unpubl. data; PWFWCP, 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, they 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, Alberta, more than 200 km from the nearest radio-telemetry study area (T. Clevenger, pers. comm.). A radio-tagged juvenile Fisher in the Williston region traveled at least 132 km and covered more than 1200 km^2 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 km^2 while transient. They also observed that major rivers and other topographic features were not impermeable barriers to movement.

The apparent contradiction between short successful dispersal distances and the 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 1994a) 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 from which Fishers have been extirpated. This relationship between recolonization and dispersal ability may hold true in British Columbia, but information on this is lacking.

3.7 Interspecific Relationships

Populations of Fishers and American Martens exist in a competitive balance where they are sympatric. It is believed that the niches of these two species have moderate overlap because they compete for some similar food resources, particularly voles and mice (*Clethrionymus* spp., *Microtus* spp., and *Peromyscus* spp.; Powell and Zielinski 1994). Coyotes, Lynx, Wolverines, and weasels (*Mustela* spp.) also potentially compete for food with Fishers.

Abiotic factors seem to mediate the competitive relationship between Fishers and American Martens. Leonard (1980) and Raine (1983) noted that Fishers are affected more by the deep, soft snow that occurs during midwinter than are American Martens (see Section 3.6.1). Krohn et al. (1995) examined the regional distribution of Fishers and American Martens in Maine with respect to snow depth and concluded that: 1) snow depth limits the distribution of Fishers; and 2) Fishers out-compete, and therefore limit the distribution of, American Martens in that region. In California, the abiotic effects of snowfall affected the distribution of these species in a similar manner (Krohn et al. 1997). Krohn et al. (1997) concluded that the distribution of Fishers in California was defined by coniferous habitats that had a mean monthly snowfall of less than 13 cm during winter and American Martens occurred primarily in coniferous forests where mean monthly snowfall was greater than 13 cm.

This state of sympatry mediated by snowfall probably also occurs in British Columbia. The distribution of Fishers and American Martens overlaps throughout the range of the Fisher in the province (Gibilisco 1994). Although Fishers may out-compete American Martens in habitats with relatively low snowfall, American Martens probably move about more easily in areas with greater snowfall, such as the Engelmann Spruce–Subalpine Fir biogeoclimatic zone. This balance probably affects the distribution of Fishers in both a regional and landscape context, but detailed data for British Columbia are lacking.

Interactions between Fishers and American Martens may also include predation. Weir (1995*a*) found remains of American Martens in 8.8% of the Fisher stomachs collected from throughout British Columbia. Trappers also occasionally report that

Fishers hunt and kill American Martens on their traplines (e.g., Quick 1953; B. Warkentin, pers. comm.).

Fishers are one of the few predators that consistently prey upon Porcupines (Douglas and Strickland 1987), a prey species for which they have virtually no competition (Powell 1993). Fishers use their speed and agility to make repeated blows to the Porcupine's face and head without sustaining substantial injuries from quills or receiving a large number of embedded quills, unlike other predators (Powell 1993).

Fishers have few natural predators, probably because their speed and agility make them a difficult species for other predators to catch and prey upon (Douglas and Strickland 1987). Of five radio-tagged Fishers that were killed by other animals in British Columbia, only one was consumed (R.D. Weir, unpubl. data; PWFWCP, unpubl. data). Thus, it is likely that most instances of mortality caused by other species are antagonistic, rather than foraging, events.

Many internal and external parasites have been documented for Fishers, although they are not likely significant mortality factors (Douglas and Strickland 1987). Prominent diseases and parasites in the Algonquin region of Ontario included Aleutian disease (2.5% of carcasses sampled), leptospirosis (5.5%), toxoplasmosis (41%), Guinea worm (*Dracunculus insignis*; 2.5%), kidney worm (*Dioctophyma renale*; 0.23%), and trichinosis (5.2%; Dick et al. 1986). In British Columbia, Fishers have been documented being infected with Coccidia and Callicivirus (Fontana et al. 1999; R.D. Weir, unpubl. data). One male Fisher captured in the Chilcotin region of central British Columbia was infected with a nematode worm (*Capillaria* sp.; Fontana et al. 1999). Fishers and American Martens appear to be the main transmission route for sylvatic trichinosis in the boreal regions of central Canada (Dick et al. 1986).

4 HABITAT

Fishers inhabit a broad range of environments across their geographic area of distribution, from deciduous forests in New Hampshire to coniferous forests in the Western Cordillera (Powell 1993). In eastern deciduous forests, Fishers appear to be habitat generalists, using a variety of stand types and structural stages (Kelly 1977; Arthur et al. 1989a; Powell 1993). However, in western conifer-dominated forests, Fishers appear to have closer affinities to specific habitat features, many of them found primarily in late-successional forests (Jones and Garton 1994; Weir 1995a). This close association of Fishers with late-successional forests prompted the Forest Service in the western United States to consider specific conservation measures for Fishers as a result of widespread changes in their forested land base (Ruggiero et al. 1994).

4.1 Habitat Requirements

4.1.1 Overhead cover

Virtually all studies of Fisher ecology have documented the need for overhead cover. Fishers have been reported by many researchers to select older seral stands with continuous canopy cover to provide security cover from predators (de Vos 1952; Coulter 1966; Kelly 1977; Powell 1977; Arthur et al. 1989a). Fishers in British Columbia have also been reported to avoid stands and patches with no overhead cover (Weir 1995a). While they were transient, translocated Fishers avoided early seral stage stands and selected coniferous forests more often than expected, a result that Weir and Harestad (1997) attributed to the need for overhead cover.

Fishers seem to be able to use many different habitats as long as these areas provide overhead cover at either the stand or patch spatial scales. For example, Weir (1995*a*) determined that Fishers in the East Cariboo region were able to use some stand types that had generally unsuitable overhead cover by exploiting patches within them that had sufficient cover.

Fishers are likely affected by deep snow in winter and this probably influences habitat selection at many spatial scales. Several researchers have reported that Fishers alter their movement patterns to avoid areas with soft snow (Leonard 1980; Raine 1983). Coniferous trees intercept snow (Harestad and Bunnell 1981), and in the East Cariboo, snow packs in coniferous habitats are denser and provide greater support than those in other habitat types (Weir 1995a). Weir (1995*a*) hypothesized that during winter, Fishers may select stands and patches with moderate canopy closure of conifers because these habitats intercept snow and have more dense snow packs, thus permitting more efficient locomotion.

4.1.2 Foraging

Fishers require the presence of catchable prey and adequate security cover to use habitats for foraging. Catchability of prey is affected by not only the abundance of the prey, but also its vulnerability (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*a*).

Suitable combinations of catchable 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. As noted in Section 3.5, Fishers in British Columbia have been recorded consuming primarily Snowshoe Hares, red squirrels, and small mammals. Researchers have documented Fishers using deciduous forests for hunting Porcupines (Powell 1994*b*), riparian zones for small mammals (Kelly 1977), and densely regenerating coniferous habitats for hunting Snowshoe Hares (R.D. Weir, pers. observ.).

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 ranges and they visit these areas to hunt for food (Powell 1994*b*). The characteristics of these patches are likely related to the type of prey that use them; Powell (1994*b*) 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 American Martens, 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 (catchability).

4.1.3 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. (in press *b*) identified four distinct types of structures used for resting by Fishers in British Columbia: branch; cavity; coarse woody debris (CWD); and ground sites. Branch rest structures were arboreal sites that typically involved abnormal growths (i.e., brooms) on spruce (*Picea* spp.) trees, caused by spruce broom rust (C*hrysomyxa arctostaphyli;* Figure 3), or on subalpine fir (*Abies lasiocarpa*) trees, caused by fir broom rust (*Melampsorella caryophyllacearum*). Weir et al. (in press *b*) occasionally observed branch rest sites associated with

Figure 3. Fishers rest on brooms in hybrid spruce trees caused by spruce broom rust most frequently when the temperature is above –10ºC. Photo by R. Weir.

exposed, large limbs of black cottonwood (*Populus balsamifera* spp. *trichocarpa*) and spruce trees. Cavity rest structures were chambers in decayed heartwood of the main bole of black cottonwood, trembling aspen (*Populus tremuloides*), or Douglas-fir (*Pseudotsuga menziesii*) trees; cavities were accessed through branch-hole entrances into heart rot (black cottonwood, aspen, 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 man-made piling. Coarse woody debris rest structures usually comprised 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. (in press *b*) 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. (in press *b*) noted Fishers used subnivean CWD rest structures at ambient temperatures that 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 (<-5ºC), deep snow pack (>15 cm), and high wind speed. Branch or cavity sites were warmer during all other combinations of ambient temperature, snow pack, 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 (see Section 3.4), 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 temperatures were below -15ºC (Weir et al. in press b). 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. 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.

4.1.4 Whelping and rearing

Female Fishers appear to have very stringent 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 portions 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) identified Fishers in south-western Oregon using cavities and witches' brooms in coniferous trees (Douglas-fir, incense cedar [*Calocedrus decurrens*], white/grand fir [*Abies grandis*], western

Table 1. Summary of scale-dependent resource requirements of Fishers in the East Cariboo, 1990-1993 (from Weir 1995*a*).

Resource requirement	Spatial scale			
	Landscape	Stand	Patch	Element
Security cover	X	X	X	-
Foraging	-	X	X	-
Snow interception	-	X	X	-
Resting	-	X	X	X
Whelping	-	-	X	X

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 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* spp. *balsamifera*) trees (R.D. Weir, unpubl. data; PWFWCP, unpubl. data; Figure 4). Den cavities in these large trees were 15 m above ground, on average (R.D. Weir, unpubl. data; PWFWCP, unpubl. data).

Elements with these traits may be rare across the landscape, as indicated by observation of natal dens being re-used by Fishers in the Williston and East Cariboo regions (Weir 1995*a*; Weir 2000). Weir (1995*a*) also 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*a*). The reason that Fishers select these types of trees 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.

4.2 Spatial Distribution of Habitat

Fishers exploit habitats at multiple spatial scales (Powell 1994*b*; Weir 1995*a*). Weir (1995*a*) noted that some of the resource requirements of Fishers in central British Columbia appeared to be filled at several spatial scales, while other resources were exploited at only one spatial scale. General resource requirements appear to be fulfilled at larger spatial scales, whereas the most specific requirements may be supplied by habitat at the patch and element scales (Table 1). For example, the resource requirements for whelping and rearing habitat appear to only be fulfilled by large, declining black cottonwood trees, which are used primarily at the element spatial scale. This means that Fishers select for single cottonwood trees as long as other resource requirements (e.g., overhead security

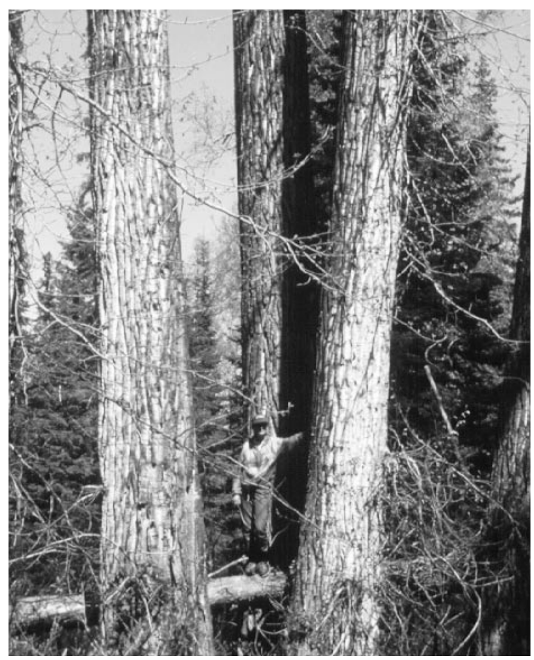

Figure 4. Female Fishers in British Columbia appear to give birth and rear kits exclusively in large diameter, declining black cottonwood or balsam poplar trees. Photo by R. Weir.

cover) are met simultaneously. Fortunately, identifying that use can occur at small spatial scales allows for considerable flexibility in habitat management (see Section 10.1). Because of this relationship between habitats and spatial scale, Fishers do not appear to be limited to a fixed array of habitats. Many different habitats probably provide the life requisites listed in the previous sections.

When spatial scale is considered, the suitable configurations of habitat that can be used by Fishers are greatly increased. However, some generalities in typical habitats that are normally used or avoided can be identified. Sparse/bryoid (stage 1), herb (stage 2), and shrub/herb (stage 3) structural stages (British Columbia Ministry of Forests and British Columbia Ministry of Environment, Lands and Parks 1998) typically lack sufficient overhead cover to be used by Fishers, particularly during winter, and Fishers generally avoid these habitats (Powell 1993). Fishers in British Columbia have shown a strong affinity for forested riparian zones (Weir 1995*b*), probably because the density of many of the late-successional habitat features that Fishers have been reported to use may be higher in these areas (e.g., large, declining black cottonwood trees, spruce trees with rust brooms; Figure 5). The apparent selectivity by Fishers for riparian habitats is likely the result of selectivity for elements that occur in these habitats (Weir 1995*a*). However, Fishers do appear to use a variety of upland habitats for many other life requirements (Weir 1995*a*).

Figure 5. Fishers are reported to use forested riparian zones frequently because these areas supply many habitat features that they require, such as large spruce trees and coarse woody debris for resting, and large-diameter cottonwood trees for denning. Photo by R. Weir.

4.3 Habitat Capability

Habitats throughout the province were ranked for their relative capability to support Fisher populations (British Columbia Ministry of Environment, Lands and Parks 2001). Capability is the ability of the habitat, under the optimal natural (seral) conditions for a species, to provide the species' life requisites, irrespective of the current condition of the habitat; it does not necessarily represent the ability of the habitat in its current condition to provide the species' life requisites (Resources Inventory Committee 1999). The rating system used in this process indicates the value of a habitat to support Fishers compared to the best habitat in the province (the provincial benchmark).

A broad habitat capability map for Fishers for British Columbia was developed based on biogeoclimatic units, Fisher harvests, and expert opinion in early 2001 (Figure 6). The provincial benchmark was defined as the dry-warm subzone of the Sub-Boreal Spruce biogeoclimatic zone (SBSdw). All other subzones were ranked relative to this standard. Radio-telemetry data from British Columbia supports these ranking assignments; home ranges in the SBSdw (high capability rank) were slightly smaller than those in the moist-cool subzone, SBSmk (moderately high capability rank; Weir et al. in press *a*).

4.4 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. Since 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.

4.4.1 Habitat Quantity

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 in prep.). Much of this habitat in the region was removed with the flooding of 1773 km^2 of the Rocky Mountain Trench during 1968-1970 to create the Williston Reservoir. Almost 700 km^2 of moderately high capability habitat was flooded during the creation of the Ootsa reservoir on the Nechako River. Similarly, flooding of approximately 700 km^2 of valley bottom habitats along 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 (Section 6.2).

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 bottoms habitats in the Skeena region is thought to have effectively removed much of the suitable habitat for Fishers (G. Schultze, pers. comm.).

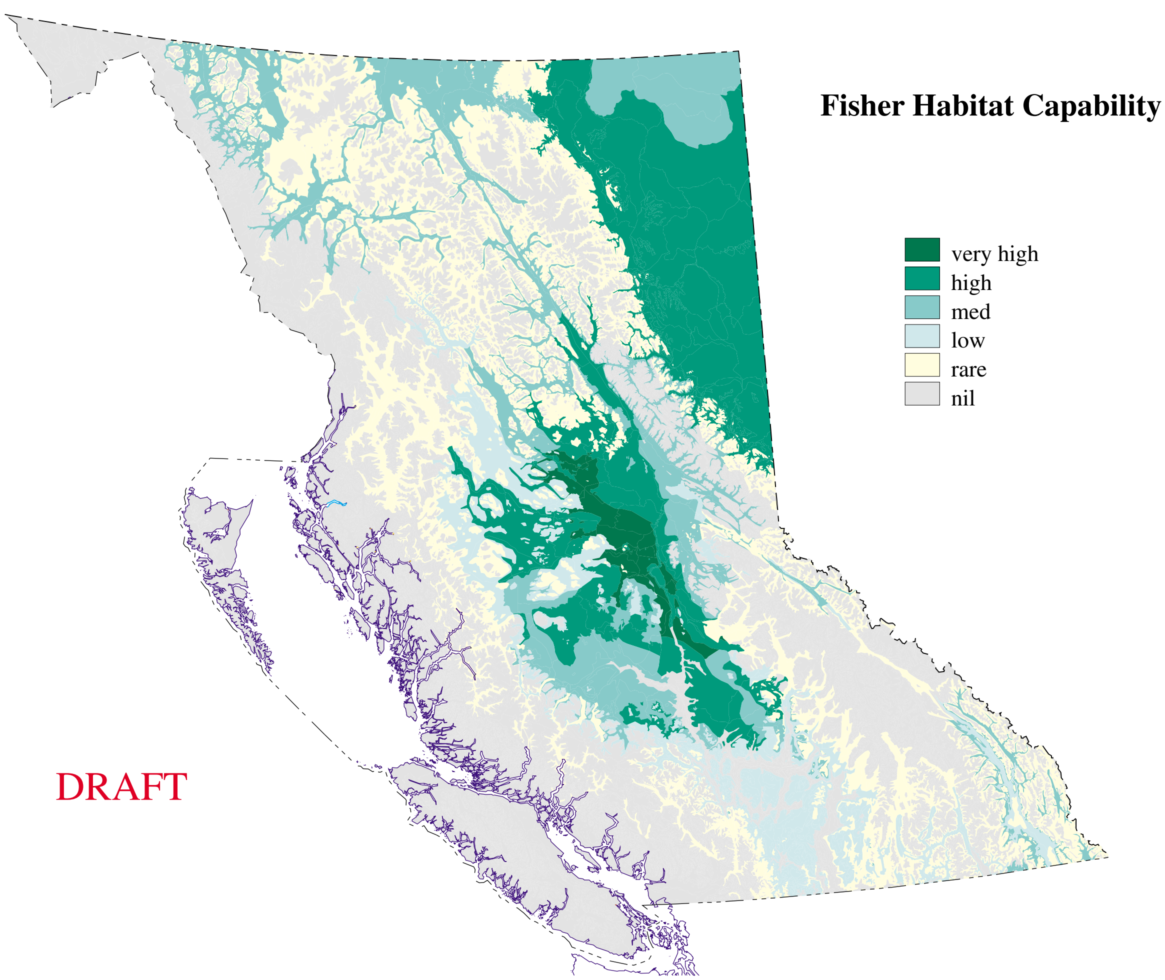

Figure 6. Estimated habitat capability for Fishers for British Columbia. Note that capability does not represent current habitat suitability.

Table 2. Annual area harvested and cumulative harvest of forested land for the period 1985/86 – 1999/00 in forest regions that support Fisher populations. (Data from Ministry of Forests annual reports.)

	Area harvested (km^2)				
Year	Cariboo	Kamloops	Prince George	Prince Rupert	Cumulative total since 1985
1985/86	417	335	572	216	1538
1986/87	485	310	575	308	3217
1987/88	570	405	616	112	4919
1988/89	539	338	577	307	6681
1989/90	479	180	600	305	8245
1990/91	335	218	374	192	9363
1991/92	378	220	450	174	10,584
1992/93	423	271	561	200	12,039
1993/94	347	269	424	208	13,287
1994/95	299	226	421	215	14,448
1995/96	338	250	382	195	15,613
1996/97	420	274	462	219	16,987
1997/98	361	211	466	141	18,166
1998/99	363	288	530	315	19,661
1999/00	429	353	592	290	21,324
Total	6181	4146	7601	3396	

4.4.2 Habitat quality

Forest harvesting has probably been the greatest single influence on the quality of habitat for Fishers throughout the province. During the past 15 years, more than 21,300 km^2 of forested land has been harvested in the four forest regions that support Fisher populations in the province (Table 2; data from Ministry of Forests annual reports 1985/86 to 1999/00). Of this 21,300 km^2, more than 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.

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*a*). 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 for Fishers varies tremendously depending upon the silvicultural systems that are implemented. As noted in Section 4.1, Fishers utilize many features of late-successional forests to fulfill several life requisites. Thus, the supply of these features is probably critical to Fisher survival and reproduction. 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 Fisher habitat. 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 fulfill few life requisites for Fishers, because many habitat elements that Fishers and their prey are dependent upon are missing in these habitats. An ideal forest to a Fisher might appear quite "unhealthy" and decadent to a silviculturist. Thus, maintaining structurally diverse and productive Fisher habitat in logged areas is a function of the method and extent of timber harvesting, and of the type of site preparation and subsequent stand tending.

4.5. Effects of Habitat Changes

The effects of alterations in habitat quantity and quality on Fisher populations probably depend upon the scale and intensity at which the changes occur. Since the stand scale is the dominant scale at which an individual Fisher operates within a home range (Table 1), 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 suppressed 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 years). The retention of CWD within harvested sites may also be insufficient to supply cold-weather resting sites. Interspersed deciduous trees, which are potential resting and denning sites, may disappear as they are removed during stand tending. Sufficient conifer cover may be present during the later stages of the rotation under intensive forest management.

4.6 Projected Habitat Changes

Reductions in the quality and quantity of habitat for Fishers will likely continue to occur in British Columbia. Continued harvesting of late-successional forests using conventional clearcut harvesting at the 15-year-average rate of 1420 km^2/year (rate derived from data in Table 2) will likely pose a substantial threat to Fisher populations in the central interior of British Columbia.

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 km^2 of forests are currently under attack from insects (British Columbia Ministry of Forests 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.).

4.7 Protection/Ownership

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, approximately 7% lies within 385 protected areas. Many of these areas are too small to have Fishers that live completely within the protected area; 65 are large enough to encompass the mean home range of a female Fisher (i.e., 35 km^2) and, of these, only 35 are large enough to encompass the mean home range of a male Fisher (i.e., 137 km^2).

Protected areas generally comprise low-quality habitat for Fishers (Table 3). There is significantly

Table 3. Extent of each habitat capability ranking within the extent of occurrence of Fishers in British Columbia.

Habitat capability ranking	Area (km²)						
	Thompson-Nicola	Cariboo	Skeena	Omineca	Peace	Provincial	Protected areas
Nil	2,156	10,197	30,006	14,191	2,352	58,900	6,452
Very low	2,950	5,896	25,680	18,740	7,474	60,739	7,672
Low	3,090	6,744	17,813	5,029	0	32,675	4,761
Moderate	2,173	23,171	6,388	21,960	30,666	84,357	5,618
Moderately high	2,864	22,555	9,485	22,331	91,739	148,975	3,673
High	0	3,441	11	10,793	0	14,245	411
Total	13,233	72,004	89,383	93,044	132,231	399,891	28,587

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 (Chi-square = 13 246, df = 5, $P \leq 0.001$, Bonferroni-adjusted Z-test, ? = 0.05).

5 DISTRIBUTION

5.1 North America

Fishers occur only in North America, south of 60° latitude (Figure 7). 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. in press). Fishers occur in most provinces and territories in Canada, except Newfoundland and Labrador, Nunuvut, and Prince Edward Island (Proulx et al. in press).

The distribution of Fishers in North America has probably shrunk considerably since pre-European contact (ca. 1600; Proulx et al. in press). 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, in the prairie provinces, and in the western United States (Gibilisco 1994). The decrease in the Fisher's range in eastern regions observed in the early 1900s has been attributed to wide-scale habitat alterations and over-trapping (Douglas and Strickland 1987). Fisher populations are believed to be stable or expanding in the central and eastern portions of the species' range (Proulx et al. in press), likely because of reforestation of abandoned agricultural lands, trapping restrictions, and several reintroduction programs. The Fisher has been extirpated from most of its former range in the western United States (Carroll et al. 1999).

5.2 British Columbia

Hagmeier (1956) completed the first detailed account of the extent of occurrence of Fishers in British Columbia through a survey of available literature and examination of museum collections. Banci (1989) further refined this by examining harvest records from registered traplines throughout the province. This information suggested that Fishers occur throughout much of central and northern British Columbia.

Analyses of habitat capability and suitability have helped redefine the extent of occurrence of Fishers within the province (British Columbia Ministry of Environment, Lands and Parks 2001). After combining habitat information with recent harvest data, the range of the Fisher in British Columbia is currently believed to primarily include the Boreal Plains, Sub-Boreal Interior, Central Interior, and Taiga Plains ecoprovinces (Figure 8). 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. The current extent of occurrence of Fishers in British Columbia is approximately 400 000 km².

Much of the apparent contraction of the distribution of Fishers in British Columbia since the work of Hagmeier (1956) and Banci (1989) can be attributed to the integration of our understanding of Fisher habitat ecology. However, Fisher populations have likely disappeared from the Cascade and Okanagan mountain ranges of the southern interior and the Columbia and Rocky mountain ranges south of Kinbasket Reservoir; these areas have low habitat suitability and no consistent harvests of Fishers over the past 15 years (total of 13 Fishers in both regions combined) despite the harvest of 56 880 American Martens (data from Provincial Fur Harvest Database). The reintroduction of 61 Fishers to the southern Columbia Mountains west of Cranbrook, may have restored a small population of Fishers in this region (Fontana et al. 1999).

The proportion of the extent of occurrence that is currently occupied by Fishers is unknown. Variation in habitat suitability and harvest suggest that the area of occupancy of Fishers is not uniform across their extent of occurrence in British Columbia (British Columbia Ministry of Environment, Lands and Parks 2001). The extent of viable Fisher populations in British Columbia is likely dictated by several factors, including regional and landscape habitat capability and suitability, trapping pressure, interspecific relationships, and abiotic conditions.

6 POPULATION SIZES AND TRENDS

6.1 Population Size

The size of the total Fisher population in British Columbia is extremely difficult to determine. Large home ranges, secretive habits, and low detectability hamper effective censuses, especially over a wide, but probably patchy, distribution in the province.

6.1.1 Inventory

Several censuses of furbearing species, including Fishers, have been done in small areas throughout

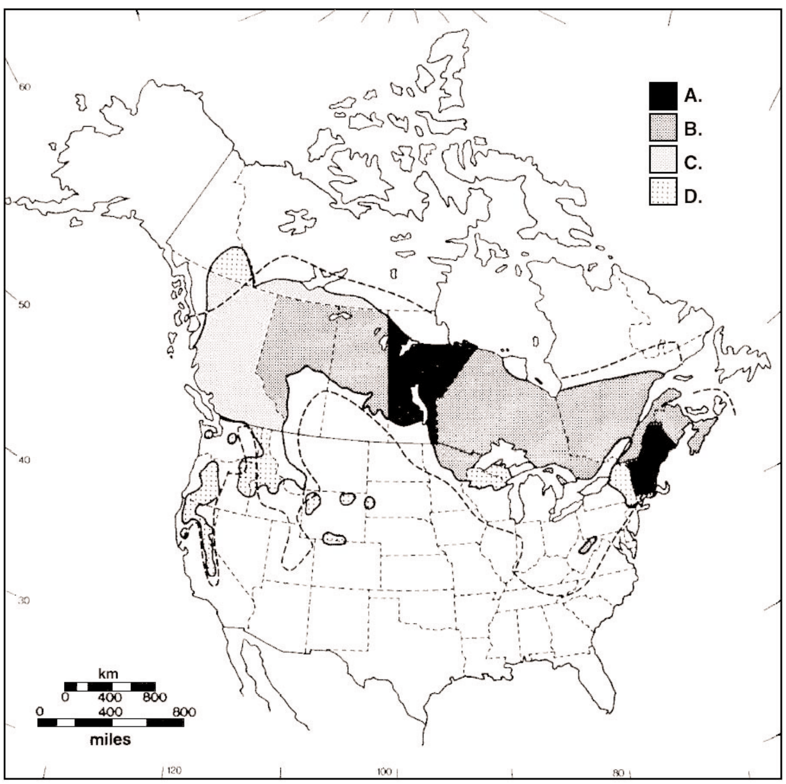

Figure 7. Distribution and harvest density of Fishers in Canada and the United States for the 1983–1984 trapping and hunting seasons (from Douglas and Strickland 1987). Legend: (A) 21–100 km^2/animal harvested (area = 467 000 km^2); (B) 101–1000 km^2/animal (2 313 000 km^2); (C) >1001 km^2/animal (1 056 000 km^2); (D) no harvest (452 000 km^2). Total current Canadian and U.S. range is 4 288 000 km^2. Historical (c. 1600) distribution, shown by dashed line, occupied 6 400 000 km^2.

British Columbia. These inventories can provide some information on the occurrence of Fishers in their respective study areas, and can be useful in identifying areas of Fisher abundance. For example, Proulx and Kariz (2001) performed track surveys for American Martens in the Prince George Forest District and detected more tracks of Fishers than Martens. Many other surveys have not detected Fishers frequently enough to provide a meaningful index of abundance (e.g., one set of tracks in 25 km of transects in the very dry-very cold Montane Spruce biogeoclimatic zone; Intrepid Biological Contracting 1999).

Only two inventory programs have been conducted in British Columbia specifically for Fishers. The first inventory occurred in the Robson Valley in early 1996. Two Fishers were detected in 159 km of track transects (Proulx and Cole 1996). An inventory of Fishers in the Williston region involved intensive live-trapping and monitoring of radio-tagged Fishers (Weir 2000). The information from the latter study was used to produce a density estimate for that study area, which may be used in other areas of the province (see below).

6.1.2 Density

The density of Fishers may vary greatly both spatially and temporally. Throughout their range, Fisher densities appear to be related to habitat suitability and to prey abundance and vulnerability (Powell and Zielinski 1994). Local densities fluctuate widely in response to changes in prey abundance, such as the 10-year Snowshoe Hare cycle (Powell 1993). In addition to prey fluctuations, Fisher populations themselves are believed to be very unstable and to go through dramatic fluctuations (Powell 1994a). Finally, harvest pressure is usually spatially and temporally uneven, which further varies survivorship, and probably density, among areas (Powell and Zielinski 1994).

Fisher populations appear to reach very high densities in eastern portions of their range. In Maine, Arthur et al. (1989*b*) recorded a maximum density of one Fisher per 2.6 km^2 during summer, while in Massachusetts, densities were estimated at one Fisher per 4 km^2 (Fuller et al. 2001). In an untrapped forest reserve in Quebec, the density of Fishers was approximately one per 3.5 km^2 (Garant and Crête 1997).

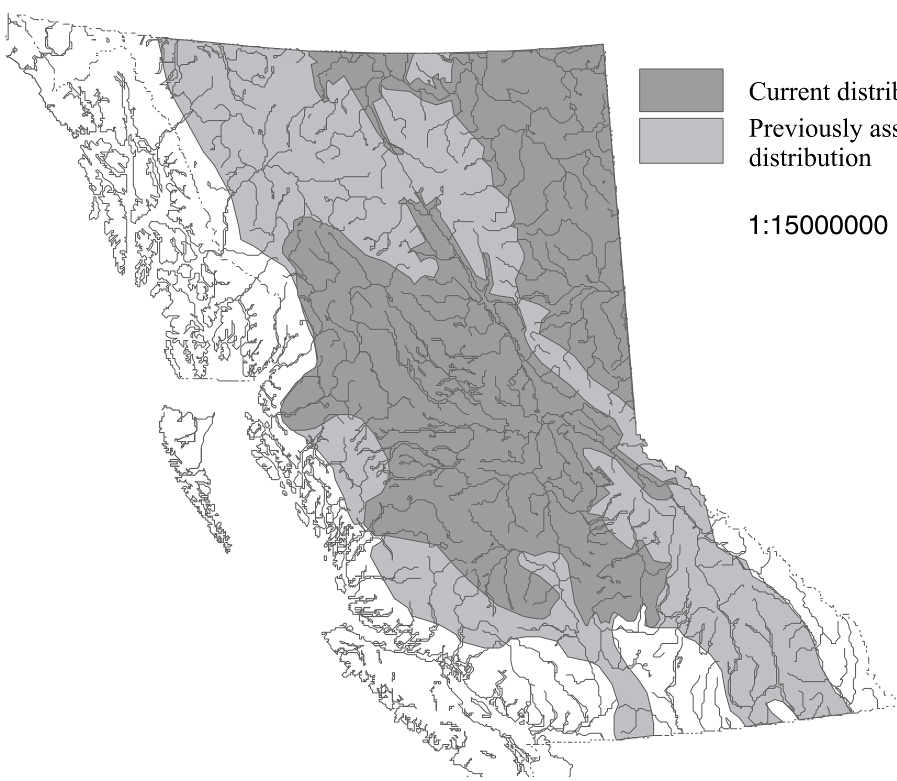

Figure 8. Current and previously assumed extent of occurrence of Fishers in British Columbia.

Densities of Fishers in British Columbia are likely considerably lower than in eastern regions. The recorded home ranges of Fishers in British Columbia were larger than those in studies from eastern North America by factors of 7.9 for males and 3.9 for females, based on means of 18.5 km^2 for males and 8.9 km^2 for females (from data reported by Arthur et al. 1989b; Garant and Crête 1997; and Fuller et al. 2001).

Weir and Corbould (in prep.) estimated the density of Fishers at the end of winter (i.e., end of March) for the Williston region of north-central British Columbia. This time period was selected because it was when the researchers had completed live-trapping that had been done throughout the winter and, therefore, had the most precise estimate of minimum number alive. The estimated late-winter density for the sampled areas ranged from one Fisher per 183 km^2 in March 1998 to one Fisher per 110 km^2 in March 2000 ($\bar{x}$ = 1 Fisher/146 km^2, SE = 2.8, n = 4; Weir and Corbould in prep.).

This suggests that the density of Fishers in a study area made up of 75% moderately high and 25% moderate capability habitat may be approximately one Fisher per 146 km^2. It is unclear why the density of Fishers in British Columbia is so much lower than elsewhere in their range, but it may be the result of variable resource densities (e.g., prey or snow difference) or some limiting factor that is not found elsewhere.

6.1.3 Estimate

A population estimate based on empirical data for Fishers in British Columbia is lacking. However, the density estimate of one Fisher per 146 km^2 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 habitat capability (SBSmk) and 25% moderate habitat capability (SBSwk; wet-cool subzone). These ranks are defined as areas that have densities of 51-75% (moderately high) or 26-50% (moderate) of the benchmark density (Resources Inventory Committee 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 km^2, the provincial benchmark density would range between one Fisher per 100 km^2 if the Williston estimate is 75% of the benchmark, and one Fisher per 65 km^2 if the Williston estimate is 51% of the benchmark (Table 4). 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. With this method, it is expected that 40 to 116 resident Fishers may occur within protected areas in British Columbia at the end of winter.

These numbers may represent a very imprecise estimate of the total British Columbia Fisher population for several reasons. The density estimate for the Williston region may not be representative or transferable to other areas because of variability in habitat suitability, trapping pressure, or prey. Areas encompassed by the habitat capability map that were covered by water were not subtracted from the total area. An estimate based on habitat capability does not account for changes in broad habitat suitability, primarily through logging and land development, across these zones. Taking all of these sources of variation into consideration, the population of Fishers in British Columbia may be less than 2000 adults.

6.2 Population Trends

Powell (1994*a*) postulated that Martes populations (including Fishers) are inherently unstable because of limitations in their numerical responses to change. Whether or not this instability makes Fisher populations more susceptible to stochastic events, over-trapping, or broad changes in habitat suitability is unclear.

Human-caused mortality of Fishers has the potential to influence the health of Fisher populations throughout the province. There is some disagreement among researchers as to whether mortality caused by trapping is compensatory or additive to natural mortality. Strickland (1994) suggested that trapping mortality within Fisher populations is additive, particularly during periods when food is scarce. Krohn et al. (1994) proposed that some component of harvest, specifically of the juvenile segment, is compensatory to natural mortality.

Table 4. Fisher population estimate for British Columbia based on habitat capability mapping and the Williston density estimate. The proportions of benchmark density for each habitat capability ranking are from the British Columbia Wildlife Habitat Ratings Standards (Resources Inventory Committee 1999). The overlap in densities between habitat capability ranks is the result of uncertainty in the density estimate for the Williston region.

			Williston is low end of ranking				Williston is high end of ranking			
	Proportion of benchmark [a]		Density (km^2/Fisher)		Estimate		Density (km^2/Fisher)		Estimate	
Habitat capability	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
Within Fisher Distribution										
nil	0%	0%	n/a	n/a	0	0	n/a	n/a	0	0
very low	1%	5%	6 500	1,300	9	47	10 000	2 000	6	30
low	6%	25%	1 083	260	30	126	1 667	400	20	82
moderate	26%	50%	250	130	337	649	385	200	219	422
moderately high	51%	75%	127	87	1 169	1 719	196	133	760	1 117
high	76%	100%	86	65	167	219	132	100	108	142
Total Estimate					**1 712**	**2 759**			**1 113**	**1 794**
Within Protected Areas										
nil	0%	0%	n/a	n/a	0	0	n/a	n/a	0	0
very low	1%	5%	6 500	1 300	1	6	10 000	2 000	1	4
low	6%	25%	1 083	260	4	8	1 667	400	3	12
moderate	26%	50%	250	130	22	43	385	200	15	28
moderately high	51%	75%	127	87	29	42	196	133	19	28
high	76%	100%	86	65	5	6	132	100	3	4
Total Estimate					**62**	**116**			**40**	**75**

[a] Resources Inventory Committee (1999)

In some areas, prey cycles may play an important role in the dynamics of Fisher populations. Powell (1994*a*) reported that Fisher populations exhibit regular 10-year cycles that correlate with, and lag about three years behind, the Snowshoe Hare cycle. Population changes in Fishers in response to the Snowshoe Hare cycle are the result of changes in juvenile or adult mortality, rather than changes in reproductive productivity (Bulmer 1974). However, in Minnesota, Kuehn (1989) reported that the consumption of small mammals was negatively correlated with the density of Snowshoe Hares, and noted that fat indices of Fisher carcasses did not change with a decline in the Snowshoe Hare population. He concluded that Fishers were not affected significantly by fluctuations in any one prey species, because they were able to switch to other more available prey at lows in the Snowshoe Hare cycle.

The effect of the Snowshoe Hare cycle on the population trends of Fishers in British Columbia is largely unknown, although prominent peaks in the harvest of Fishers did occur in 1973-1974 and 1982-1983 (roughly coinciding with a 3-year lag following peaks in the Snowshoe Hare cycle). Weir (1995*a*) noted that Snowshoe Hares were the most frequently used prey species in a sample of Fisher carcasses collected in

British Columbia during 1988-1993; however, he did not detect differences in the consumption of Snowshoe Hares across years. Fisher carcasses in that study were collected during the peak and crash of the Snowshoe Hare cycle in central British Columbia. Although Snowshoe Hares occurred more frequently in Fisher stomachs collected during the peak years (1990-1992) than in the crash year (1993), the difference between years was not statistically significant (Weir 1995a).

Fur harvesting affects the age structure of the unharvested residual population and thus may affect the ability of these populations to respond to change. The age structure of harvested populations of Fishers tends to be biased towards young animals, because few individuals are able to survive to mature age classes (Powell 1994*a*). This type of structure affects the ability of the population to respond to habitat or prey changes, because populations that have a high proportion of animals with low reproductive capability (i.e., many juvenile Fishers) cannot respond as rapidly to increases in prey populations as those with a more balanced age structure (Powell 1994*a*).

6.2.1. Provincial population trend

Very little is known about Fisher population trends in British Columbia and most of the information that we have is derived from harvest statistics. The harvest of Fishers in the province has fluctuated widely since 1919 (Figure 9). 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 in British Columbia during 1994-2001 was 276 Fishers (SE = 17, range: 206-348). However, harvest information can be quite 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), so the following assessment should be considered with caution.

Strickland (1994) speculated that population trends within harvested populations could be assessed by examining the age and sex composition of the harvest. Douglas and Strickland (1987) determined the sex and age ratios of Fishers harvested in Ontario over a 17-

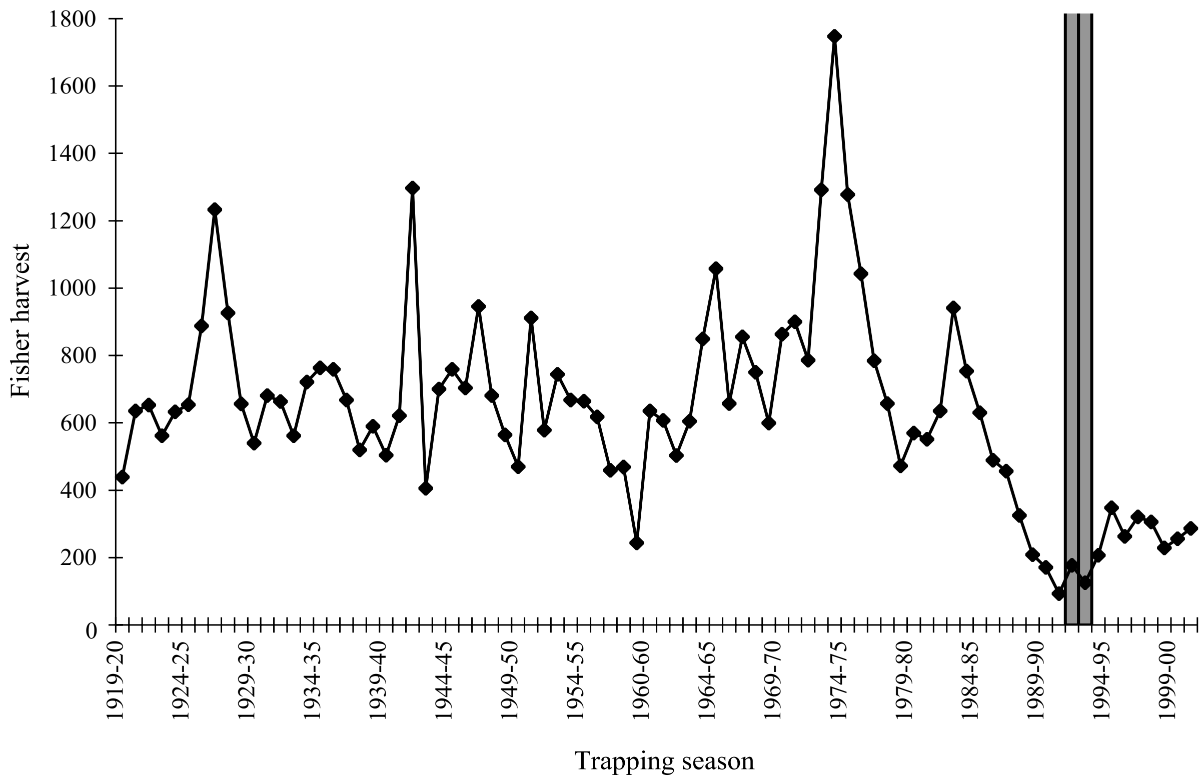

Figure 9. Fisher harvests in British Columbia from 1919-1920 to 2000-2001. The trapping season for Fishers was closed during the 1991-1992 and 1992-1993 seasons, as shown in grey.

Table 5. Age, sex, and timing of harvest of Fishers submitted to the Ministry of Environment, 1988-1993. Fishers were aged as either juvenile (<1 year) or adult (≥1 year). Harvest date was recorded as early (31 December or earlier) or late (1 January or later) in the trapping season. N = 329 Fisher carcasses.

		Harvest date			
Sex	Age class	Early	Late	Unknown	Total
Female	Adult	40	18	28	86
	Juvenile	59	13	29	101
	Unknown	1	1	1	3
Female total		100	32	58	190
Male	Adult	19	18	16	53
	Juvenile	46	17	22	85
	Unknown	1			1
Male total		66	35	38	139
Total		166	67	96	329

year period and compared these ratios with a simulated population model. The index of harvest rate that provided the best indicator of annual population trends was the ratio of juveniles to females ≥2.5 years of age (i.e., those females old enough to be mothers of juveniles) in the harvest. In Ontario, which has a relatively high density of Fishers, this ratio was high (e.g., ≥~9) during periods of population increase and low harvest pressure. They determined that a population with a fecundity rate of 3.2 corpora lutea (CL) per adult female would decline when there were less than 5.7 juveniles per female ≥2.5 years old in the harvest (Douglas and Strickland 1987). In Minnesota, Fisher populations were in decline when this ratio dropped below seven juveniles per female ≥2.5 years old, probably because the fecundity rate was slightly lower (W.E. Berg, pers. comm. cited in Douglas and Strickland 1987). However, Strickland (1994) warned that this index should be used with caution when considering populations with small harvests (e.g., <300).

The Ministry of Environment collected 329 Fisher carcasses from throughout British Columbia between 1988 and 1993, for the purpose of assessing the harvest rate and population trends of Fishers. Timing, and age and sex composition of the harvest were determined from these carcasses (Table 5). The harvest ratio during this survey was 1.34 juveniles per adult and 1.36 females per male. The ratio of juveniles to females ≥2.5 years old in the harvest was 4.28. Using Strickland's (1994) regression formulae developed for Ontario, this harvest information suggests that 36% (derived from the juvenile-to-mother ratio) or 34% (derived from the female-to-male ratio) of the pre-trapping population was harvested during this time period. However, it is unclear how applicable the relationships between harvest composition and harvest rate developed for Ontario are to British Columbia.

Fishers are believed to be capable of maintaining an annual harvest rate of 15-25% of the pre-trapping population (Douglas and Strickland 1987). In Ontario, where the fecundity rate was 3.2 CL per adult female, the population could sustain a harvest rate of 25% of the pre-trapping population (Douglas and Strickland 1987). In Minnesota, where the fecundity rate was approximately 2.2 CL per adult female, the population began to decline when more than about 20% of the pre-trapping population was harvested (W.E. Berg, pers. comm. cited in Douglas and Strickland 1987). In British Columbia, where the mean CL was recorded at 2.3 CL per adult female, it is probable that Fisher pop-

Table 6. Regional harvests of Fishers throughout British Columbia, 1993-2001, as reported to the Provincial Fur Harvest Database (Ministry of Water, Land and Air Protection). The majority of Fishers harvested in the province were killed in the Cariboo and Omineca/Peace regions.

	Trapping season									
Region	1993/94	1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	2000/01	Mean	SE
Lower Mainland	0	0	0	0	1	1	0	0	0.3	0.2
Thompson	6	16	19	25	17	14	7	15	14.9	0.9
Kootenay	3	0	1	1	0	0	0	0	0.6	0.4
Cariboo	100	165	86	102	143	68	87	109	107.5	2.0
Skeena	25	69	33	32	30	46	27	21	35.4	1.4
Omineca/Peace	72	98	122	161	115	100	135	142	118.1	1.9
Okanagan	0	0	2	0	0	0	0	0	0.3	0.3

ulations may be capable of sustained harvest at the lower end of this spectrum as well.

The low juvenile-to-mother ratio in the harvest, in combination with the 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 per year). This may be due to the natural recovery of Fisher populations following years of decline (Powell 1994a).

Insufficient population inventory restricts our ability to assess the rate of decline or growth during the past 10 years.

6.2.2. Regional population trends

Opinions of regional furbearer biologists and technicians in British Columbia regarding regional trends in Fisher populations reflect the harvest statistics (Table 6). Most regional wildlife staff felt there was little empirical data on which to base assessments of regional population trends other than fur harvest data. Most agreed that consistent harvests do not necessarily mean that the population is consistent as well.

Most of the Fishers harvested in British Columbia were killed in the Cariboo and Omineca/Peace regions. The harvest of Fishers in the Cariboo region was gauged as being stable and possibly growing (R. Wright, pers. comm.). The Fisher harvest in the Omineca region is believed to be stable, but aside from incidental captures and the work done in the Williston region (Weir 2000), very little is known about the population in this area (G. Watts, pers. comm.). Harvests of Fishers in the Thompson region appear to be low and stable, but limited to the Bonaparte Plateau and North Thompson areas (K. Kier, pers. comm.). In the Skeena region, the Fisher harvest is believed to be decreasing as result of continued changes to the land base (G. Schultze, pers. comm.). Little is known about the harvest of Fishers in the Peace region, other than that there is a consistent and low harvest of Fishers from year to year (R. Woods, pers. comm.). In 2000-2001, Fishers were occasionally trapped in unusual early-successional habitats near Dawson Creek (C. Gitscheff, pers. comm.). In the East Kootenay region, a reintroduced Fisher population is believed to be persisting, but probably at extremely low levels and limited to two to three wildlife management units (B. Warkentin, pers. comm.).

6.3 Past population management

In response to a perceived decline in the Fisher harvest during the 1980s, the trapping season for Fishers was closed during 1991-1992 and 1992-1993. During the time of this closure, trappers incidentally captured 302 Fishers in traps set for other furbearers (M. Badry, pers. comm.). This suggests that control of incidental captures may play an important role in the effective management of Fishers in British Columbia. The effectiveness of the closure is not known, although Fisher populations may have increased in subsequent years (D. Hatler, pers. comm.).

Several translocations of Fishers have occurred in British Columbia with the intent of re-establishing or supplementing populations. Fishers have been translocated into previously occupied habitats in the eastern Cariboo (Hebert 1989; Weir 1995a) and East Kootenay regions (Apps 1995; Fontana et al. 1999). Unfortunately, the success of these translocation programs was never fully evaluated, so the success rate of this technique is not known. Fishers were also translocated into the forests of the Khutzeymateen Inlet in an attempt to control Porcupine damage to regenerating cutblocks. However, the transplant process may have been largely ineffective, as the radio-tagged, translocated Fishers immediately abandoned their release areas and were not subsequently monitored (D. Steventon, pers. comm.).

7 LIMITING FACTORS AND THREATS

Several characteristics of Fisher ecology make the species susceptible to anthropogenic disturbance (see Sections 3 and 4). Fishers have a short lifespan with low reproductive output and, as a result, small changes in survival rates can have considerable effect on the persistence of both individuals and populations (Powell and Zielinski 1994). The primary threats to Fisher populations in British Columbia are likely anthropogenic, which occur through changes to habitats from development of forested land (i.e., logging, hydroelectric developments, and land clearing) and changes in survival rates caused by trapping.

7.1 Habitat

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

Because Fishers appear to be closely linked to the presence of late-successional forest structures, altering the availability of these habitat components likely has an effect on survival. Although it has not been specifically examined in any research studies, decreases in the abundance and distribution of habitats that are required by Fishers are presumed to have direct cumulative effects on their survival and reproductive rates.

Changes in habitat likely occur, and therefore have effects, at landscape, stand, patch, and element spatial scales. The broad-scale conversion of late-successional forests into early structural stages throughout the Fisher's range within British Columbia has likely profoundly affected the persistence of populations, although historic data to examine this effect are not available. A reduction in the availability and distribution of habitats as identified in Section 4 has probably resulted from forest harvesting activities. Changes in the availability and distribution of these habitats at the landscape scale have likely contributed to the decline of the population in the province. On a smaller spatial scale, individual Fishers are affected by forest harvesting and stand-tending activities within their home ranges. In combination, the large- and small-scale changes in abundance, distribution, and recruitment of Fisher habitat that have occurred (and continue to occur) likely have had a profound effect on the ability of localized populations to persist throughout their range within the past 50 years.

7.2 Trapping

The Fisher's susceptibility to over-trapping contributed to the species' decline throughout much of eastern North America in the early 1900s (Douglas and Strickland 1987).

Trapping has the potential to affect Fisher populations 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). Since Fishers older than two years are responsible for reproduction within the population, 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 they generally have a moderate capability to recover from a reduction in numbers. However, this assessment was primarily based on information from eastern portions 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.

8 SPECIAL SIGNIFICANCE OF THE SPECIES

Fishers have several features that make them a significant species. They are rare, but important, predators in the forests that they occupy. The Fisher is one of the few carnivores that consistently preys upon Porcupines, so may be useful in controlling Porcupine damage to regenerating forests, although it is unclear to what the extent Fishers in British Columbia prey upon Porcupines. Fishers are also predators of Snowshoe Hares, which browse upon small regenerating trees (Litvaitis et al. 1985) and, as such, the disappearance of Fishers from a healthy functioning ecosystem could be followed by an increase in wildlife damage to regenerating trees. Fishers are highly secretive animals, so they have little wildlife viewing potential.

Fishers are a valued component of the fur harvest in British Columbia. As "furbearers" they can be trapped for their pelts on traplines and private land by qualified trappers in the Thompson, Cariboo, Skeena, Omineca, and Peace regions. The average price of Fisher pelts reached a high value of $280 in 1986-1987 (Banci 1989). Since then, the annual average price per pelt in British Columbia has declined somewhat and was $42.63 when averaged over the trapping seasons of 1994-2001 (SE = $3.35, range $28.77-$55.08; M. Badry, pers. comm.). Relative to other furbearers, Fisher pelts are moderately valuable, ranking between sixth and eighth provincally in average values since 1993-1994. Fisher pelts accounted for 3.2% ($902,930) of the total wild fur revenue in Canada in 1997-1998. Over the past eight trapping seasons, Fishers have accounted for an average of $11,986.82 (SE = $1,389.56), or 0.9% of the total value of furs harvested in British Columbia.

9 EXISTING PROTECTION OR OTHER STATUS

Globally, Fishers are widespread, abundant, and secure as a species and have a global ranking of G5. Fisher populations are considered secure across Canada (N5), although the Committee on the Status of Endangered Wildlife in Canada has not officially reviewed their status. Fisher populations currently have a status rank of S3 in British Columbia and the Conservation Data Centre (2001) considers populations to be "vulnerable."

Fishers are classified as "furbearers" in British Columbia, with trapping seasons in the Thompson, Cariboo, Skeena, and Omineca/Peace regions lasting for 106 days, from 1 November to 15 February. 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). Trappers who began trapping after 1 July 1982 are required to complete a trapper education course delivered by the Ministry of Water, Land and Air Protection (MWLAP). Trappers are required to report to MWLAP, within 15 days of the end of the trapping season, the capture of Fishers in the Thompson, Cariboo, Skeena, and Omineca/Peace regions. Trappers that accidentally capture Fishers in regions with closed seasons (i.e., Lower Mainland, Okanagan, and Kootenay regions) are required to submit the carcasses to MWLAP for compulsory inspection. There is no quota on the harvest of Fishers in British Columbia.

Fishers are also considered "Identified Wildlife" under the *Forest Practices Code of BC Act* and special habitat management guidelines for the species are recommended for forest development plans.

Table 7. Subnational rank and management status of Fishers in jurisdictions adjacent to British Columbia.

	Subnational rank [a]	Management status	Length of trapping season (days)
Alberta	S4	Furbearer - sensitive	92
Northwest Territories	n/a	Furbearer (May be at risk)	135
Yukon	n/a	Furbearer	135
California	S3/S4	Protected	
Idaho	S1	Protected	
Washington	n/a	Endangered	
Montana	n/a	Species of special concern	
Oregon	S2	Protected	
Wyoming	S1	Protected	

[a] Subnational ranks reflect the conservation status of the species at the provincial, territorial or state level.
S1 = **Critically Imperilled** because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. Typically 5 or fewer occurrences or very few remaining individuals (<1,000).

S2 = **Imperilled** because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction. Typically 6 to 20 occurrences or few remaining individuals (1,000 to 3,000).

S3 = **Vulnerable** either because very rare and local throughout its range, found only in a restricted range (even if abundant at some locations) , or because of other factors making it vulnerable to extinction. Typically 21 to 100 occurrences or between 3,000 and 10,000 individuals.

S4 = **Apparently Secure:** Uncommon but not rare, and usually widespread. Possibly cause for long_term concern. Typically more than 100 occurrences provincially or more than 10,000 individuals.

9.1 Adjacent Jurisdictions

The status of Fishers varies greatly among adjacent jurisdictions (Table 7). In the majority of Canadian provinces, Fishers are classified as "furbearers" and trapping seasons for the species occur each winter (Proulx et al. in press). Fisher populations in Alberta are ranked as "sensitive" and "stable to increasing" (rank of S4). The length of the trapping season in Alberta is 92 days, with no quota. Fishers are rare in the Yukon, with fewer than five Fishers harvested per year. In the Northwest Territories, Fishers are considered furbearers that have the status of "may be at risk."

In the western United States, populations of Fishers are a considerable conservation concern and advocacy groups have petitioned twice for the species to be classified as endangered under the *Endangered Species Act.* Fishers are protected in Washington, Idaho, Montana, Wyoming, Oregon, and California; there are no trapping seasons for Fishers in any of these jurisdictions. Fishers were listed as endangered in Washington State in 1998 (Lewis and Stinson 1998). Fishers in Idaho are classified as critically imperiled (S1). The species is considered imperiled because of rarity (S2) in both Montana and Oregon. Fisher populations in California are ranked as S3/S4 (vulnerable/apparently secure). This conservation concern has prompted special habitat conservation measures to be recommended for the western United States (Ruggiero et al. 1994).

10 RECOMMENDATIONS AND MANAGEMENT OPTIONS

10.1 Habitat Management

Forest silvicultural activities have great potential to affect habitats that Fishers use in British Columbia. Options for management of Fisher habitat come primarily from changes to forest development plans and silvicultural prescriptions. Knowledge of resource requirements at a variety of spatial scales allows for flexibility in management options.

Selectivity for resources by Fishers appears to be compensatory across spatial scales. That is, when using sub-marginal habitats at large spatial scales, Fishers appear to be able to select habitat at smaller spatial scales within the otherwise unsuitable habitat, and thus meet their resource needs. For example, when Fishers use stands with low density of overhead cover (i.e., a generally unsuitable stand, such as a logged area) they use remaining patches of trees that provide overhead cover within this otherwise poor matrix. Conversely, Fishers appeared to select atypical elements within patches to fulfill their most specific resource requirements. Hence, Fishers have stringent requirements for structural attributes for activities such as resting or rearing kits (Weir 1995*a*).

Weir's (1995*a*) research on Fishers in the SBSdw biogeoclimatic subzone of the East Cariboo region provides wildlife managers with recommendations to help conserve Fisher habitat in managed forests. Using a scale-based approach, managers may be able to partially compensate for habitat alteration at coarse spatial scales by maintaining structural attributes at finer scales. These results provide a stronger ecological basis for the management of Fisher habitat in British Columbia than currently exists. Fishers rely upon features of stands, patches, and elements provided by many different stages of forest development. Fishers require forests that provide structural complexity and diversity through the natural processes of growth, disease, death, and decay to fulfill many of their needs. Management of forested land that emphasizes tree growth and suppresses other natural forest dynamics, such as the management applied in a monotypic forest plantation, will negatively affect the quality of Fisher habitat. To ensure the maintenance of habitat for Fishers, forest harvesting prescriptions must be developed that provide for the retention of appropriate structural attributes from all stages of forest development. Because Fishers select resources at several spatial scales, knowledge of which habitat requirements can be fulfilled at each scale allows for more effective and flexible management of their habitats.

This multi-scaled approach to habitat management, although flexible, must be applied prudently. Caution should be used with its application, because all of the habitat requirements of Fishers likely cannot be maintained solely at small spatial scales. It is unlikely that the cumulative degradation of larger scale habitats (e.g., landscapes, stands) can be totally compensated for at increasingly smaller scales. This scale-based approach may be compensatory to a point because: 1) there likely are increased energetic costs for moving between smaller suitable patches and avoiding a matrix of dangerous habitats; and 2) the life requisites that are met at the stand scale may not always be met at the patch scale.

In all likelihood, the best management practice for Fisher habitat involves conservation at broader spatial scales, because this approach automatically preserves habitats that are required at finer scales.

10.1.1 Landscape management

Fishers fulfill several life requirements at the landscape scale. Landscapes must have enough habitat to support viable populations of Fishers, but must also have enough connectivity within them to maintain juvenile dispersal. Changes to the composition or structure of the landscape may influence the persistence of Fisher populations, because Fishers rely upon specific landscape attributes for these population processes to continue at sustainable levels (Weir and Harestad 1997). Management of habitat at the landscape scale is largely constrained by Landscape Unit Objectives (i.e., lower, intermediate and higher biodiversity emphasis) as defined in the *Forest Practices Code of BC Act.*

Lower biodiversity emphasis landscape units—

It is unlikely that the retention objectives for mature and old seral stages in lower biodiversity emphasis landscape units will be able to support viable populations of Fishers because of insufficient habitat. Landscape units in which all of the mature and old forest area is contiguous and concentrated in one area may support residual populations of Fishers that, unless immigration occurs, will eventually disappear. Landscape units in which mature and old seral stages are distributed in patches smaller than approximately 50 ha throughout the unit will not likely support Fisher populations.

Immigration and dispersal of juveniles will likely be negatively affected by the amount and spatial distribution of early seral stages. Transient Fishers avoid early to mid seral stages (Weir and Harestad 1997), so dispersal between populations will be negligible within landscape units. Retaining young-forest or mature seral stages as movement corridors may enhance immigration within the landscape unit; however, this will reduce the overall concentration of suitable habitat for the establishment of home ranges.

Intermediate Biodiversity Emphasis Landscape Units—

The mature and old seral stage objectives for intermediate biodiversity emphasis landscape units may be sufficient to support a viable population of Fishers if the mature and old forest is contiguous and concentrated in one area of the landscape unit. Contiguous patches of mature and old forest of at least 1000 ha should be juxtaposed to mid-seral forests. However, connectivity of suitable patches of habitat will need to be maintained for immigration, which may reduce the amount of mature or old seral stages that can be maintained in contiguous patches.

Higher Biodiversity Emphasis Landscape Units—

The mature and old seral stage retention objectives for the higher biodiversity emphasis option are sufficient to support populations of Fishers, assuming that the stands that comprise these seral stages are suitable for Fishers (e.g., sufficient riparian habitats). Connectivity within these landscapes should be maintained through riparian corridors or contiguous tracts of mature or old seral stages.

10.1.2 Stand Management

Several life requisites of Fishers appear to be fulfilled at the stand spatial scale, so management of these habitat features should continue to occur at this scale. Fishers use stands that provide sufficient snow interception, security cover, and foraging and resting habitat (Table 1). Table 8 provides recommendations for habitat features that managers should strive to conserve at the stand scale and those they should avoid creating.

10.1.3 Patch management

Fishers are also capable of fulfilling many habitat requirements at the patch spatial scale. Within otherwise unsuitable stands, Fishers use patches that provide sufficient habitat for security cover, foraging, snow interception, resting, and whelping (Table 1). If habitat managers are unable to conserve stands with the features listed in Table 8 (or if they create unsuitable stands), they should conserve patches within these stands as outlined in Table 9. If the stand that is created or otherwise altered has structural features that are less than any of the minimum levels, patches with more structure should be retained. For example, if a clearcut is planned that will reduce the mean volume of CWD within the cutblock to less than 200 m^2/ha, the silvicultural prescription should call for the creation or conservation of patches with at least 200 m^2/ha of CWD distributed throughout the harvested area.

10.1.4 Element management and recruitment

The most specific habitat requirements of Fishers are met at the element spatial scale. Elements that Fishers use for resting and rearing kits are usually atypical habitat features that need to be retained across the landscape for these critical activities to persist. Because these elements typically result from the natural processes of disease, death, and decay of trees, these habitat features may only be produced through natural forest succession. These structures accumulate over time and reach the greatest densities in mature and late-successional forests (Cline et al. 1980). They also take considerable time to develop, so recruitment of these elements needs to be considered in habitat management plans.

Cottonwood trees appear to have distinctive characteristics that make them suitable for denning. All of the natal and maternal dens that have been identified in British Columbia consisted of holes through the hard outer sapwood into cavities in the inner heartwood (R.D. Weir, unpubl. data; PWFWCP, unpubl. data). Black cottonwood trees are prone to heartwood decay 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 greater than 54 cm diameter

Table 8. To help maintain Fisher habitat, habitat managers should try to either conserve or avoid creating stands with particular structural features as determined by Weir (1995a). For example, silvicultural prescriptions should try to avoid producing stands in the herb structural stage with no CWD and strive to conserve stands with >200 m_/ha of CWD and 21-60% closure of the coniferous canopy.

Structural variable	Conserve	Avoid creating
Structural stage		Herb
Forest phase [a]	MI	MISL, NF
Total volume of CWD (m^3/ha)	>200	0
Volume of hard CWD >20 cm diameter (m^3/ha)	1-25, >50	
Volume of elevated CWD (m^3/ha)	21-40	
Coniferous canopy closure (%)	21-60	
Deciduous canopy closure (%)	21-40	0
High shrub (2-10 m) closure (%)	41-60	
Low shrub (0.15-2 m) closure (%)		>80
Stocking of all trees (stems/ha)		0
Stocking of trees with rust brooms (stems/ha)	1-20	
Stocking of trees >40 cm dbh (stems/ha)	1-100	
Stocking of hybrid spruce trees (stems/ha)	401-800	

[a] MI — mixed coniferous-deciduous forest; MISL — mixed forest, selectively logged; NF — non-forested

Table 9. Recommended retention targets for structural variables to be maintained in patches within modified stands as determined by Weir (1995*a*).

Structural variable	Retain patches with
Total CWD	>200 m_/ha
Hard CWD >20 cm diameter	>50 m_/ha
Elevated CWD	>0 m_/ha
Coniferous canopy closure (%)	>0 %
Deciduous canopy closure (%)	>0 %
High shrub (2-10 m) closure (%)	>0 %
Stocking of all trees (stems/ha)	1-1000 stems/ha
Stocking of trees with rust brooms	>0 stems/ha
Stocking of trees >40 cm dbh	>0 stems/ha
Stocking of hybrid spruce trees	>0 stems/ha

(R.D. Weir, unpubl. data; PWFWCP, unpubl. data). Although the relationship between diameter at breast height (dbh) and diameter at the height of the den is unclear, it appears that cottonwood trees larger than 88 cm dbh are most suitable as den trees. For the cavity to be used by Fishers, cavity entrances may need to be greater than 5 m above the ground (R.D. Weir, unpubl. data; PWFWCP, 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 greater than 54 cm at 5 m above ground level.

Conservation is the most practical form of habitat management for elements used by Fishers for resting and for rearing kits. Table 10 outlines the characteristics of these elements that should be conserved. Conservation of these elements needs to occur in concert with planning for the recruitment of these features to ensure long-term supply.

10.2 Population Management

Fishers are considered "Class II" furbearers because they have large home ranges that can encompass multiple traplines and are susceptible to traps set for other species. Therefore, management of Fisher populations by a single trapline owner is extremely difficult, especially on small traplines. Successful conservation or management of Fishers on one trapline can easily be negated by actions on adjacent and surrounding

Table 10. Minimum sizes and characteristics of elements required by Fishers for resting and for rearing kits. These minima are based on the lower quartile of all elements recorded as being used by Fishers in British Columbia (R.D. Weir, unpubl. data; PWFWCP, unpubl. data).

Element	Use	Minimum dbh (cm)
Declining black cottonwoods	Rearing kits	88.0
Trees with rust brooms	Resting	39.8
Single pieces of large elevated CWD	Resting	65.9
Cottonwoods with cavities	Resting	74.3
Aspens with cavities	Resting	44.2

traplines. Thus, management of Fisher harvests is the responsibility of MWLAP, which has the power to set trapping season dates, gear restrictions, and quotas.

Increasing the specificity of traps used by trappers for other target species may be one method to reduce the incidental harvests of Fishers. Weir and Corbould (2000) outlined a method by which the incidental harvest of Fishers in traps set for American Martens could be reduced. The zygomatic arch (in the skull) is the widest section of the body of both Fishers and American Martens. Fishers are significantly larger than Martens and the mean width of the zygomatic arch of juvenile female Fishers is significantly larger than that of adult male American Martens (juvenile female Fisher: 5.47 cm, SD = 0.20, n = 198; adult male American Marten: 4.46 cm, SD = 0.25, n = 444; Strickland 1982). Thus, a trap with an entry hole that is small enough to exclude female Fishers but large enough to allow male American Martens to pass through (about 5 cm diameter) could reduce the incidental harvest of Fishers. However, the effect that the use of this type of exclusionary device would have on strike location, trap attractiveness, ease of use, and pelt damage potential for American Martens is unknown and needs to be determined prior to potential implementation of this modification.

Changes to the trapping season could also be made to reduce the proportion of adult females in the harvest (Strickland 1994). Ending the Fisher trapping season early is a potential tool to control the removal of reproductive animals from the population. The ratio of juveniles to adult females in the harvest before 1 January was 2.63, but dropped to 1.67 after this point (Table 5), but the timing of harvest would need to be more closely assessed to identify an effective closure date. Since it appears that a substantial proportion of the Fisher harvest is incidental to trapping for American Martens, a similar shortening of the trapping season for American Martens may also help reduce the harvest of adult Fishers. This approach would help maintain the reproductive potential of the population and allow populations to recover as quickly as possible during periods of high prey availability.

Another option for Fisher population management is the use of refuges (Strickland 1994). Refuges are untrapped pockets of Fisher populations that act as source populations for trapped areas and 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 Fisher's range in British Columbia would involve considerable cooperation among registered trapline owners and regulatory agencies, including MWLAP and MOF.

10.3 Research Needs

Data from studies of Fisher ecology in British Columbia indicate that many of the characteristics of Fisher populations in eastern regions are substantially different from those in this province. Thus, much of the information from these intensively studied populations may not be as applicable to Fishers in British Columbia as previously thought. Further research is needed on several aspects of Fisher biology to help guide proper management of the species in British Columbia:

1. Inventory information needs to be collected to document Fisher population trends. This information is critical to the appropriate assessment of the status of Fishers in the province.

2. Reproduction of wild Fishers in British Columbia is poorly understood. The reproductive rate of Fishers has not been examined, yet this information is critical to appropriate population management. We need to collect information on 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.
3. It is unclear how sustainable the harvest of Fishers in British Columbia is in light of changes to their habitat. An attempt should be made to calculate (in a population viability model such as Vortex) whether the annual Fisher harvest rate is sustainable given the provincial estimate of the Fisher population. Although simplistic, a coarse province-wide assessment would give a clearer indication of how sustainable trapping harvest is at present.
4. The reasons for the re-use of structures for whelping and resting are unclear. Perhaps trees that are suitable for whelping are rare across the landscape and females have a limited selection of appropriate sites for rearing kits. Conversely, females that have successfully reared kits in previous years in a particular element may simply select that element in future years because it is known to possess the appropriate combination of features that are needed to raise kits. Efforts to assess re-use of natal dens and to determine whether the availability of suitable denning sites is limited across the landscape should continue.
5. It is unclear what effects trapping and habitat modifications have on the relationships between Fishers, American Martens, and snow. This may be determined by examining the relative distribution of Fisher harvests and American Marten harvests, both spatially and temporally, and perhaps testing the hypothesis of Krohn et al. (1997) that Fishers out-compete American Martens in areas with less snowfall to see if it fits in British Columbia. Trapping may also create a competitive imbalance in the relationship between Fishers and American Martens in areas where these species occur together. When Fishers are trapped out of an area, American Martens may be able to colonize the area and begin to exploit the same resources that Fishers had used previously. This effect may make recolonization by Fishers of areas of local extirpation extremely difficult, because not only do dispersing Fishers have to avoid being trapped, they also have to compete for resources with American Martens. Understanding these relationships will help us to identify areas where harvesting of American Martens will not be detrimental to Fisher populations and further refine our knowledge of the distribution of Fishers in British Columbia.
6. Survival rates of Fishers in the province are unknown. Analysis of existing radio-telemetry data to examine survivorship of Fishers would help answer this question.
7. A closer assessment of the catch of Fishers needs to be conducted. Additional work should attempt to identify trends in harvest by ecosection, biogeoclimatic zone, and broad ecosystem unit to help identify options for modifying the harvest.
8. Much of the available information on the ecology of Fishers in British Columbia is based on studies conducted solely within the Sub-Boreal Spruce biogeoclimatic zone. However, a substantial portion of the species' extent of occurrence in the province lies outside this zone. Research should be conducted in other zones with healthy populations of Fishers to help determine differences in ecology of the species between areas.
9. Density estimates are needed to validate or refine the population estimate for the province.
10. Threshold densities at which Fishers can no long acquire sufficient resources at each spatial scale (such as in lower biodiversity emphasis landscapes; Section 10.1.1) need to be determined. Assessing the landscape thresholds at which Fishers can no longer persist would involve energetic modeling along with empirical field studies of prey capture rates in home ranges (assemblages of stands) of very different combinations of stand ages. This assessment would provide much more concrete data on which to build management direction for the retention of old and mature forests in the landscape.

Table 11. Results of genetic assignment tests of individuals suggest that Fishers in the Omineca region receive little gene flow from either the Peace or East Cariboo regions (C. Kyle, unpubl. data). Three individuals sampled from the Omineca and Peace and one from the East Cariboo were assigned to the Alberta population.

Population	Omineca	Peace	East Cariboo
Omineca (*N* = 66)	53	4	6
Peace (*N* = 16)	1	11	1
East Cariboo (*N* = 18)	3	0	14

11. A subset or complementary research task would be to test the use of alternative silvicultural systems (partial and patch retention) as a way of mitigating the adverse effects of removing mature forest on Fisher survival and reproduction.

10.4 Development of Management Tools

British Columbia needs effective management tools for Fishers. The following management activities should be undertaken:

1. Test exclusionary devices for reducing the incidental harvest of Fishers in traps set for other furbearing species. Field test the different designs on active traplines to assess the incidental harvest of Fishers, changes in strike location of harvested animals, ease of use, and effect on capture rates of American Martens, and to identify pelt damage agents. From this information, we can estimate the rate of incidental harvest of Fishers with each trap design and perform qualitative assessments of changes in the efficacy of each trap design for harvesting Martens.
2. Refine the habitat suitability/capability ranking for the province. This will help better define the extent of Fisher populations and identify where to best administer conservation efforts. On-the-ground testing of the rankings through track surveys would further increase the utility of the ranking system. Also, we should establish an accurate population density for the benchmark ecosystem.
3. Develop a pictorial habitat ratings guide to help forest managers identify and evaluate habitat for Fishers. This will facilitate conservation of habitat features in forest development plans.
4. Identify target areas for population enhancement/re-establishment.

11 EVALUATION

Known Occurrences: Unknown

There are likely at least four subpopulations of Fishers in British Columbia: East Cariboo, Omineca/Skeena, Peace, and East Kootenay. Kyle et al. (2001) found little gene flow between samples of Fishers from the Omineca/Skeena, East Cariboo, and Peace regions (Table 11), suggesting that these regions may support distinct populations. This genetic isolation may be due to geographic features such as the Rocky Mountains and Fraser River. The reintroduced Fisher population in the East Kootenay region is also geographically isolated from the remainder of the population in the province. However, the number of actual populations has yet to be determined.

Abundance: B (1000 to 3000 individuals)

It is difficult to determine the abundance of adult individuals within each of these subpopulations. Applying the method from Section 6.1.2 to Table 3, each MWLAP region would have the following approximate numbers of Fishers:

Thompson:	22 – 64
Cariboo:	206 – 522
Skeena:	78 – 247
Omineca:	258 – 626
Peace:	548 – 1300
East Kootenay:	~20 (introduced)

Range: C (Widespread globally, occurs over less than half of British Columbia)

Fishers are widely distributed across North America and they occur in 10-50% of British Columbia.

Trend: Undetermined

Insufficient inventory information has been collected to determine Fisher population trends in British Columbia. Harvest levels have declined substantially since the mid-1980s, but have remained stable since 1994. However, the use of the total number harvested has many confounding factors that affect its reliability. Harvest is influenced by a number of variables in addition to population levels, including behaviour, weather, food availability, season, pelt prices, trapper numbers, regulations and quotas, access, and cultural values (Strickland 1994).

Protected Occurrences: A (no occurrences protected)

It is likely that insufficient portions of the habitat or range of Fishers in British Columbia are protected to support viable Fisher populations.

Threats: A/B (species exploited/habitat lends itself to other uses)

Current trends in habitat change and incidental trapping pressure have the potential to decrease Fisher populations considerably. Populations may have difficulty recovering from declines without changes to these threats.

Recommended Rank: S2/S3

Several Fisher populations (Omineca/Skeena, Peace, East Kootenay) in British Columbia appear to be at risk because of threats to their habitats and continued exploitation through fur harvesting activities. In the Cariboo region, where Fisher populations may be stable or expanding, Fishers are still susceptible to continued habitat alterations. Insufficient information on the relative health and status of these populations hinders an accurate estimate of trends in their populations. However, a low total population size, continued exploitation, and continued degradation of the habitats that they seem to require, all probably contribute to their vulnerability. Therefore, it is recommended that Fisher populations in British Columbia be ranked as S2/S3.

12 REFERENCES CITED

Apps, C. 1995. East Kootenay Fisher reintroduction habitat feasibility assessment. B.C. Minist. Environ., Lands and Parks, Wildl. Branch, Cranbrook, BC.

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

_____. 1989*b*. 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.

_____, T.F. Paragi, and W.B. Krohn. 1993. Dispersal of juvenile Fisher in Maine. J. Wildl. Manage. 57:686-674.

Aubry, K.B., and D.B. Houston. 1992. Distribution and status of the Fisher (*Martes pennanti*) in Washington. Northwest. Nat. 73:69-79.

_____, C.M. Raley, T.J. Catton, and G.W. Tomb. 2000. Ecological characteristics of Fishers in southwestern Oregon: annual report 2000. U.S. Dep. Agric., For. Serv., Pac. Northwest Res. Stn., Olympia, WA. 2 pp.

_____, _____, _____, _____, and _____. 2001. Ecological characteristics of Fishers in southwestern Oregon: annual report 2001. U.S. Dep. Agric., For. Serv., Pac. Northwest Res. Stn., Olympia, WA. 10 pp.

Badry, M.J., G. Proulx, and P.M. Woodward. 1997. Home-range and habitat use by Fishers translocated to the aspen parkland of Alberta. Pp. 233-251 *in* G. Proulx, H.N. Bryant, and P.M. Woodward, eds. *Martes*: taxonomy, ecology, techniques, and management. Prov. Mus. Alberta, Edmonton, AB.

Banci, V. 1989. A Fisher management strategy for British Columbia. B.C. Minist. Environ., Wildl. Branch, Victoria, BC. Wildl. Bull. B-63.

_____, and G. Proulx. 1999. Resiliency of furbearers to trapping in Canada. Pp. 175-204 *in* G. Proulx, ed. Mammal trapping. Alpha Wildl. Res. and Manage., Sherwood Park, AB.

British Columbia Ministry of Environment, Lands and Parks. 2001. Fisher habitat capability map. Wildl. Branch, Victoria, BC. Unpubl. map.

British Columbia Ministry of Forests. 2002. Annual performance report for fiscal year ending March 31, 2001. B.C. Minist. For., Victoria, BC.

_____, and British Columbia Ministry of Environment, Lands and Parks. 1995. Biodiversity guidebook. Victoria, BC.

_____. 1998. Site description. Field manual for describing terrestrial ecosystems. Land Manage. Handb. 25. Victoria, BC.

Buck, S., C. Mullis, and A. Mossman. 1979. A radio telemetry study of Fishers in northwestern California. Cal-Neva Wildl. Trans.:166-172.

Bulmer, M.G. 1974. A statistical analysis of the 10-year cycle in Canada. J. Animal Ecol. 43:701-718.

Buskirk, S.W., and R.A. Powell. 1994. Habitat ecology of Fishers and American martens. Pp. 283-296 *in* S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell, eds. Martens, sables, and fishers: biology and conservation. Cornell Univ. Press, New York, NY.

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. M.Sc. Thesis, Univ. Guelph, Guelph, ON.

Cline, S.P., A.B. Berg, and H.M. Wright. 1980. Snag characteristics and dynamics in Douglas-fir forests, western Oregon. J. Wildl. Manage. 44:773-786.

Conservation Data Centre. 2001. Vertebrate tracking list. B.C. Minist. Sustainable Resour. Manage., Victoria, BC.

Coulter, M.W. 1966. Ecology and management of Fishers in Maine. Ph.D. Thesis, Syracuse Univ., Syracuse, NY.

Crowley, S.K., W.B. Krohn, and T.F. Paragi. 1990. A comparison of Fisher reproductive estimates. Trans. Northeast Sect. Wildl. Soc. 47:36-42.

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

Dick, T.A., B. Kingscote, M.A. Strickland, and C.W. Douglas. 1986. Sylvatic trichinosis in Ontario, Canada. J. Wildl. Dis. 22:42-77.

Douglas, C.W., and M.A. Strickland. 1987. Fisher. Pp. 511-529 *in* M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch, eds. Wild furbearer management and conservation in North America. Ontario Trappers Assoc., North Bay, ON.

Fontana, A., I.E. Teske, K. Pritchard, and M. Evans. 1999. East Kootenay Fisher reintroduction program. Minist. Environ., Lands and Parks, Cranbrook, BC. 29 pp.

Frost, H.C., and W.B. Krohn. 1997. Factors affecting the reproductive success of captive female Fishers. Pp. 100-109 *in* G. Proulx, H.N. Bryant, and P.M. Woodward, eds. *Martes*: taxonomy, ecology, techniques, and management. Prov. Mus. of Alberta, Edmonton, AB.

_____, _____, and C.R. Wallace. 1997. Age-specific reproductive characteristics in Fishers. J. Mammal. 78:598-612.

Fuller, T.K., E.C. York, S.M. Powell, T.A. Decker, and R.M. DeGraaf. 2001. An evaluation of territory mapping to estimate Fisher density. Can. J. Zool. 79:1691-1696.

Garant, Y., and M. Crête. 1997. Fisher, *Martes pennanti*, home range characteristics in a high density untrapped population in southern Québec. Can. Field-Nat. 111:359-364.

Gibilisco, C.J. 1994. Distributional dynamics of modern *Martes* in North America. Pp. 59-71 *in* S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell, eds. Martens, sables, and fishers: biology and conservation. Cornell Univ. Press, New York, NY.

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. Pp. 135-145 *in* G. Proulx, H.N. Bryant, and P.M. Woodward, eds. *Martes*: taxonomy, ecology, techniques, and management. Prov. Mus. Alberta, Edmonton, AB.

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. California Fish and Game 28:143-147.

Harestad, A.S., and F.L. Bunnell. 1981. Prediction of snow-water equivalents in coniferous forests. Can. J. For. Res. 11:854-857.

Hebert, D. 1989. Cariboo Fisher transplant project proposal. Minist. Environ., Wildl. Branch, Williams Lake, BC.

Heinemeyer, K.S. 1993. Temporal dynamics in the movements, habitat use, activity, and spacing of reintroduced Fishers in northwestern Montana. M.Sc. Thesis, Univ. Montana, Missoula, MT.

Intrepid Biological Contracting. 1999. 1999 Anahim furbearer inventory: Snow-track survey. Williams Lake, BC.

Jones, J.L. 1991. Habitat use of Fisher in northcentral Idaho. M.Sc. Thesis, Univ. Idaho, Moscow, ID.

_____, and E.O. Garton. 1994. Selection of successional stages by Fishers in north-central Idaho. Pp. 377-388 *in* S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell, eds. Martens, sables, and Fishers: biology and conservation. Cornell Univ. Press, New York, NY.

Kelly, G.M. 1977. Fisher (*Martes pennanti*) biology in the White Mountain National Forest and adjacent areas. Ph.D. Thesis, Univ. Massachusetts, Amherst, MA.

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. Pp. 137-146 *in* S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell, eds. Martens, sables, and Fishers: biology and conservation. Cornell Univ. Press, New York, NY.

_____, 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.

_____, W.J. Zielinski, and R.B. Boone. 1997. Relations among Fishers, snow, and martens in California: results from small-scale spatial comparisons. Pp. 211-232 *in* G. Proulx, H.N. Bryant, and P.M. Woodward, eds. *Martes*: taxonomy, ecology, techniques, and management. Prov. Mus. of Alberta, Edmonton, AB.

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. Molecular 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. M.Sc. Thesis, Univ. Manitoba, Winnipeg, MB.

Lewis, J.C., and D.W. Stinson. 1998. Washington Dep. Fish and Wildl., Wildl. Manage. Prog., Olympia, WA.

Litvaitis, J.A., J.A. Sherburne, and J.A. Bissonette. 1985. Influence of understory characteristics on snowshoe hare habitat use and density. J. Wildl. Manage. 49:866-873.

Maini, J.S. 1968. Silvics and ecology of *Populus* in Canada. Pp. 21-69 *in* J.S. Maini and J.H. Crayford, eds. Growth and utilization of poplars in Canada. Dep. For. and Rural Dev., Ottawa, ON.

Martin, S.K. 1994. Feeding ecology of American martens and Fishers. Pp. 297-315 *in* S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell, eds. Martens, sables, and Fishers: biology and conservation. Cornell Univ. Press, New York, NY.

_____, and R.H. Barrett. 1991. Resting site selection by marten at Sagehen Creek, California. Northwest. Nat. 72:37-42.

Mead, R.A. 1994. Reproduction in *Martes*. Pp. 404-422 *in* S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell, eds. Martens, sables, and fishers: biology and conservation. Cornell Univ. Press, New York, NY.

Paragi, T.F. 1990. Reproductive biology of female Fishers in southcentral Maine. M.Sc. Thesis, Univ. Maine, Orono, ME.

_____, 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. 1977. Hunting behavior, ecological energetics and predator-prey community stability of the Fisher (*Martes pennanti*). Ph.D. Thesis, Univ. Chicago, Chicago, IL.

_____. 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*). Pp. 883-917 *in* J.A. Chapman and D. Pursley, eds. Proc. Worldwide Furbearer Conference. II. Frostburg, MD.

_____. 1993. The Fisher: life history, ecology, and behavior. Second edition. Univ. Minnesota Press, Minneapolis, MN.

_____. 1994*a*. Structure and spacing of *Martes* populations. Pp. 101-121 *in* S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell, eds. Martens, sables, and fishers: biology and conservation. Cornell Univ. Press, New York, NY.

_____. 1994*b*. Effects of scale on habitat selection and foraging behavior of Fishers in winter. J. Mammal. 75:349-356.

_____, and R.B. Brander. 1977. Adaptations of Fishers and porcupines to the predator prey system. Pp. 45-53 *in* R.L. Phillips and C. Jonkel, eds. Proceedings of the 1975 Predator Symp. Montana For. Conserv. Exp. Stn., Univ. Montana. Missoula, MT.

_____, and W.J. Zielinski. 1994. Fisher. Pp. 38-72 *in* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski, tech. eds. The scientific basis for conserving forest carnivores: American marten, fisher, lynx, and wolverine in the western United States. U.S. Dep. Agric., For. Serv., Rocky Mt. For. and Range Exp. Stn., Fort Collins, CO.

Powell, S.M., E.C. York, J.J. Scanlon, and T.K. Fuller. 1997. Fisher maternal den sites in central New England. Pp. 265-278 *in* G. Proulx, H.N. Bryant, and P.M. Woodward, eds. *Martes*: taxonomy, ecology, techniques, and management. Prov. Mus. Alberta, Edmonton, AB.

Proulx, G., and P.J. Cole. 1996. Robson Valley Fisher Assessment. Columbia Basin Fish and Wildl. Compensation Prog., Nelson, BC. 36 pp.

Proulx, G., and R. Kariz. 2001. Occurrence of American marten and other furbearers in TFL #30, Prince George Forest District. Can. For. Products Ltd., Prince George, BC. Unpubl. rep.

_____, 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. In press. World distribution and status of the genus *Martes*. *In* D.J. Harrison, A.K. Fuller, and B.J. Hearn, eds. Ecology and management of *Martes* in human altered landscapes.

Quick, H.F. 1953. Wolverine, Fisher, and marten studies in a wilderness region. Trans. of Eighteenth North American Wildl. Conf.: 513-533.

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

_____. 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. Pp. 146-165 *in* G. Proulx, H.N. Bryant, and P.M. Woodward, eds. *Martes*: taxonomy, ecology, techniques, and management. Prov. Mus. Alberta, Edmonton, AB.

Resources Inventory Committee. 1999. British Columbia wildlife habitat ratings standards. Resour. Inventory Comm., Victoria, BC.

Roy, K.D. 1991. Ecology of reintroduced Fishers in the Cabinet Mountains of northwest Montana. M.Sc. Thesis, Univ. Montana, Bozeman, MT.

Ruggiero, L.F., W.J. Zielinski, K.B. Aubry, S.W. Buskirk, and L.J. Lyon. 1994. A conservation assessment framework for forest carnivores. Pp. 1-6 *in* L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinski, tech. eds. The scientific basis for conserving forest carnivores: American marten, Fisher, lynx, and wolverine in the western United States. U.S. Dep. Agric., For. Serv., Rocky Mt. For. and Range Exp. Stn., Fort Collins, CO.

Strickland, M.A. 1982. Fisher and marten study 1979-80 and 1980-81, Algonquin region. Ontario Minist. Nat. Resour., Owen Sound, ON.

_____. 1994. Harvest management of Fishers and American martens. Pp. 149-164 *in* S.W. Buskirk, A.S. Harestad, M.G. Raphael, and R.A. Powell, eds. Martens, sables, and Fishers: biology and conservation. Cornell Univ. Press, New York, NY.

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

Teit, J.A. 1975. Mythology of the Thompson Indians. 2nd edition. AMS Press, New York, NY.

Weir, R.D. 1995*a*. Diet, spatial organization, and habitat relationships of Fishers in south-central British Columbia. M.Sc. Thesis, Simon Fraser Univ., Burnaby, BC.

_____. 1995*b*. Use of riparian and riparian-associated habitats by Fishers. Pp. 49-56 *in* K.H. Morgan and M.A. Lashmar, eds. Riparian habitats: management and research – proceedings. Can. Wildl. Serv., Delta, BC.

_____. 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, BC. Report No. 206. 39pp.

_____. 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, BC. Report No. 222. 38pp.

_____, and A.S. Harestad. 1997. Landscape-level selectivity by Fishers in south-central British Columbia. Pp. 252-264 *in* G. Proulx, H.N. Bryant, and P.M. Woodward, eds. *Martes*: taxonomy, ecology, techniques, and management. Prov. Mus. Alberta, Edmonton, AB.

_____, and F.B. Corbould. 2000. Fishers in British Columbia: options for conservation of a Blue-listed species (abstract only). Pp. 690 *in* L.M. Darling, ed. Proceedings of a conference on the biology and management of species and habitats at risk: volume 2. Prov. B.C. and Univ. College of the Cariboo, Kamloops, BC.

_____, A.S. Harestad, and F.B. Corbould. In press *a*. Home ranges and spatial organization of Fishers in central British Columbia. *In* D.J. Harrison, A.K. Fuller, and B.J. Hearn, eds. Ecology and management of *Martes* in human altered landscapes.

_____, F. B. Corbould, and A. S. Harestad. In press *b*. Effect of ambient temperature on the selection of rest structures by Fishers. *In* D.J. Harrison, A.K. Fuller, and B.J. Hearn, eds. Ecology and management of *Martes* in human altered landscapes.

Zielinski, W.J., T.E. Kucera, and R.H. Barrett. 1995. Current distribution of the Fisher, *Martes pennanti*, in California. California Fish and Game 81:104-112.

13 BIOGRAPHICAL SUMMARY OF CONTRACTOR

Richard Weir has spent 10 years studying the habitat ecology of Fishers in British Columbia. He conducted his first study of Fisher ecology in 1990-1993 for the British Columbia Ministry of Environment, the results of which were contained in his Masters of Science thesis. From 1996 to 2000, he conducted a second research project on Fishers to the west of the Williston Reservoir for the Peace/Williston Fish and Wildlife Compensation Program, examining the effects of habitat change on Fisher ecology. Richard has also been involved with research and management projects involving Badgers, Wolverines, American Martens, Black Bears, and Grizzly Bears. Richard's research has focused on identifying habitat requirements for wildlife and mitigating the effects of habitat change from logging, mining, and hydroelectric development. The results of his work have been utilized in the creation of management recommendations to conserve vulnerable wildlife populations within British Columbia. Richard is currently the Western Canadian representative for the Martes Working Group.

14 AUTHORITIES CONSULTED

Badry, Michael. Commercial Wildlife/Furbearer Specialist. Fish and Wildlife Recreation and Allocation Branch, Ministry of Water, Land and Air Protection, Victoria, BC.

Clevenger, Tony. Warden Service, Banff National Park, Banff, AB.

Corbould, Fraser. Peace/Williston Fish and Wildlife Compensation Program, Prince George, BC.

Gitscheff, Carl. British Columbia Trappers Association, Dawson Creek, BC.

Hatler, David. British Columbia Trappers Association, Enderby, BC.

Kier, Kurt. Fish and Wildlife Science and Allocation Section, Ministry of Water, Land and Air Protection, Kamloops, BC.

Kyle, Chris. Ph.D. candidate, University of Alberta, Edmonton, AB.

Schultze, George. Ecosystems Section, Ministry of Water, Land and Air Protection, Terrace, BC.

Steventon, Doug. Research Branch, Ministry of Forests, Smithers, BC.

Warkentin, Bill. Fish and Wildlife Science and Allocation Section, Ministry of Water, Land and Air Protection, Cranbrook, BC.

Watts, Glen. Fish and Wildlife Science and Allocation Section, Ministry of Water, Land and Air Protection, Prince George, BC.

Rob Woods, Fish and Wildlife Science and Allocation Section, Ministry of Water, Land and Air Protection, Fort St. John, BC.

Wright, Randy. Ecosystems Section, Ministry of Water, Land and Air Protection, Williams Lake, BC.