Chapter 2

WORLD DISTRIBUTION AND STATUS OF THE GENUS *MARTES* IN 2000

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***Abstract*:** The genus *Martes* is comprised of 7 species of martens, sables and fishers, most of them forest-dwelling animals with valuable fur, distributed throughout North America, Europe and Asia. The pine marten (*Martes martes*) is indigenous over most of Europe, from Mediterranean biotopes to Fennoscandian taiga, and to western Siberia and Iran. It is found in insular wooded areas, shrublands, and coniferous forests. The stone marten (*M. foina*) occurs from Mongolia and the northern Himalayas to most of Europe. It frequents forests, woodlands and pastures, and is expanding in suburban and urban areas. The sable (*M. zibellina*) occurs in Russia, Mongolia, China, North Korea, and Japan. Over most of its distribution, the sable inhabits coniferous taiga forests with late seral attributes. The yellow-throated marten (*M. flavigula*; including the Nilgiri marten, *M. gwatkinsi*) occurs in sub-tropical and tropical forests from the Himalayas to eastern Russia, south to the Malay Peninsula and Sunda Shelf to Taiwan. The Japanese marten (*M. melampus*) occurs in forests of the main Japanese archipelago and the Korean peninsula. The American marten (*M. americana*) occurs in large contiguous populations in forested habitats of North America north of 35° latitude. It is associated with mesic coniferous and mixed forests with overhead cover and structural complexity near the ground. The fisher (*M. pennanti*) occurs in large contiguous areas across Canada, and in disjunct areas within the United States, north of 35° latitude. Whereas the distribution of *Martes* significantly expanded in many parts of the world over the last 20 years, largely due to several reintroduction programs, many populations are threatened by habitat loss and alteration. There is a need to develop cost-effective survey methods, monitor populations and fur-harvest activities, and assess the effects of natural and anthropogenic disturbance agents on habitat use by *Martes* species.

1. INTRODUCTION

The genus *Martes* occurs in tropical, temperate, and boreal forest zones of the Old and New Worlds. It is comprised of 7 species of martens, sables and fishers (Buskirk 1994), most of them forest-dwelling animals with valuable

fur. Their distribution and abundance are strongly influenced by habitat change resulting from forestry and agricultural practices (Brainerd et al. 1994, Kryštufek 2000, Messenger and Birks 2000, Proulx 2000), and the resiliency of populations to trapping and hunting pressure (Banci and Proulx 1999). It is, therefore, important to regularly monitor the distribution of *Martes* species across their range to assess the effects of human activities on population changes, recognize information gaps, develop effective research programs, and implement sound management programs that will ensure the future of these species.

This paper reviews the distribution of the Eurasian pine marten (*Martes martes*), stone marten (*M. foina*), sable (*M. zibellina*), yellow-throated marten (*M. flavigula* including the Nilgiri marten, *M. gwatkinsi*), Japanese marten (*M. melampus*), American marten (*M. americana*), and fisher (*M. pennanti*). It focuses on the conservation status and geographic distribution of extant populations during the last 20 years, discusses factors explaining population trends, and identifies present and future management and research activities addressing these species within their current geographic distributions.

2. DATA COLLECTION AND ACKNOWLEDGMENTS

Basic information on the status and distribution of *Martes* species was obtained from scientific literature and technical reports from various government agencies and conservation organizations. This information was updated with a questionnaire sent to wildlife researchers and agencies in countries where *Martes* species are or might be present. Questionnaires requested information on: 1) conservation status, i.e. endangered, threatened, special concern, furbearer, or other; 2) harvest status, with mean length of trapping/hunting seasons, harvest limits, and characteristics of harvested populations; 3) geographic distribution and variation in abundance from 1980 to 2000; 4) habitat loss or expansion during the last 20 years; 5) factors associated with population changes; and 6) management (e.g., reintroduction programs) or research activities affecting the distribution of species.

There was a marked variation in the quantity and quality of information provided by respondents. The information was first used to define the contemporary distribution of each *Martes* species. Because of taxonomic uncertainties or lack of precise data, changes in geographic distribution and variations in abundance usually did not include sub-species. Information on habitat loss or expansion in various ecosystems was largely subjective and was used only to identify major trends at the country level. Questionnaires were used to differentiate harvested and protected populations, and to identify population trends.

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3. SPECIES ACCOUNTS

3.1 The Pine Marten (*Martes martes*)

3.1.1 Distribution

The pine marten is indigenous over most of Europe, from Mediterranean biotopes to Fennoscandian taiga, and to western Siberia and Iran (Clevenger 1994, Helldin 1998, De Marinis et al. 2000) (Fig. 2.1).

Formerly widespread in Britain, the pine marten declined due to habitat loss and persecution and is now mainly confined to northern Scotland, with small, relict populations surviving in parts of England and Wales. Since 1980, the species range has been slowly expanding in Scotland. Martens were reintroduced in 1980–1981 in the southwest portion of the country. Elsewhere in Britain, populations remain isolated, vulnerable, and difficult to monitor (Messenger and Birks 2000). The situation is complicated by the recent confirmation of the presence of *M. americana* (believed to have escaped from fur farms) and evidence of possible introgression with *M. martes* in areas of the latter's relict distribution in northern England (Kyle et al. 2003). In Ireland, the distribution is patchy (Mitchell-Jones et al. 1999), but expanding due to increased coniferous forest and legal protection (P. Sleeman, Department of Zoology and Animal Ecology, National University of Ireland, Cork, Ireland, personal communication).

The occurrence of the pine marten in continental Portugal was unknown until the late 1980s. In her review of the status and distribution of the Portuguese mustelids, Santos-Reis (1983) did not include the pine marten as a resident species. The first mention of the pine marten in Portugal occurred in the Red Data Book for Terrestrial Vertebrates on the basis of carcass analyses (Serviço Nacional de Parques Reservas e Conservação da Natureza 1990). It appears that, because of its scarcity and morphological similarities with the much more abundant stone marten, the inclusion of the pine marten in the Portugal mammalian fauna was delayed. The species is now considered indigenous to Portugal (Santos-Reis and Petrucci-Fonseca 1999). Validated records of the species and responses to questionnaires sent to municipalities (H. Matos and M. Santos-Reis, Faculdade de Ciêcias, Lisbon University, Portugal, un-

published data) confirmed the scarcity of the pine marten in Portugal and suggest the species is scattered in the north and interior portions of the country. It is absent from the Atlantic islands (Azores and Madeira archipelagos).

Still in the Mediterranean region, the pine marten occurs in northern Spain (Clevenger 1993), particularly in the Pyrenean mountains, the Cordillera Cantabrica, and the Atlantic areas (J. Ruiz-Olmo, Servei de Protecció I Gestió de la Fauna, Direcció del Medi Natural, Barcelona, Spain, and J.M. Lopez-Martin, Department of Animal Biology, Barcelona University, Spain, personal communication) (Fig. 2.1). Insular populations occur in the Balearic Islands of Minorca and Majorca (Clevenger 1993). In France, the pine marten mostly occurs in the Pyrenees, Limousin, and the eastern portion of the country, except Provence and Côte d'Azur (Bouchardy and Labrid 1986). It is rare in southwest France and the Mediterranean area but occurs in Corsica (T. Lode, Laboratoire d'Écologie Animale, UFR Sciences, Université d'Angers, France, personal communication). In Italy, the species is present in the forested areas of the peninsula, with a distribution that appears to be very fragmented; insular populations also occur in Sardinia, Sicily and Elba (De Marinis and Masseti 1993, De Marinis et al. 2000, Fornasari et al. 2000; P. Genovesi, National Wildlife Institute, Italy, personal communication).

In Switzerland, the pine marten is believed to be widespread. However, since 1980, most observations have occurred in the western and southern regions (S. Capt, Centre Suisse de Cartographie de la Faune, Neuchâtel, Switzerland, personal communication). In Belgium, the pine marten is restricted to southern regions (Libois 1983). It is present throughout Luxembourg (A. Baghli, National History Museum, Luxembourg, and L. Schley, Service de la Conservation de la Nature, Direction des Eaux et Forêts, Luxembourg, personal communication). The distribution of marten in The Netherlands is patchy (S. Broekhuizen, Wageningen, The Netherlands, personal communication; Muskens et al. 2000). In Denmark, the pine marten is a rare species occurring mainly in the southern forests of the peninsula of Jutland; small populations also occur in the islands of Fyn, Lolland-Falster, and Zealand (T. Asferg, National Environmental Research Institute, Department of Landscape Ecology, Rønde, Denmark, personal communication). Martens are present throughout the forested regions of Germany (M. Stubbe, personal communication). The species is widespread in Austria (A. Kranz, Hunting Association of Styria, Graz, Austria, personal communication) and Hungary (M. T. Apathy, Department of Biology, Eotvos Lorand University, Budapest, Hungary, personal communication) (Fig. 2.1).

In Finland, the pine marten is present in Lapland, at the northern limit of its range (Pulliainen 1984), but its populations reach higher densities in the

Figure 2.1. General distribution of *Martes martes* throughout Europe and western Asia (after King 1977, O'Sullivan 1983, Fayard 1984, Velander 1983, 1991, Balharry et al. 1996, Strachan et al. 1996, Messenger et al. 1997, De Marinis et al. 2000; Muskens et al. 2000; T. Asferg, National Environmental Research Institute, Department of Landscape Ecology, Rønde, Denmark, personal communication; S. Capt, Centre Suisse de Cartographie de la Faune, Neuchâtel, Switzerland, personal communication; M. Dumitru, "Grigore Antipa" National Museum of Natural History, Bucharest, Romania, personal communication; A. Legakis, Zoological Museum, Department of Biology, University of Athens, Greece, personal communication; C. Prigioni, Department of Animal Biology, University of Pavia, Italy, personal communication; P. Sleeman, Department of Zoology and Animal Ecology, National University of Ireland, Cork, Ireland, personal communication; F. Spitzenberger, Museum of Natural History, Vienna, Austria, personal communication).

more forested eastern and southern regions of the country (Helle et al. 1996, Kurki et al. 1997, Kauhala and Helle 2000). It is also more abundant in the central and southern forests of Norway (Helldin 2000, Ryvarden 2001). The pine marten is present throughout Sweden (except Gotland Island; J. O. Helldin, Grimsö Wildlife Research Station, Swedish University of Agricultural Sciences, Riddarhyttan, Sweden, personal communication), Lithuania (Mickevicius and Baranauskas 1992; L. Balciauskas, Institute of Ecology, Vilnius, Lithuania, personal communication), Latvia (Ozolins and Pilats 1995, •. Andersone, Kemeri National Park, Latvia, personal communication), the Czech Republic (Andera and Hanzal 1996; M. Andera, Department of Zoology, National Museum, Praha, Czech Republic, personal communication) and Poland (A. Zalewski, Mammal Research Institute, Polish Academy of Science, Poland, personal communication), with no apparent change in distribution over the last 20 years (Fig. 2.1). The species is common in the Carpathian Mountains (Bakeyev 1994), which lie mostly in Romania and the Czech Republic. In Romania, the species occurs in the central region of the country, and along the Hungarian and Ukrainian borders (M. Dumitru, "Grigore Antipa" National Museum of Natural History, Bucharest, Romania, personal communication). The pine marten is present in Slovenia, Macedonia, Bosnia-Herzegovina, and European Turkey, but the limits of its range are poorly defined (Stubbe 1993, Kryštufek 2000). In Bulgaria, it inhabits mountainous forests, preferably over 1,500 m above sea level (ASL) (Grigorov 1986). Between the 1940s and the 1960s, the species was considered in danger of extinction. Since then, it has recovered even though it is still considered as threatened (Spriridonov and Spassov 1998; N. Spassov, National Museum of Natural History, Sofia, Bulgaria, personal communication). The pine marten is widely distributed in Serbia and Montenegro (Mitchell-Jones et al. 1999, M. Paunovic, Zoological Department for Vertebrata, Natural History Museum, Belgrade, Yugoslavia, personal communication). It is also recorded in all the continental parts of Croatia (N. Tvrtkovic, Croatian Natural History Museum, Zagreb, Croatia, personal communication), in eastern Albania (C. Prigioni, Department of Animal Biology, University of Pavia, Italy, personal communication), and northern Greece (A. Legakis, Zoological Museum, Department of Biology, University of Athens, Greece, personal communication) (Fig. 2.1).

In the Siberian taiga, the pine marten is replaced by the closely related *M. zibellina*; some overlap occurs around the Ural Mountains in central Russia, and hybridization between the two species is not uncommon (Helldin 1998). The resulting offspring is called "kidus"; it is not believed to be fertile (Grakov 1994).

3.1.2 Habitat Relations

The pine marten is found in a variety of habitat types including insular wooded areas and shrublands (Clevenger 1993, De Marinis and Masseti 1993), alpine shrublands with coniferous and broad-leaved stands (Fornasari et al. 2000), lowland deciduous forests (Marchesi 1989), mesic pine stands (Fedyk et al. 1984, Jędrzejewski et al. 1993), and spruce-dominated forests (Pulliainen 1984, Brainerd et al. 1994).

Although many respondents were unable to describe marten-habitat relationships, it appears that forested areas continue to be the main strongholds of this species. In Britain and Ireland, small marten populations occur in young and old forests, and riparian woodland. In these heavily deforested countries, pine martens also use alternative three-dimensional habitats provided by rocky mountains and cliffs. It is suggested that these habitats provided refuges for pine martens when forest cover fell to as low as 4%; today rock crevices still provide secure natal denning sites in place of tree cavities that are scarce in modern forests in the British Isles (Birks et al. 2003). In Portugal, the species may be associated with forested hills. In France, Switzerland, Austria, Hungary, Bulgaria,Yugoslavia, Italy, Sweden, Poland, Lithuana, Albania, and Croatia, marten populations reach higher densities in mature or old coniferous, deciduous or mixed forests. While Hayden and Harrington (2000) consider pine marten to be extremely adaptable and opportunistic, respondents reported that martens are usually scarce or absent in agricultural lands, urban developments, and in areas without trees.

The presence of martens in forested areas and, concurrently, their absence in treeless areas, raise concerns about the effects of forestry development in several countries. For example, respondents reported a decrease in mature and old-growth forests, and an increase in <20-year-old stands in Sweden and Latvia during the last 5 years. Because clearcuts (barren or with trees <1 m in height) and fragmentation of mature forest types have been documented to exert negative effects on pine martens (Brainerd et al. 1994, Kurki et al. 1998), recent landscape changes resulting from forestry practices could have long-term effects on the distribution of the species. The scarcity of tree cavities suitable as natal den sites in managed forests may be a limiting factor to pine marten populations (Brainerd et al. 1995, Zalewski 1997, Birks et al. 2003). Also, respondents from Spain, France, Italy, Austria, Switzerland, Albania, Croatia, Bulgaria, Greece and Turkey have identified habitat loss resulting from forestry practices as a major concern for pine marten conservation.

3.1.3 Population Status and Trends

Hunting or trapping of pine martens is permitted in 13 of 25 countries (Table 2.1). In most of these countries, forested regions still cover large areas,

and most marten populations are considered stable. In Latvia, the marten population is increasing, likely because of decreased hunting pressure due to a significant reduction in fur prices (Ozolinš and Pilats 1995). In Scandinavia, marten population densities may be limited by red fox (*Vulpes vulpes*) predation and competition (J.-O. Helldin, Grimsö Wildlife Research Station, Swedish University of Agricultural Sciences, Riddarhyttan, Sweden, personal communication; see Storch et al. 1990, Lindström et al. 1995), possibly in combination with modern forestry practices (Brainerd 1997). Fox predation may limit marten populations in other countries, especially where tree cover is low (Birks et al. 2003). In Austria, where martens may be captured as furbearers or pests, animals are trapped year-round, and little is known about population trends (Table 2.1). In France, the pine marten was removed from the national list of potential pest species in 2002 (Moutou 2003).

In most countries where the pine marten is protected, population trends are either increasing due to habitat improvement, or are unknown (Table 2.1). In the latter case, the pine marten is so rare that respondents did not want to risk an assessment. Pine marten populations may be decreasing in Albania due to habitat loss (C. Prigioni, Department of Animal Biology, University of Pavia, Italy, personal communication), and in Portugal, because of forest replacement by *Eucalyptus* plantations, which support fewer prey and resting and denning sites (Santos-Reis, Faculdade de Ciêcias, Lisbon University, Portugal, unpublished data). Respondents from Britain, Germany, Ireland, Luxembourg, and The Netherlands reported that pine martens are threatened by habitat fragmentation, loss of connectivity between populations, increased urbanization and roadkills, increased predation by foxes, illegal or widespread use of toxicants (particularly herbicides and rodenticides), and illegal trapping or shooting by gamekeepers (Strachan et al. 1996). Habitat loss and overharvesting or poaching threatens marten populations in France (T. Lode, Laboratoire d'Écologie Animale, UFR Sciences, Université d'Angers, France, personal communication), Romania (M. Dumitru, "Grigore Antipa" National Museum of Natural History, Bucharest, Romania, personal communication), and Turkey (Ö. E. Can, Turkish Society for the Conservation of Nature, Ankara, Turkey, personal communication).

3.1.4 Research and Management Needs

While information about pine marten populations is limited, there are a few research and management programs that are evaluating population monitoring techniques (Britain), distribution (Hungary), reintroduction (Ireland), reproduction, mortality and dispersal (France and The Netherlands), and general ecology (Poland and Spain). Harvest records are maintained in many countries (Table 2.1) and are the primary data used to monitor populations.

Table 2.1. Responses to questionnaires on the status of pine marten populations since 1995.

	Marten Population Status			Marten Harvest				
Country	No Status	Furbearer/ Pest	Special Status	Length of trapping/hunting season (days)	Mean Annual Harvest	Data Collected	Population Trend[a]	Reasons for Population Change
Albania			Protected (Vulnerable or endangered)[b]				D	Habitat loss
Austria		x		365	700–1000	Number and location of captures	U	
Britain			Protected				I	Habitat increase
Bulgaria			Protected (Vulnerable)				I	Protection from hunting
Croatia		x		90	Unknown	Location of captures	U	
Czech Rep.		x		120	4,000–5,000	Number and location of captures	S-I	Unknown
Denmark			Protected (Threatened)				S-I	Habitat increase
France		x		365	10,000	Questionnaires to trappers	U	
Germany		x		≤140	3,000–7,000	Number of captures	S	
Greece	x						S	
Hungary			Protected (Endangered)				S	
Ireland			Protected				I	Habitat increase & legal protection
Italy			Protected				U	
Latvia		x		166	800	Number and location of captures	I	Decreased trapping

Table 2.1. Continued.

Country	Marten Population Status: No Status	Marten Population Status: Furbearer/ Pest	Marten Population Status: Special Status	Marten Harvest: Length of trapping/hunting season (days)	Marten Harvest: Mean Annual Harvest	Marten Harvest: Data Collected	Population Trend[a]	Reasons for Population Change
Lithuania		x		275	200–300	Number of captures[c]	S	
Luxembourg	x						U	
Poland		x		181	900-1,200	Number of captures	S	
Portugal			Protected (Undetermined)				U[d]	
Romania		x		196	1,500	Quotas	S	
Spain			Protected (Threatened)				S-I	No harvest, and habitat recovery in the mountains
Switzerland		x		168	170		S	
The Netherlands			Protected (Vulnerable)				U	
Turkey		x		77	500–1,000		S	
Sweden		x		165	10,000	Number and location of captures	D	Predation by fox
Yugoslavia		x[e]		120	> 1,250		S-I	Habitat conservation

[a]S = stable; I = increasing; D = decreasing; U = unknown.
[b]Hunting is allowed by special permission of the Ministry of Agriculture.
[c]Total number of *Martes martes* and *M. foina*.
[d]Under the International Union for Nature Conservation, the "undetermined" category implies that the species is threatened to an unknown extent. Martens are scarce and its populations are probably in decline due to habitat loss.
[e]Protected in the northern province of Vojvodina.

There is a need to develop cost-effective detection, survey, and monitoring methods for pine marten populations, particularly those at low densities. This should be done in parallel with the development of recovery programs for sparse populations inhabiting fragmented landscapes. The restoration and linkage of woodlands should be promoted to maximize the viability of populations. Management should also include measures to increase the availability of arboreal cavities suitable as natal dens.

3.2 The Stone Marten (*Martes foina*)

3.2.1 Distribution

The stone marten occurs from Mongolia and the northern Himalayas to most of Europe (Fig. 2.2). It is absent from most of the Mediterranean islands except Crete, and from Great Britain and Ireland. The northern limit of its range is Denmark (Lachat 1991). The distribution of the stone marten has increased in many European countries (e.g., Swiss Jura, Denmark, Germany, and Poland) (Godin and Vivier 1995; A. Zalewski, Mammal Research Institute, Polish Academy of Science, Poland, personal communication). In The Netherlands, the stone marten was found along the border with Germany in 1980 (Broekhuizen and Müskens 1984). The species range has now expanded to include central portions of the country, both in the south and the north, (S. Broekhuizen, Wageningen, The Netherlands, personal communication). The stone marten is widespread in Portugal (but absent in the Atlantic islands, and Madeira and Azores; Santos-Reis 1983), France except Corsica (Bouchardy and Libois 1986), Luxembourg (A. Baghli, National History Museum, Luxembourg, and L. Schley, Service de la Conservation de la Nature, Direction des Eaux et Forêts, Luxembourg, personal communication), Switzerland (S. Capt, Centre Suisse de Cartographie de la Faune, Neuchâtel, Switzerland, personal communication), Denmark (T. Asferg, National Environmental Research Institute, Department of Landscape Ecology, Rønde, Denmark, personal communication), Germany (M. Stubbe, Institut fûr Zoologie, Martin-Luther-Universität, Halle, Germany, personal communication), Austria (A. Kranz, Hunting Association of Styria, Graz, Austria, personal communication), Hungary (M. T. Apathy, Department of Biology, Eotvos Lorand University, Budapest, Hungary, personal communication), Bulgaria (N. Spassov, National Museum of Natural History**,** Sofia, Bulgaria, personal communication), Serbia and Montenegro (Milenkovic 1985, Mitchell-Jones et al. 1999, M. Paunovic, Zoological Department for Vertebrata, Natural History Museum, Belgrade, Yugoslavia, personal communication), Greece (A. Legakis, Zoological Museum, Department of Biology, University of Athens, Greece, personal commu-

Figure 2.2. General distribution of *Martes foina* in Europe (after Broekhuizen and Müskens 1984; S. Broekhuisen, Wageningen, The Netherlands, personal communication; M. Dumitru, "Grigore Antipa" National Museum of Natural History, Bucharest, Romania, personal communication; A. Legakis, Zoological Museum, Department of Biology, University of Athens, Greece, personal communication; C. Prigioni, Department of Animal Biology, University of Pavia, Italy, personal communication; F. Spitzenberger, Museum of Natural History, Vienna, Austria, personal communication).

nication), Italy (Serafini and Lovari 1993, Fornasari et al. 2000, De Marinis et al. 2000, P. Genovesi, National Wildlife Institute, Italy, personal communication), the Czech Republic (Andera and Hanzal 1996; M. Andera, Department of Zoology, National Museum, Praha, Czech Republic, personal communication), Albania (except in the Alps; C. Priogioni, Department of Animal Biology, University of Pavia, Italy, personal communication) and Croatia (N. Tvrtkovic, Croatian Natural History Museum, Zagreb, Croatia, personal communication) (Fig. 2.2). In Spain, the stone marten is widespread but absent from coastal environments and areas intensively farmed for cereal crops (E. Virgós, Instituto de Investigación en Recursos Cinegéticos, Spain, personal communication). In Romania, distribution is patchy and partly overlaps that of the pine marten. The stone marten occurs in the northwest between the cities of Cluj and Hunedoara, and in the south, near the cities of Craiova, Brasov, and Galati (M. Dumitru, "Grigore Antipa" National Museum of Natural History, Bucharest, Romania, personal communication).

In Lithuania, the stone marten is not as common as the pine marten, and its distribution is patchy, with greater densities in the south (L. Balciauskas, Institute of Ecology, Vilnius, Lithuania, personal communication) (Fig. 2.2). In Latvia, the species is rare, and considered to be at the periphery of its distribution (Ozolinš and Pilats 1995). A few martens occur in Estonia (Timm 1991). The species is also present in the forests of the Carpathians (Bakeyev 1994). It occurs throughout the Balkans, but its distributional dynamics are poorly documented (Kryštufek 2000).

The stone marten is present in the Ukraine and Russia, with higher populations in areas where hunting is prohibited, such as in Chernobyl near the site of the nuclear catastrophe (Bakeyev 1994). In Russia, the stone marten occurs in the Caucasus and the Crimea, as far east as the Volga River (Fig. 2.2). Whereas the ranges of stone martens and pine martens overlap extensively, population sizes of the 2 species on a site have been reported to be inversely related. Pine martens are more common in extensive forests; stone martens in areas with less forest and more openings (Bakeyev 1994).

The stone marten is best adapted to warm climates and lacks morphological adaptations (i.e., its fur is less dense and its feet are hairless) to survive severe winters with deep snow (Lachat Feller 1993, Bakeyev 1994). However, with increasing populations, the stone marten inhabits mountain forests almost to the subalpine zone (Bakeyev 1994). It occurs to 2,400 m altitude in the Alps, and 2,000 m in the Pyrenees (Saint-Girons 1973). In India, Prater (1971) reports the presence of stone martens in Kashmir and the Himalayas (between 1500 and 3600 m ASL, Pocock 1999) (Fig. 2.3). Choudhury (1997a) reported the stone marten in the middle and higher ranges of the Eastern Himalaya and

Figure 2.3. General distribution of *Martes foina* in Asia (after Chotolchu et al. 1980, Bakeyev 1994, Heilin et al. 1999).

Mishmi Hills, where it coexists with the yellow-throated marten. Mallon (1991) recorded stone martens in northern India, near the border of Pakistan and the People's Republic of China. He believed that they were widely distributed at low densities in mountainous areas. The stone marten also occurs in the Annapurna Mountain Range of Nepal (Oli 1994).

In Iraq, Hatt (1959) believed that the stone marten was probably confined to hilly forestlands (Fig. 2.3). However, recent records on the distribution of this species in Iraq, Iran, and Syria are lacking. The stone marten occurs in central and northwest China where its distribution overlaps with the sable (Helin et al. 1999). The stone marten also occurs in southwest Mongolia, mostly along the Chinese border (Chotolchu et al. 1980) (Fig. 2.3).

3.2.2 Habitat Relations

The stone marten frequents forests (Amores 1980, Mickevicius and Baranauskas 1992), cork oak (*Quercus suber*) woodlands (Santos-Reis et al. 2003), rocky areas (Waechter 1975, Mallon 1991), fields, pastures, gardens and wooded farmlands (Lachat Feller 1993, Genovesi and Boitani 1997), and villages and towns (Waechter 1975, Clément and St-Girons 1982, Lucherini and Crema 1993, Tóth 1998). The stone marten is well adapted to humans and continues to expand its range in suburban and urban areas (Bouchardy and Libois 1986, Lachat 1991).

Respondents from France, Switzerland, Denmark, Germany, Italy, Hungary, Romania, Czech Republic, Greece, Lithuana, Croatia, Poland, and Yugoslavia indicated that densities of stone martens were greatest in agricultural, industrial and urban areas. In Portugal and Spain, however, the stone marten is not closely associated with human settlements as in central Europe. When resting, the stone marten prefers mature oaks or riparian vegetation; when foraging, it selects cultivated fields and riparian vegetation (Santos-Reis et al. 2003). In Spain, the stone marten prefers rocky areas and riparian and plain forests to urban and rural habitats (Virgós et al. 2000, E. Virgós, Instituto de Investigación en Recursos Cinegéticos, Spain, personal communication). Likewise, in Albania, stone martens are more frequent in riverine habitat with good riparian vegetation (C. Prigioni, Department of Animal Biology, University of Pavia, Italy, personal communication). Interestingly, a feral population of stone martens was established 20 years ago near Milwaukee, in southeast Wisconsin, USA where the animals inhabit small open and forested deciduous uplands (Long 1995).

3.2.3 Population Status and Trends

In most countries where it occurs, the stone marten is a legally harvested species with stable or increasing populations (Table 2.2). The species is often viewed as a pest and is hunted in response to damages to houses and cars, poultry depredation, smells associated with feces, urine and prey remains, and noise (Waechter 1975, Lachat 1991, Lucherinni and Crema 1993, T. Asferg, National Environmental Research Institute, Department of Landscape Ecology, Rønde, Denmark, personal communication). In Romania, the annual har-

Table 2.2. Responses to questionnaires on the status of stone marten populations since 1995.

	Marten Population Status			Marten Harvest				
Country	No Status	Furbearer/ Pest	Special Status	Length of trapping/hunting season (days)	Mean Annual Harvest	Data Collected	Population Trend[a]	Reasons for Population Change
Albania		x		181	Unknown		U	
Austria		x		365	1,000		S	
Bulgaria		x			Unknown[b]		S	
Croatia		x		360	Unknown		S-I	
Czech Rep.		x		120	5,000–6,000	Number and location of captures	I	Possible high food supply (pigeons) in urban areas
Denmark		x		133	4,250	Number and location of captures, and questionnaires to hunters	S-I	Unknown
France		x		365	30,000	Questionnaires to trappers	S	
Germany		x		≤140	46,000–52,000	Number of captures	S	
Greece	x							
Hungary		x[c]		168	200–400	Harvest records and questionnaires to hunting clubs	S-I	
Italy	x							
Latvia		x		166	Insignificant		U	
Lithuania		x		275	200–300	Total captures of *M. martes* and *M. foina*	S	

Table 2.2. Continued.

	Marten Population Status			Marten Harvest				
Country	No Status	Furbearer/ Pest	Special Status	Length of trapping/hunting season (days)	Mean Annual Harvest	Data Collected	Population Trend[a]	Reasons for Population Change
Luxembourg		x		137	270	Number and location of captures	S	
Poland		x		181	Unknown	Total captures of *M. martes* and *M. foina*	S	
Portugal	x						U	
Romania		x		196	500	Quotas	D	Poaching
Spain	x						U	
Switzerland		x		168	2,600		S	
The Netherlands			Protected				S-I	
Turkey		x		77	500–1,000		S	
Yugoslavia (Serbia and Montenegro)		x[d]		120	>2,500		S-I	

[a] S = stable; I = increasing; D = decreasing; U = unknown.
[b] Pelt numbers are recorded at the regional level and it is difficult to obtain a figure for the national harvest.
[c] Since 1993 due to increasing urban populations.
[d] Protected in the northern province of Vojvodina.

vest has decreased from 1,000 in 1980 to 500 in 2000. There is a general decline of the population possibly caused by poaching activities (M. Dumitru, "Grigore Antipa" National Museum of Natural History, Bucharest, Romania, personal communication). In Turkey, overharvesting is also a concern (Ö. E. Can, Turkish Society for the Conservation of Nature, Ankara, Turkey, personal communication). In The Netherlands, the species has been protected until recently. However, its status will soon be revised, and it will be possible to catch and kill individuals that cause serious damage (S. Broekhuizen, Wageningen, The Netherlands, personal communication). In Greece and Italy, the species has no special status. In Italy, fewer than 100 animals are thought to be killed each year for damage control (P. Genovesi, National Wildlife Institute, Italy, personal communication).

The stone marten is well adapted to survive in agricultural and urban areas, and most respondents did not identify any population threat. In Spain, however, the stone marten may be threatened by non-selective predator control programs, particularly poisons, and habitat fragmentation (E. Virgós, Instituto de Investigación en Recursos Cinegéticos, Spain, personal communication). In Portugal, stone marten populations are reduced by habitat loss (deforestation, summer fires, afforestation with *Eucalyptus*), poisoning, and trapping.

3.2.4 Research and Management Needs

There is currently little research on the stone marten. Recent studies were conducted or are still underway on habitat preference and food habits in Spain (e.g., Virgós et al. 2000), Germany, Luxembourg, Italy (e.g., Genovesi and Boitani 1997), Hungary, Croatia, and Poland. More research on the distribution of the stone marten in Asia, particularly in mountainous regions, is needed. There is a need to develop cost-effective detection, survey, and monitoring methods. Interspecific relationships of martens inhabiting agricultural and urban areas should be studied. In these areas, stone martens are either protected, legally hunted or controlled as pests. The dynamics of populations subject to different management programs should be investigated in order to better assess the effects of human activities on the viability of populations.

3.3 The Sable (*Martes zibellina)*

3.3.1 Distribution

The sable occurs in 5 countries: Russia, Mongolia, China, North Korea, and Japan (Buskirk et al. 1994) (Fig. 2.4). In Russia, the current distribution is largely the result of mass reintroductions from 1940 to 1965 involving > 19,000 animals (Bakeyev and Sinitsyn 1994). In the nineteenth and early twentieth

centuries, sables were intensively harvested over vast areas, and reintroductions and subsequent protection allowed the distribution to recover. The range of the sable extends northward to the limit of trees, reflecting the tolerance of the species for extremely low temperatures. Sables extend southward to 55–60° latitude in western Siberia, and 42° in the mountains of eastern Asia. The sable occurs in the southernmost part of its distribution in mountains that tend to be peninsular or insular. To the west, the sable extends to the Ural Mountains, where it is sympatric with the European pine marten (Geptner et al. 1967, Bakeyev and Sinitsyn 1994, Grakov 1994). The sable is also found on Sakhalin Island (Corbet 1978, Geptner et al. 1967), off the eastern coast of Siberia.

In Mongolia, the sable occurs in the Altai Mountains of the far Northwest, and in forests around Lake Hovsgol. The latter sable habitat is contiguous with the Trans-Baikal boreal forest region, which produces the best-known and most valuable sable pelts. This region has the most sharply continental climate experienced by any *Martes*, with warm summers, but long, severe winters. In China, the sable currently occurs in a small area of the Xinjiang Uygur Autonomous Region, where the southern Altai Mountains enter China from the north (Fig. 2.4). In northeastern China, the sable is now limited to the Daxinganling Mountains of Heilongjiang province and Inner (Nei) Mongolia. In the Xiaoxinganling Mountains of eastern Heilongjiang, the persistence of the sable is suspected, but not confirmed (Ma and Xu 1994, Helin et al. 1999). Sables also occupy the Changbaishan Mountains along the border with, and southward into North Korea (Ma and Xu 1994). Areas of China occupied by the sable have declined drastically over the last 100 years, with the southern margin of the distribution of sables retreating northward by as much as 900 km in some places (Ma and Xu 1994). This contraction of the distribution is attributable to human activities, particularly trapping and hunting, timber harvest, and conversion of land to agriculture.

The sable occurs in Hokkaido, the northernmost major island of Japan, in the main Japanese archipelago, and on the Korean peninsula (Anderson 1970, Corbet 1978, Hosoda et al. 1997) (Fig. 2.4).

3.3.2 Habitat Relations

Sables inhabit taiga forests and their southern montane extensions. Over most of their distribution, they occupy coniferous taiga forest, but in the Daxinganling Mountains and eastward, forests are increasingly deciduous (Ma and Xu 1994). Sables prefer attributes associated with late successional stages: large diameter trees and large diameters and volumes of coarse woody debris (Buskirk et al. 1994). In northern China, these attributes tend to be found on north-facing slopes and in riparian associations. Although mixed coniferous – deciduous forests are suitable habitats, sables avoid pure deciduous stands (V.

Figure 2.4. General distribution of *Martes zibellina* in Asia.

Monakhov, Institute of Plant and Animal Ecology, Ekaterinburg, Russian Federation, unpublished data). Little is known about habitats of sables in Japan.

Bakeyev and Sinitsyn (1994) believed that forest cutting and fire had not yet greatly influenced sable populations in Russia, and that timber harvest had been effective in creating habitat mosaics that support many small mammals and plants that are important foods of sables (Bakeyev and Sinitsyn 1994,

Brzezinski 1994). However, effects of extensive forestry such as large-scale clearcutting have not been studied and could detrimentally affect sables. In Japan, habitat conservation programs are virtually non-existent and the sable is affected by forest destruction and fragmentation.

3.3.3 Population Status and Trends

In Russia, the sable is a furbearer, and is subject to extensive trapping, hunting, and captive propagation, which all contribute to a lucrative fur industry. In the western part of the country, from the Urals to the Yenisey River, 19,600–36,000 pelts are harvested from the wild annually (Minkov 1998; V. Monakov, Institute of Plant and Animal Ecology, Ekaterinburg, Russian Federation, unpublished data). Yet, sable populations have remained stable in the last decade (Minkov 1998, Monakhov 1995, 2000). The most important threats to sable populations in Russia are land conversion, overharvesting, and diseases and parasites (Monakhov 1983, 1999; Valentsev 1996). In China, the sable has been listed as endangered since 1989 (Buskirk et al. 1993). Also, since 1989, all uses of sables, including for research, are under government supervision. One national and 7 provincial nature reserves totaling 812,161 ha have been established for the protection of sables and their habitats (Ma and Xu 1994). However, populations are still threatened by uncontrolled hunting, conversion of forests to other land uses, and logging (Buskirk et al. 1994).

3.3.4 Research and Management Needs

There is an apparent need for more research on sable populations and their habitat relationships. In Russia, several ongoing studies are being conducted at the Institute of Plant and Animal Ecology (Ekaterinburg), All-Russia Institute of Hunting and Fur Farming (Kirov), and Krasnoyarsk State University. In Hokkaido, only one study was carried out on sable food habits (Nitta 1982). More research is needed on sable habitat use, particularly in coniferous forests. A population monitoring program and a better control of harvest activities is required to ensure the future of sables in Japan.

3.4 The Yellow-Throated Marten (*Martes flavigula*)

3.4.1 Distribution

The yellow-throated marten occurs in sub-tropical and tropical forests from the Himalayas to eastern Russian Federation (V. Monakhov, Institute of Plant and Animal Ecology, Russian Federation, unpublished data), south to the Malay Peninsula and Sunda Shelf (Borneo, Sumatra, and Java) to Taiwan (Medway 1978, Buskirk 1994) (Fig. 2.5).

In India, the yellow-throated marten has been reported in the northeast states of Arunachal Pradesh (Choudhury 1997a), Manipur (Ramakantha 1994), and Assam (Choudhury 1997b), and in Indo-Myanmar (Burma) border areas (Ramakantha 1994). In southwest India, the Nilgiri marten (*Martes gwatkinsi*) is regarded by some as a subspecies of *Martes flavigula* (Corbet and Hill 1992). This subspecies is a rare mustelid endemic to the forested tracts of the western Ghat (Madhusudan 1995).

The yellow-throated marten occurs in central and northeast China (Helin et al. 1999), and on the Korean peninsula (Tatara 1994). In Malaya, the species is not common but it is well distributed throughout the mainland in all types of tall forest (Medway 1978). In Taiwan, it occurs in the Central Mountain Range and in southern areas (Lin 2000).

3.4.2 Habitat Relations

In spite of a general lack of data on yellow-throated marten habitat associations, observations indicate that it is associated with forested areas, both tropical and subtropical (Medway 1978, Ramakantha 1994, Choudhury 1997a, Helin et al. 1999). In the Himalayas, the yellow-throated marten inhabits the temperate forest belt between 1220 and 2745 m; it is not found above tree line. It is also found in sub-tropical and tropical forests extending downslope to the edge of the plains (Prater 1971).

3.4.3 Population Status and Trends

There is little information on yellow-throated marten population status and trends. The species is considered to be rare (Helin et al. 1999, Lin 2000). The yellow-throated marten is not typically killed for its fur, but some pelts are sold in Taiwan shops (Wang 1986).

The Nilgiri marten is listed as threatened by the IUCN (Groombridge 1993, Christopher and Jayson 1996). It is well known to the Kani tribals of southwestern India. Being hunter-gatherers, the Kanis consume many types of wild animals. However, they avoid eating the Nilgiri marten because they believe its meat to be poisonous. The unpleasant body odor of the marten may be the reason for this belief (Christopher and Jayson 1996).

3.4.4 Research and Management Needs

There is a significant lack of information about yellow-throated martens and Nilgiri martens, and their habitat relationships. More research is required on the reproductive biology, food habits, movements, and behavior in order to develop sound management programs.

Figure 2.5. General distribution of *Martes flavigula* in Asia.

3.5 The Japanese Marten (*Martes melampus)*

3.5.1 Distribution

The Japanese marten occurs in the main Japanese archipelago and the Korean peninsula. Three separate subspecies are recognized on the basis of differences in their coat coloration (Anderson 1970, Corbet 1978): *M. m. melampus* in Honshu, on the islands of Shikoku, Kyushu, Awaji, and Sado (introduced),

and in southwestern Hokkaido (introduced); *M. m. tsuensis* on Tsushima Island; and *M. m. coreensis* on the Korean Peninsula (although the identity of this subspecies is subject to controversy).

3.5.2 Habitat Relations

The Japanese marten occurs only in forested areas (Tatara 1994): mainly old deciduous forests in the north, and coniferous forests in the south. Martens avoid plantations and open fields.

3.5.3 Population Status and Trends

In Japan, this marten is trapped for its fur from 1 December to 31 January except on Hokkaido Island, where it is sympatric with the fully protected sable, and on Tsushima Islands where it is designated as a rare species by IUCN and as a species at risk by the Environment Agency of Japan. The annual harvest rate is 5,000–10,000 pelts.

Logging constitutes a serious threat to martens as large tracts of broad-leaved forests are replaced by conifer plantations, which are poor in food resources (Tatara 1994). Other threats include habitat fragmentation from roads, road kills, and mortality caused by feral dogs (Tatara 1994, M. Saeki, Osaka, Japan, unpublished observation). Greater interspecific competition by introduced carnivores (e.g., mongoose, *Herpestes* spp.; civet, *Paguma larvata*; raccoon, *Procyon lotor*; Yamada 1998) may also affect the survival of Japanese martens.

3.5.4 Research and Management Needs

Research on the reproduction and interspecific relationships of the Japanese marten is needed for science-based management. There is a need to establish sound population monitoring programs, including the management of trapping activities, and to designate protected areas.

3.6 The American Marten (*Martes americana)*

3.6.1 Distribution

The American marten occurs in forested habitats of North America north of 35° latitude. It is present in all of the Canadian territories and provinces, except Prince Edward Island. In the United States, it is found in regions west of 105° longitude (except for a re-introduced population in South Dakota), and east of 95° longitude (Fig. 2.6). The following review of marten distribution in North America covers 4 regions: eastern, central, western, and northern.

3.6.1.1 Eastern region

The marten populations of southern Québec (south of St. Lawrence River), New Brunswick, Maine, and New Hampshire are contiguous (Fig. 2.6). In Québec, the marten is absent from the St. Lawrence River valley and Anticosti Island (Newsom 1937). In New Brunswick, martens occur in the central and northwest regions of the province, and in Fundy National Park where they were introduced in the 1980s (C. Libby, Fish and Wildlife Branch, Department of Natural Resources, Fredericton, New Brunswick, Canada, personal communication). Individuals have been seen in the southern and eastern regions of the province, but their numbers are unknown. In Maine, the marten has expanded its range since 1980, due partly to the translocation of 63 martens from northern and western Maine to southeast portions of the state (W. Jakubas, Department of Inland Fisheries and Wildlife, Maine, USA, personal communication). Dispersal movements between northern Maine and Canada may occur in the northern portion of the state where forestlands are contiguous. The marten is also indigenous to New Hampshire, and has also benefited from reintroductions in the early 1970s. Martens occur in northern New Hampshire where most of the species' current habitat is in the White Mountain National Forest (E. Orff, Fish and Game Department, New Hampshire, USA, personal communication).

Disjunct populations of the American marten are found in Newfoundland, Nova Scotia, and New York (Fig. 2.6). In the 1980s, in Newfoundland, the species was found only in the western part of the province (Forsey et al. 1995). However, after a series of reintroductions from 1984–1988, a small population is now present on the east side of the island, in Terra Nova National Park. In Nova Scotia, there is a small remnant population on Cape Breton Island (Anonymous 1998) and a reintroduced population in the south. The marten population in the Adirondack Mountains of New York State is second to Maine's in size, and is disjunct from all other martens in the northeast United States (M. Brown, Department of Environmental Conservation, New York, USA, personal communication).

3.6.1.2 Central region

The marten populations of Labrador (Province of Newfoundland), Québec (north of St. Lawrence River), Ontario, Manitoba, and Minnesota are contiguous (Fig. 2.6). In Labrador, martens are found over most of the territory, except in the northernmost areas dominated by tundra (R. Otto, Inland Fish and Wildlife Division, Labrador, Canada, personal communication). The marten is present in all forest regions of Québec north of the St. Lawrence River (Prescott and Richard 1996, Fortin et al. 1997). Although the species distribution did not include the Ungava Peninsula in 1980, recent research has detected it there

Figure 2.6. General distribution of *Martes americana* in North America (after Gibilisco 1994, Aune and Schladweiler 1997, Groves et al. 1997, Johnson and Cassidy 1997, Zielinski et al. 2001; W. Melquist, Idaho Department of Fish and Game, Idaho, USA, personal communication).

(Fortin et al. 1997). In Ontario, the marten is found throughout most of the province; the Algonquin region is on the southern fringe of the species' current range (Strickland 1989) (Fig. 2.6). The distribution of marten populations in Ontario and Manitoba is contiguous along their common border. In Manitoba, however, martens are mainly located north of Lake Winnipeg (~ 53° latitude)

(Gibilisco 1994). In southwestern Manitoba, a disjunct population has been reintroduced (1991–1993) in Riding Mountain National Park, in the forest-agricultural transition zone; reproduction has been observed since then (Schmidt and Baird 1995). In Minnesota, martens occur only in the northern districts. In northeastern Minnesota, its distribution is contiguous with forested areas in Ontario (Berg and Kuehn 1994). In the northwest, however, the species' distribution extends to the edges of the prairies (W.E. Berg, Minnesota Department of Natural Resources, unpublished report).

In Michigan, following a successful reintroduction in the northern Lower Peninsula in 1985–1986, martens appear to be expanding their distribution widely, but Earle and Reis (1996) believe that they are still below the region's carrying capacity. Martens have been reintroduced to the Upper Peninsula 3 times between 1955–1981. Natural dispersal has also been supplemented by translocations in 1990 and 1992 (Earle and Reis 1996). The presence of marten has recently been confirmed throughout most of the upper peninsula (Earle 1999). In Wisconsin, after several reintroduction programs from 1975–1987 (Kohn and Ashbrenner 1996), martens are found in Nicolet and Chequamegon National Forests and adjacent areas (Anonymous 2000). The Wisconsin population is contiguous with that of Michigan, and is close to the southernmost range of the Minnesota population (Fig. 2.6). A total of 125 martens were released in the Black Hills of South Dakota from 1980–1983. The population is considered to be well established on the basis of documented reproduction, observations, and recoveries (Fredrickson 1995).

3.6.1.3 Western region

In western North America, the marten is found in 3 Canadian provinces (Saskatchewan, Alberta, and British Columbia) and 10 states (Washington, Oregon, California, Nevada, Montana, Idaho, Wyoming, Colorado, Utah, and New Mexico) (Fig. 2.6).

From the eastern border of Saskatchewan to the western border of British Columbia, the distribution is contiguous. In Saskatchewan, the marten occurs in boreal ecoregions. It is rare in the lower portion of the southern boreal ecoregion, but common in the northern and subarctic regions (A. Arsenault, Saskatchewan Environment and Resource Management, Saskatoon, Saskatchewan, Canada, personal communication). It is also present in the southeast, in Cypress Hills Provincial Park, a coniferous and mixed forested area within the mixed-grass prairie, where females with kits and adult males were released in 1986 (Hobson et al. 1989). In Alberta, it is present in boreal, subalpine and montane forest regions (Skinner and Todd 1988, G. Proulx, Alpha Wildlife Research & Management Ltd., Alberta, Canada, unpublished data). In British Columbia, the marten is present throughout the province and on the

coastal islands (M. Badry, Ministry of Environment, Lands and Parks, Victoria, British Columbia, personal communication) (Fig. 2.6).

In the western United States, marten populations typically occur in upper-elevation montane habitats, and are geographically disjunct (Gibilisco 1994, Graham and Graham 1994). In Washington, the marten is found in 4 distinct regions corresponding to the Selkirk Mountains in the northeast, the Blue Mountains in the southeast, the Cascade Range in the center, and the Olympic Mountains in the northwest (Johnson and Cassidy 1997) (Fig. 2.6). The range of the marten in coastal areas of Washington contracted substantially during the 20th century, and appears now to be restricted to a small population on the east slope of the Olympic Mountains (Zielinski et al. 2001). In Oregon, the marten is found in the Blue Mountains in the northeast, the Cascade Range in the center, and the southern portions of the Coast Range in the west (Marshall 1992). Coastal populations are restricted in distribution and abundance. In California, the marten is found in several mountain ranges including the Klamath, the Cascades, and the Sierra Nevada, but has drastically decreased in northwestern California within the range of *M. a. humboldtensis* (Zielinski et al. 2001, Slauson 2003). Although the distribution and abundance of inland marten populations in the Pacific States have remained relatively stable, coastal populations have been substantially reduced in distribution and appear to occur at extremely low densities (Zielinski et al. 2001); these populations are particularly vulnerable to extirpation. In Nevada, martens have been documented in the Tahoe Basin and along portions of the Carson Range (S. Espinosa, Department of Wildlife, Nevada, personal communication). In Montana, martens occur on the west side of the state. In the northwest region, they occur in habitats ranging from low forested valley bottoms to the alpine zone (Aune and Schladweiler 1997). In southwestern Montana, martens are restricted to high elevation mountain ranges (Fig. 2.6). Their distribution is interrupted by large open grassland valleys, resulting in naturally fragmented habitats that isolate populations (Gibilisco 1994). In Idaho, on the basis of habitat types (Groves et al. 1997) and capture locations, the distribution of marten populations is likely limited to the northern half of the state, which includes the Bitterroot Range and several groups of mountains. There is also a small population in southern Idaho where 59 martens were re-introduced in 1993 and 1994 (W. Melquist, Idaho Department of Fish and Game, Idaho, USA, personal communication). In Wyoming, the marten is found in the Absaroka Mountains, Bighorn Mountains, Wind River Mountains, Uinta Mountains, and Medicine Bow Mountains. In Utah, martens are most abundant in mature forest stands located in the Uinta Mountains (C. McLaughlin, Division of Wildlife Resources, Utah, personal communication). Scattered sightings also indicate their presence in other

high, forested ranges such as the Wasatch Mountains (Parker 2001). In Colorado, the marten is found in the western half of the state, which is characterized by the presence of several mountain ranges such as the Rocky Mountains, the Sangre de Cristo Mountains, and the San Juan Mountains (Fitzgerald et al. 1994, Byrne 1998). The American marten is very rare and restricted in distribution in New Mexico, but its presence has been verified in the San Juan and Sangre de Cristo Mountains (Anonymous 1996).

3.6.1.4 Northern region

The American marten generally occurs throughout forested areas of northern Canada and Alaska (Fig. 2.6). The range encompasses most of the Northwest Territories, from the Mackenzie Delta to the southern border of the territories (R. Mulders and R. Popko, Resources, Wildlife, and Economic Development, Government of the Northwest Territories, Northwest Territories, Canada, personal communication). In Nunavut, the species is limited to narrow zones in the northwest and along the southern border of the Territories. The marten is absent along eastern portions of the arctic coastal region and on the islands of the high arctic. The marten is found throughout most of the Yukon, being absent only in the treeless tundra of the north and in the high mountains of the southwestern region of the province (H. Slama, Yukon Department of Renewable Resources, Whithorse, Yukon, Canada, personal communication). In the Whitehorse area of southwestern Yukon, marten declined during the 1940s and 1950s because of habitat loss and overtrapping. However, martens are now more common (H. Slama, Yukon Department of Renewable Resources, Whithorse, Yukon, Canada, personal communication) following a successful reintroduction in the late 1980s (Slough 1994).

The American marten is common in the central and southern portions of mainland Alaska, south and east of the northern tree line (Fig. 2.6). Insular populations are recorded for Afognak Island in southcentral Alaska, and for several large islands (some with introduced populations from the 1930s and 1940s) in southeast Alaska. The presence of the marten on remote smaller islands in southeast Alaska is uncertain because these islands are typically not trapped (R. Flynn, Department of Fish and Game, Douglas, Alaska, USA, H. Golden, Department of Fish and Game, Anchorage, Alaska, USA, and M. McNay, Department of Fish and Game, Fairbanks, Alaska, USA, personal communication).

3.6.2 Habitat Relations

The American marten is a forest specialist. Martens are associated with areas of overhead cover, especially near the ground, large volumes of large-diameter (> 50 cm dbh) live trees, snags, and coarse woody debris for denning

and resting, and small-scale horizontal heterogeneity especially the interspersion of herbaceous vegetation and patches of large old trees (Buskirk and Ruggiero 1994, Raphael and Jones 1997). Particularly in the West, the marten is commonly associated with late-successional mesic coniferous or conifer-dominated mixed forests (Strickland et al. 1982, Buskirk and Powell 1994). Work in Acadian forests of eastern North America has indicated that mid-successional (9–12 m in height) forests and mature forests of deciduous, mixed conifer-deciduous, and conifer compositions are preferred similarly by martens (Chapin et al. 1997, Payer 1999). These mesic forests contain high volumes of the necessary vertical and horizontal cover required by martens (Chapin et al. 1997, Payer and Harrison 2003); forest-maturity thresholds determining marten use of forest stands in the Acadian region have been estimated to be trees and snags >9 m in height with basal areas of >18 m^2/ha (Payer and Harrison 2003). Habitat fragmentation (often measured by the percent of the landscape that is unforested) even at low levels, i.e., 20–30% of a home range area, may have negative effects on martens (Thompson and Harestad 1994, Hargis and Bissonette 1997, Chapin et al. 1998, Potvin et al. 2000).

All respondents reported the importance of late-seral coniferous forests for American marten. In most jurisdictions, logging has been identified as a major threat for the species. Concerns are mainly about the loss of canopy cover and coarse woody debris (e.g., Flynn and Schumacher 1999).

Although some timber harvesting occurs in the Northwest Territories, Yukon and Alaska, the predominant disturbance is fire. While burns with early successional shrub-sapling vegetation may be inhabited by juvenile martens, they are not used by adult females, and they may act as population sinks for nonbreeders (Paragi et al. 1996). In many jurisdictions, insect epidemics, e.g., bark beetles (*Dendroctonus* spp.) and spruce budworm (*Choristoneura fumiferana*), have resulted in intensive timber harvest operations, often with little or no forest retention, that impact significantly on marten habitat. On the other hand, Yeager (1950) reported that, while outbreaks of the Engelmann spruce bark-beetle (*Dendroctonus engelmanii*) created forests of standing dead trees, such outbreaks were not detrimental to martens where preferred small mammals were still present and cover was provided by residual fir (*Abies* spp.) stands. Chapin et al. (1997) also reported that forest stands with significant mortality from spruce budworm were preferred by marten, despite a canopy closure of mature trees that was typically <30%. These naturally disturbed stands were characterized by increased numbers of snags, windfalls, and root mounds. Habitat loss through urban and sub-urban encroachment is an issue in some jurisdictions.

3.6.3 Population Status and Trends

Trapping seasons for American martens occur in 17 of 25 jurisdictions (Table 2.3). Annual harvests range from 30 in Oregon to ≥30,000 in Québec and Ontario (Robitaille 2000; Table 2.3). In most of these areas, marten populations appear stable. Because habitat loss is a general concern, however, careful monitoring will be required to ensure the future of sustainable populations. For example, in the Northwest Territories and the Yukon, increased numbers of seismic trails for oil and gas exploration results in greater access to areas that have received little trapping pressure in the past. The combined effects of habitat degradation and trapping pressure might be detrimental to the future of marten populations (Banci and Proulx 1999). In New Brunswick, Michigan, Washington, and Oregon, harvest seasons are relatively short, and appear to take into account the small populations. In Colorado, the season is closed due to a lack of ecological and population data. Finally, in some jurisdictions (e.g., Michigan, Maine), quotas have been established to better control fur catches.

The status of most protected American marten populations is unknown (Table 2.3). However, respondents have identified serious threats such as demographic and environmental stochasticity in California, South Dakota, and islands in southeast Alaska. In California, the range of the Humboldt marten has been reduced to one small area that probably contains fewer than 20 individuals (Zielinski et al. 2001, Slauson 2003). The decline of the Humboldt marten is probably the result of habitat loss due to excessive logging of the redwood region during the 20th century. In South Dakota, coyotes may be a threat to marten during winter, when access into deep snow areas is facilitated by compacted snowmobile trails (Buskirk et al. 2000). The resumption of trapping has been, and continues to be, an objective for restoring marten to the Black Hills in South Dakota. If trapping occurs, the population could become vulnerable to over-exploitation unless the harvest is strictly regulated and monitored. In Newfoundland, the marten is endangered by habitat loss, but also by incidental capture from snowshoe hare (*Lepus americanus*) snaring and fur trapping (Thompson 1991, Proulx et al. 1994a, B. Hearn, Canadian Forest Service, Corner Brook, Newfoundland, personal communication).

3.6.4 Research and Management Needs

Marten populations are the subject of many investigations throughout North America. Whereas surveys (e.g., remote cameras, track plate surveys, aerial and ground track counts, questionnaires, trappers' logbooks) are being conducted in many jurisdictions (e.g., New Brunswick, Québec, Washington, Oregon, and California), there is a need to identify and quantify regional habitat requirements of martens in order to customize forest management plans. Conservation assessments at the regional level (e.g., Proulx 2001) are needed to

Table 2.3. Responses to questionnaires on the status of American marten populations since 1995.

	Marten Population Status			Marten Harvest				
Country	No Status	Furbearer/ Pest	Special Status	Length of trapping/hunting season (days)	Mean Annual Harvest	Data Collected	Population Trend[a]	Reasons for Population Change
Alaska		x		77 to 120 depending on regions	> 3,000	Number and location of captures in most regions; age-sex composition in select areas	S	
Alberta		x		92	1,100	Number and location of captures		
British Columbia		x		120	18,500	Number and location of captures	S	
California			Protected			Camera and track surveys, roadkills	U	
Colorado	x (non-game)						U	
Idaho		x		92	575	Harvest locations	U	
Labrador		x		150	1,000–5,500	Number and location of captures	S	
Maine		x		61	3,795 (quota of 25 martens/trapper/ season)	Number and location of captures, and voluntary trapper log book	S	
Michigan		x		10	1 per trapper		S-I	
Nevada			Protected			U		
Newfoundland			Protected (endangered)				S	

Table 2.3. Continued.

Country	Marten Population Status: No Status	Marten Population Status: Furbearer/ Pest	Marten Population Status: Special Status	Marten Harvest: Length of trapping/hunting season (days)	Marten Harvest: Mean Annual Harvest	Data Collected	Population Trend[a]	Reasons for Population Change
New Brunswick		x		14	1,800–2,200	Number and location of captures, and age-sex composition; camera-track surveys	S	
New Hampshire			Protected (threatened)				I	
New York		x		44	91 (6 martens per trapper/ season)	Number and location of captures, trapping effort, sex-age composition, and voluntary log book		
Northwest Territories		x		135	6,000–11,000	Number and location of captures; age-sex composition in select areas	S	
Nova Scotia			Protected (endangered)				U	
Oregon		x		61–92 depending on regions.	30	Number and location of captures, trapping effort, and sex-age composition, camera and track surveys	S in most regions D in coastal mountains	Non-coastal regions: urban encroachment Coastal:timber harvest

Table 2.3. Continued.

Country	Marten Population Status			Marten Harvest			Population Trend[a]	Reasons for Population Change
	No Status	Furbearer/ Pest	Special Status	Length of trapping/hunting season (days)	Mean Annual Harvest	Data Collected		
Québec		x		128	30,000	Number and location of captures, trapping effort, and sex-age composition	S	
Saskatchewan		x		120	2,400	Number and location of captures	S	
South Dakota			Protected			Agency personnel interviews	U	
Utah		x		126	<100	Number and location of captures, and sex-age composition	S	
Washington		x		48–71 depending on regions.	70	Number and location of captures, and trapping effort, camera and track surveys	S in most regions D in coastal mountains	Non-coastal regions: urban encroachment Coastal:timber harvest
Wisconsin			Protected				U	
Wyoming		x		182	Unknown		U	
Yukon		x		118	5,000	Number and location of captures	S	

[a]S = stable; I = increasing; D = decreasing; U = unknown.

develop effective management programs. The effects of severe forest fires, bark beetle infestations, emerging silvicultural practices (e.g., partial harvests vs. clearcutting), agricultural developments in forested regions, and urban sprawl on habitat use by martens need to be investigated. In British Columbia, habitat selection (e.g., Therrien and Eastman 1999, Proulx and Kariz 2001) and connectivity (Proulx and Verbisky 2001) studies are underway. More work on habitat fragmentation and protection (e.g., importance of refugia) is needed. In many jurisdictions where martens are trapped for their fur, carcasses are being collected in order to better assess the status of population and harvest programs (e.g., Fortin et al. 2003). Annual meetings of state and provincial biologists responsible for managing furbearers at the regional level are needed to identify issues of common concern, track research progress, and when appropriate assemble information to be provided to the public on special management issues.

3.7 The Fisher (*Martes pennanti*)

3.7.1 Distribution

The fisher occurs in all of the Canadian provinces and territories except Newfoundland and Prince Edward Island, and in disjunct areas within the United States, north of 35° N latitude (Fig. 2.7). This review of its distribution encompasses 3 regions of North America: eastern, central, and western.

3.7.1.1 Eastern region

The fisher populations of southeastern Québec (south of St. Lawrence River), New Brunswick, Maine, Massachusetts, New Hampshire, Vermont, New York, Connecticut, Rhode Island, and northeastern Pennsylvania are contiguous (Fig. 2.7). Fishers occur throughout southeastern Québec, except in the Montreal and Laval urban areas, and on Anticosti Island. Fishers occur throughout New Brunswick, with the exception of Grand Manan, Deer, and Campbello Islands.

In Maine, fishers occur statewide, with the highest densities from central Maine southward (Krohn et al. 1995) (Fig. 2.7). Densities of fishers and martens appear inversely related; Krohn et al. (1995) hypothesized that fishers were limited in northern Maine by deep snow, and that martens were excluded from southern Maine by high fisher densities. In New York, the fisher's distribution has expanded, due in part to past reintroductions of animals in southeastern New York and a recent release in northcentral Pennsylvania, with animals moving into southern New York. Between 1957–1967, 124 fishers were translocated to northern Vermont. Today, the species occurs throughout Vermont, even in the Champlain Valley, a region of extensive agriculture. In New

Hampshire, fishers occupy the entire state and reach highest population densities in the southwestern and southern regions. The species occurs in central and western Massachusetts and is expanding into highly populated areas to the east. It inhabits both Connecticut and Rhode Island, except the coastal islands (Fig. 2.7). The eastern Connecticut population has resulted from southward expansion of populations from central Massachusetts, whereas expansion in the western half of the state probably originated from a release of 32 animals in 1989 and 1990. During 1994–1998, 190 fishers were released at 5 primary reintroduction sites in northern Pennsylvania: Fish Dam Wild Area (25 fishers), Quehanna Wild Area (23 fishers), and Pine Creek Valley (37 fishers) in northcentral Pennsylvania; Sullivan and Wyoming counties (40 fishers) in northeastern Pennsylvania; and the Allegheny National Forest (61 fishers) in northwestern Pennsylvania (T. Serfass, Department of Biology, Frostburg State University, Maryland, USA, personal communication).

The fisher populations in West Virginia, southern Pennsylvania, and Maryland are also contiguous (Fig. 2.7). The occurrence of fishers in southern Pennsylvania is undoubtedly the result of a reintroduction of 23 fishers in West Virginia in 1969 (Pack and Cromer 1980, Williams et al. 1999, 2000). Fishers expanded into Maryland (Garrett County) and into southern Pennsylvania (Somerset, Fayette, Westmorland, Bedford, and Cambina Counties) toward central Pennsylvania (T. Serfass, Department of Biology, Frostburg State University, Maryland, USA, personal communication).

Disjunct populations of fishers exist in Nova Scotia (Fig. 2.7). Reintroductions from 1947–1948 and 1963–1966 of 80 fishers from Maine into eastern and western Nova Scotia resulted in 2 geographically separate and expanding populations (Potter 2002).

3.7.1.2 Central region

The fisher populations of Québec (north of St. Lawrence River), Ontario, Manitoba, Minnesota, Wisconsin, and Michigan are contiguous (Fig. 2.6). Pilgrim (1980) reported a first record of a fisher in Labrador; however, to our knowledge, there is no evidence of an established population in this part of Newfoundland. In Québec, it was believed that fisher populations were well established from Labrador to the Canada-USA border (Banfield 1974). However, recent information on fisher ecology and capture locations suggests that their current distributional range is smaller and south of 50° latitude (Fortin et al. 2003). In Ontario, the distribution of the fisher overlaps that of the American marten (Gibilisco 1994), but has expanded eastward in the suburban and agricultural areas of the Ottawa Region (Egan 2003). In Manitoba, the distribution of fisher coincides with that of the boreal forest, north of 50° latitude (Leonard 1986, Gibilisco 1994).

Figure 2.7. General distribution of *Martes pennanti* in North America (after Gibilisco 1994, Aubry and Lewis 2003).

In Minnesota, fisher populations are found in the northeastern corner of the state where they are contiguous with Ontario populations (Berg and Kuehn 1994) (Fig. 2.7). In Michigan, 61 fishers were reintroduced to 3 counties in the western Upper Peninsula from 1961–1963, and these animals, combined with a few immigrants from Wisconsin, populated most of the forested portions of the west and central Peninsula by 1987. Natural dispersal was supplemented

by the translocation of 190 fishers to the eastern Upper Peninsula from 1988 to 1992. The fisher is now distributed throughout forested portions of the Upper Peninsula, but has not been reintroduced to the Lower Peninsula (Earle and Reis 1996). In Wisconsin, 120 fishers were successfully reintroduced during 1956–1967. By 1981, fishers occupied all of Wisconsin's Northern Forest Region. There are now approximately 14,000–17,000 fishers in the state and they occupy all suitable habitat (Kohn and Ashbrenner 1996). Gibilisco (1994) reported a recent increase in fisher sightings in North and South Dakota. However, we were unable to confirm the occurrence of resident populations in those 2 states.

3.7.1.3 Western region

In Canada, contiguous populations of fishers occur in Saskatchewan, Alberta, British Columbia, and in a narrow belt in southern Yukon and Northwest Territories tapering off along the Saskatchewan-Nunavut border (Fig. 2.7). In the United States, the fisher occurred historically in most coniferous forest habitats in Montana, Idaho, Wyoming, Washington, Oregon, and California. However, during the 20th century, the range of the fisher in the Pacific states has changed dramatically. The fisher has apparently been extirpated in Washington (Lewis and Stinson 1998) and, in Oregon and California, its range has been reduced to a few disjunct and relatively small areas (Zielinski et al. 1995, Aubry and Lewis 2003). Fisher populations in Montana and Idaho occur over ≤25% of those states; fishers are totally absent from Wyoming.

In Saskatchewan, the fisher is found in the boreal forest, mainly between 52° and 58° N. Although present farther north, it is considered rare in the subarctic boreal region (A. Arsenault, Saskatchewan Environment and Resource Management, Saskatoon, Saskatchewan, Canada, personal communication). In Alberta, Skinner and Todd (1988) reported the presence of fishers in the Rocky Mountains along the British Columbia border, and in the boreal forest, mostly above 54° N. However, they indicated that over most of their range, fisher populations were in decline. In 2000, the distribution of fishers still encompassed boreal and montane forests (G. Proulx, Alpha Wildlife Research & Management Ltd., Sherwood Park, Alberta, Canada, unpublished data). In 1990, Proulx et al. (1994b) released fishers in the parklands of Alberta, near the City of Edmonton. Until recently, the population was thriving (Badry et al. 1997), and reproduction was confirmed in 1993 (G. Proulx, Alpha Wildlife Research & Management Ltd., Sherwood Park, Alberta, Canada, unpublished data). However, the animals were persecuted by local landowners (poisoning and run-down by snowmobiles), and accidentally captured in traps set for beaver (*Castor canadensis*) and other furbearers. The status of this re-introduced population is now uncertain. In British Columbia, the fisher was found throughout the

province in the 1980s except for coastal islands (Banci 1989) (Fig. 2.7). Today, fishers are believed to occur at low densities throughout much of the province (Weir 2003); the species is likely extirpated from the Lower Mainland, portions of the Thompson and Okanagan Valleys, and the southeast corner of the province (M. Badry, Ministry of Environment, Lands and Parks, Victoria, British Columbia, Canada, personal communication). Fishers are rare in coastal ecosystems and may be found in boreal forest habitats (Proulx et al. 2003).

The northernmost extent of the range of fishers is the Great Slave Lake region of the Northwest Territories, where the species is found at 63° N latitude (Fig. 2.7). The fisher occurs throughout the southern portion of the Northwest Territories and Nunavut, and the southeast corner of the Yukon Territory. Since 1980, the species' range may have expanded northward in the Northwest Territories and westward in the Yukon (R. Mulders, Resources, Wildlife, and Economic Development, Government of the Northwest Territories, Northwest Territories, Canada, and H. Slama, Yukon Department of Renewable Resources, Whithorse, Yukon, Canada, personal communication). The presence of fishers near Juneau in southeast Alaska (Fig. 2.7) was confirmed by the recovery of a skull in 1993, and the incidental harvest of 4 individuals between 1997–2003. It is likely that these fishers emigrated from British Columbia via the Taku River valley. As of 2003, however, there is no evidence that a viable fisher population occurs in Alaska (R. Flynn, Department of Fish and Game, Douglas, Alaska, USA, personal communication).

In Montana, fishers are rare and found mainly in the northwest portion of the state, in the Swan mountain range (Roy 1990) (Fig. 2.7). In Wyoming, Gibilisco (1994) questioned the presence of fishers in the vicinity of Yellowstone National Park, in the extreme northwestern corner of that state. Uhler (1998) listed fisher as a rare mammal in Yellowstone Park, if present. We were unable to confirm the presence of fishers in Wyoming. The fisher is not common in Idaho despite a reintroduction program in the 1960s (Williams 1963). Its distribution is limited to the northern portion of the state (C. E. Harris, Idaho Department of Fish and Game, Boise, Idaho, USA, personal communication). Fishers are probably extirpated in Washington. Since 1969, documented evidence of their occurrence in the state is limited to 2 records in anomalous habitats along Puget Sound near captive facilities from which fishers are known to have escaped, and 1 marked animal in northeastern Washington that had been translocated into Montana (Lewis and Stinson 1998). There is no evidence that fishers were ever translocated into Washington or California, but planning is currently underway to assess the feasibility of reintroducing fishers to Washington (Lewis 2002). Fishers were translocated from south-central British Columbia and northern Minnesota to several localities in the southern Cascade

Range in southwestern Oregon and the Wallowa Mountains in northeastern Oregon from 1961–1981 (Kebbe 1961, Aubry and Lewis 2003). Although reintroduction efforts in the Wallowa Mountains appear to have failed, translocations to the southern Cascade Range were successful. Currently, fishers occur in Oregon in only 2 small areas in the southwestern portion of the state: the southern Cascade Range and the northern Siskiyou Mountains. The Cascade population is reintroduced and descended primarily from British Columbia fishers, whereas fishers in the northern Siskiyou Mountains are believed to represent the northeastern extension of a relatively large indigenous population in northwestern California (Aubry and Lewis 2003, Aubry et al. 2004, Drew et al. 2003). In California, there are 2 known disjunct populations (Zielinski et al. 1997). One inhabits the Coast Range and Klamath Mountains of the northwest; the other is found in the southern Sierra Nevada (Fig. 2.7).

3.7.2 Habitat Relations

Fishers occur primarily in late-seral coniferous and mixed-coniferous-deciduous forests (Coulter 1966, Powell 1977, Arthur et al. 1989a, Weir and Harestad 2003), but also use younger stands, especially as foraging habitat (Jones 1991, Buskirk and Powell 1994, Powell and Zielinski 1994, Weir and Harestad 2003). In all regions where they occur, fishers inhabit forests with multi-storied and contiguous overhead cover, and complex structure near the ground that typically includes abundant coarse woody debris and a well-developed understory. While trapping can be a limiting factor to fishers (Krohn et al. 1994, Banci and Proulx 1999), especially during periods of high pelt prices, responses to the questionnaires uniformly indicated that loss of forestland habitat from human development is the main long-term threat to fisher populations. For species like the fisher with large spatial requirements (Arthur et al. 1989b, Garant and Crête 1997), the long-term maintenance of extensive forestlands will be a major conservation challenge.

3.7.3 Population Status and Trends

Fisher populations are harvested in 65% of the surveyed jurisdictions, and most of them are stable or increasing (Table 2.4). In Canada, harvest seasons last at least 90 days. In the United States, most seasons are markedly shorter. Approximately 50% of the harvests consist of less than 400 animals per jurisdiction. In 5 jurisdictions where the fisher is protected, 1 population is stable and 1 is increasing. The status of the other populations is unknown. In British Columbia, the fisher has been identified as “imperiled” by the Conservation Data Centre (2003).

Like most carnivores, fisher populations are threatened by habitat loss through fire, logging, oil and gas exploration, and urban encroachment. Many

Table 2.4. Responses to questionnaires on the status of fisher populations since 1995.

	Fisher Population Status			Fisher Harvest				
Country	No Status	Furbearer/ Pest	Special Status	Length of trapping/hunting season (days)	Mean Annual Harvest	Data Collected	Population Trend[a]	Reasons for Population Change
Alberta		x		92	1,100	Number and location of captures, and age-sex composition	S-I	
British Columbia		x[b]		107	275	Number and location of captures, age-sex composition, and trapper effort	D-S	Loss of habitat and trapping
California			Protected[c]			Roadkills, and camera and track surveys	U	
Connecticut			Protected				I	Reintroduction
Idaho			Protected			Sightings and incidental harvest	U	
Maine		x		61	2,091	Number and location of captures, and voluntary trapper log book	S-I	
Massachusetts		x		22	290	Number and location of captures, age-sex composition, and voluntary survey	I	
New Hampshire		x	31	814 (quota of 10 fishers/ trapper/ season)		Number and location of captures, and mandatory trapper log book	S	

Table 2.4. Continued.

	Fisher Population Status			Fisher Harvest				
Country	No Status	Furbearer/ Pest	Special Status	Length of trapping/hunting season (days)	Mean Annual Harvest	Data Collected	Population Trend[a]	Reasons for Population Change
New York		x		44	1,486	Number and location of captures	I	Reintroductions
Northwest Territories			x[d]	135	22	Number and location of captures	S	
Oregon			Protected			Roadkills, and camera and track surveys	S	
Pennsylvania			Protected				I	Reintroductions
Québec		x		128	4,215	Number and location of captures, age-sex composition, and trapper log book	S	
Rhode Island		x		30	No data – 1st season in November 2000 (quota of 2 fishers/ trapper/season)	Number and location of captures to be collected	S-I	
Saskatchewan		x		120	1,950	Number and location of captures	S-I	
Vermont		x		16	343	Number and location of captures, and mandatory mail survey	I	

Table 2.4. Continued.

	Fisher Population Status			Fisher Harvest				
Country	No Status	Furbearer/ Pest	Special Status	Length of trapping/hunting season (days)	Mean Annual Harvest	Data Collected	Population Trend[a]	Reasons for Population Change
Washington		State endangered[c]				Camera and track surveys	S	May be extirpated
West Virginia		x		90	36 (quota of 1 fisher/ trapper/season)	Number and location of captures	I	Reintroductions
Wyoming			Protected				U	
Yukon		x		135	22	Number and location of captures	S	

[a]S = stable; I = increasing; D = decreasing; U = unknown.
[b]The Government of British Columbia has designated the current status of this “furbearer” as “imperiled”.
[c]The fisher has been petitioned 3 times in the Pacific states for listing under the U.S. Endangered Species Act, the most recent petition is pending (Beckwitt 1990, Carlton 1994, Greenwald et al. 2000).
[d]The Government of the Northwest Territories has designated the current status of this “furbearer” as “may be at risk”.

of them (e.g., California, Oregon) are vulnerable to demographic and environmental stochasticity. A phylogeographic study of fisher populations in the western United States is currently underway (Buskirk et al. 2002). Fishers have a valuable pelt and they are easily enticed in traps set for other furbearers (Banci and Proulx 1999). Trapping activities must be carefully monitored to ensure the future of exploited populations. Fortunately, most jurisdictions monitor harvest captures and locations, and some of them enforce strict quotas (Table 2.4).

3.7.4 Research and Management Needs

Respondents pointed out that the response of fishers to loss and fragmentation of old forest habitat through natural disturbance agents or human activities is a priority research subject. More research is also needed to improve our understanding of broad-scale ecological factors that may affect the abundance and distribution of fishers, and its relationships with sympatric species such as American martens and lynx (*Lynx canadensis*). Special attention should be paid to climatic changes and snowfall patterns.

In jurisdictions where fishers are trapped, the size and distribution of the harvest, and the sex and age composition of captured populations, should be determined to detect major population changes, and to modify harvest programs through adaptive management. Where fisher populations are endangered, monitoring and modeling of habitats needs to be investigated to improve forest development plans. As for martens, annual meetings of state and provincial biologists responsible for managing furbearers at the regional level are a necessity to track research progress and identify specific management concerns.

4. DISCUSSION

While this review provides up-to-date information on distribution limits of the genus *Martes*, scientific information is lacking in some parts of the world and for some species. For example, more data on the distribution of the pine marten are needed in Portugal, Austria, Hungary and the Balkans. The exact distribution of the sable in Mongolia, North Korea, and Japan still needs to be established. We also know little about the distributional range of the yellow-throated marten.

All *Martes* species (even the stone marten) are associated with forest habitats, preferably late seral conditions in either coniferous or mixed coniferous-deciduous forests. On the basis of today's known distribution records, and the apparent association existing between *Martes* and forest habitats, one can conservatively develop habitat management programs. For the yellow-throated

and the Japanese martens, however, baseline research on the species' habitat requirements is required before developing such programs.

This review demonstrated well how valuable reintroduction programs are in the reestablishment of *Martes* species. Today, through repeated release programs, the fisher and the sable reoccupy large portions of their original range. However, the genetic implications of reintroductions are unknown and potentially deleterious (Greig 1979, Templeton 1986, Storfer 1999); unique local adaptations can be disrupted by animals introduced from elsewhere. Reintroductions will not be enough to reestablish *Martes* where habitat has been significantly altered. For example, reintroductions of fishers in many areas of western Washington and Oregon where the species has been extirpated, will be problematic until closed-canopy conditions and key structural elements have been restored. It is therefore essential to develop habitat management programs for landscapes that meet the current needs of *Martes* populations, and that will retain enough interconnected habitats in the future to ensure the long-term viability of populations.

As contradictory as it may seem, *Martes* populations that are annually harvested appear to be the most secure. Data on the distribution of harvested populations are more complete than those of protected populations. Also, because government agencies monitor numbers and locations of captures, changes in population densities or habitat quality are readily determined. Unfortunately, populations that are protected from hunting and trapping are not necessarily better understood. In many cases, these populations have received a special status only after being seriously reduced, and it is difficult to monitor the presence of animals. Data on the dynamics of populations harvested for economic reasons (e.g., pelt value) also are usually more complete than those of populations that are controlled because of damage caused by "pest" animals. It appears that an economically viable *Martes*:human interaction may facilitate the proper management of their populations and habitats.

Martes management programs should take into consideration the impact of global warming on the distribution of species. For example, warmer temperatures and less snow could result in an extension of the geographic range of the stone marten, possibly at the expense of the pine marten and the sable (Lachat Feller 1993, Bakeyev 1994). Likewise, milder winters may benefit fishers over American martens (Krohn et al. 2004).

The limits of distribution of *Martes* species depends on several factors associated with the demographic dynamics of populations and their habitat needs. Scientific studies properly addressing our lack of knowledge on populations and habitats, thorough surveys, and effective monitoring programs will all improve our understanding of the distribution of *Martes* worldwide. We

hope that the knowledge gaps identified in this review will be addressed by research organizations and government agencies in the near future so that, in a decade or less, a precise distribution of all *Martes* species and a greater understanding of their population dynamics are available.

5. LITERATURE CITED

Amores, F. 1980. Feeding habits of the stone marten *Martes foina* (Erxleben, 1777) in southwestern Spain. Säugetierkundliche Mitteilungen 28:316–322.

Andera, M., and V. Hanzal. 1996. Atlas of the mammals of the Czech Republic. A provisional version. II. Carnivores (*Carnivora*). National Museum, Praha, Czech Republic.

Anderson, E. 1970. Quaternary evolution of the genus *Martes* (Carnivora, Mustelidae). Acta Zoologica Fennica 130:1–133.

Anonymous. 1996. Threatened and endangered species of New Mexico - 1996 biennial review and recommendations. Unpublished report, New Mexico Department of Game and Fish, Santa Fe, New Mexico, USA.

_____. 1998. Mammalian species of Nova Scotia. Nova Scotia Department of Natural Resources, Kentville, Nova Scotia, Canada.

_____. 2000. Pine marten (*Martes americana*). Wisconsin Department of Natural Resources, Madison, Wisconsin, USA.

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

_____, _____, and _____. 1989b. Home range characteristics of adult fishers. Journal of Wildlife Management 53:674–679.

Aubry, K. B., and J. C. Lewis. 2003. Extirpation and reintroduction of fishers (*Martes pennanti*) in Oregon: implications for their conservation in the Pacific states. Biological Conservation 114:79–90.

_____, S. M. Wisely, C. M. Raley, and S. W. Buskirk. 2004. Zoogeography, spacing patterns, and dispersal in fishers: insights gained from combining field and genetic data. Pages 201–220 *in* D. J. Harrison, A. K. Fuller, and G. Proulx, editors, Martens and fishers (*Martes*) in human-altered environments: An international perspective. Kluwer Academic Press, Boston, Massachusetts, USA.

Aune, K., and P. Schladweiler. 1997. Age, sex structure, and fecundity of the American marten in Montana. Pages 61–77 *in* G. Proulx, H. N. Bryant, and P. M. Woodard, editors. *Martes*: taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Alberta, Canada.

Badry, M. J., G. Proulx, and P. M. Woodard. 1997. Home-range and habitat use by fishers translocated to the aspen parkland of Alberta. Pages 233–251 *in* G. Proulx, H. N. Bryant, and P. M. Woodard, editors. *Martes*: taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Alberta, Canada.

Bakeyev, N. N., and A. A. Sinitsyn. 1994. Status and conservation of sables in the Commonwealth of Independent States. Pages 246–254 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

Bakeyev, Y. N. 1994. Stone martens in the Commonwealth of Independent States. Pages 243–245 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

Balharry, E. A., G. M. McGowan, H. Kruuk, and E. Halliwell. 1996. Distribution of pine marten in Scotland as determined by field survey and questionnaire. Scottish Natural Heritage Report No. 48, Edinburgh, Scotland.

Banci, V. 1989. A fisher management strategy for British Columbia. British Columbia Ministry of Environment, Wildlife Bulletin No. B-63, Victoria, British Columbia, Canada.

_____, and G. Proulx. 1999. Resiliency of furbearers to trapping in Canada. Pages 175–203 i*n* G. Proulx, editor. Mammal trapping, Alpha Wildlife Research & Management Ltd., Sherwood Park, Alberta, Canada.

Banfield, A. W. F. 1974. Les mammifères du Canada. Musée National des Sciences Naturelles, Presses de l'Université Laval, Québec, Canada.

Beckwitt, E. 1990. Petition for a rule to list the fisher as endangered. Sierran Biodiversity Project, North San Juan, California, USA.

Berg, W. E., and D. W. Kuehn. 1994. Demography and range of fishers and American martens in a changing Minnesota landscape. Pages 262–271 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

Birks, J. D. S., J. E. Messenger, S. P. Rushton, and P. W. W. Lurz. 2003. Reintroducing pine martens – habitat constraints and enhancement opportunities. *In* C. P. Quine, R. C. Trout, and R. F. Shore, editors. Managing woodlands and their mammals: proceedings of a joint Mammal Society/Forestry Commission symposium, Forestry Commission, Edinburgh, Scotland.

Bouchardy, C., and P. Labrid. 1986. La martre (*Martes martes*). Office National de la Chasse,Bulletin Mensuel No. 104, Fiche No. 33, Paris, France.

_____, and R. Libois. 1986. La fouine (*Martes foina*). Office National de la Chasse, Bulletin Mensuel No. 105, Fiche No. 34, Paris, France.

Brainerd, S. M. 1997. Habitat selection and range use by the Eurasian pine marten (*Martes martes*) in relation to commercial forestry practices in southern boreal Scandinavia. Dissertation, Agricultural University of Norway, Ås, Norway.

_____, J.-O. Helldin, E. Lindström, and J. Rolstad. 1994. Eurasian pine martens and old industrial forest in southern boreal Scandinavia. Pages 343–354 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

_____, J.-O. Helldin, E. Lindström, J. Rolstad, and I. Storch. 1995. Pine marten (*Martes martes*) selection of resting and denning sites in Scandinavian managed forests. Annals Zoologica Fennici 32:151–157.

Broekhuizen, S., and G. J. D. M. Müskens. 1984. Wat is er met de steenmarter *Martes foina* (Erxleben, 1777) in Nederland aan de hand? Lutra 27: 261–273.

Brzeziński, M. 1994. Summer diet of the sable *Martes zibellina* in the Middle Yenisei taiga, Siberia. Acta Theriologica 39:103–107.

Buskirk, S. W. 1994. Introduction to the Genus *Martes*. Pages 1–10 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

_____, K. B. Aubry, S. M. Wisely, G. A. Russell, and W. J. Zielinski. 2002. Population genetic structure of the fisher in the western states. *Martes* Working Group Newsletter 10:10.

_____, Y. Ma, and L. Xu. 1993. Sable ecology in Chinese taiga forests. National Geographic Research and Exploration 9:479–480.

_____, _____, and _____. 1994. Sables (*Martes zibellina*) in managed forests of northern China. Small Carnivore Conservation 10:12–13.

_____, and R. A. Powell. 1994. Habitat ecology of fishers and American martens. Pages

283–296 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

_____, and L. F. Ruggiero. 1994. American marten. Pages 7–37 *in* L. F. Ruggiero, K. B. Aubry, K.B., S. W. Buskirk, L. J. Lyon, and W. J. Zielinski, editors. American marten, fisher, lynx, and wolverine in the western United States. USDA Forest Service, General Technical Report RM-254, Fort Collins, Colorado, USA.

_____, _____, and C. J. Krebs. 2000. Habitat fragmentation and interspecific competition: implications for lynx conservation. Pages 83–100 *in* L. F. Ruggiero, K. B. Aubry, S. W. Buskirk, G. M. Koehler, C. J. Krebs, K. S. McKelvey, and J. R. Squires, editors. Ecology and conservation of lynx in the United States. University Press of Colorado, Boulder, Colorado, USA.

Byrne, G. 1998. A Colorado winter track survey for snowshoe hares and other species. Colorado Division of Wildlife, Glenwood Springs, Colorado, USA.

Carlton, D.C. 1994. Petition for a rule to list the fisher, *Martes pennanti*, as "threatened" in the western United States under the Endangered Species Act, 16 U.S.C. Sec. 1531 *et seq*. (1973) as amended. Biodiversity Legal Foundation, Boulder, Colorado, USA.

Chapin, T. G., D. J. Harrison, and D. D. Katnik. 1998. Influence of landscape pattern on habitat use by American marten in an industrial forest. Conservation Biology 12:1327–1337.

_____, _____, and D. M. Phillips. 1997. Seasonal habitat selection by marten in an untrapped forest preserve. Journal of Wildlife Management 61:707–717.

Chotolchu, N, M. Stubbe, and N. Dawaa. 1980. Der steinmareder *Martes foina* (Erxleben, 1777) in der Mongolei. Acta Theriologica 25:105–114.

Choudhury, A. 1997a. Small carnivores (mustelids, viverrids, herpestids, and one ailurid) in Arunachal Pradesh, India. Small Carnivore Conservation 17:7–9.

_____. 1997b. The distribution and status of small carnivores (mustelids, viverrids, and herpestids) in Assam, India. Small Carnivore Conservation 16:25–26.

Christopher, G., and A. A. Jayson. 1996. Sightings of Nilgiri marten (*Martes gwatkinsi* Horsfield) at Peppara Wildlife Sanctuary and Silent Valley National Park, Kerala, India. Small Carnivore Conservation 15:34.

Clément, R., and M. C. Saint-Girons. 1982. Le régime de la fouine *Martes foina* Erxleben 1777 dans l'agglomération nantaise et en milieu rural. Mammalia 46:550–553.

Clevenger, A. P. 1993. The European pine marten *Martes martes* in the Balearic Islands, Spain. Mammal Review 23(2):65–72.

_____. 1994. Feeding ecology of Eurasian pine martens and stone martens in Europe. Pages 326–340 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

Conservation Data Centre. 2003. *Martes pennanti*. B. C. Species and Ecosystem Explorer Website, Ministries of Sustainable Resource Management and Water, Land, and Air Protection, Victoria, British Columbia, Canada.

Corbet, G. B. 1978. The mammals of the Palaearctic region: a taxonomic review. British Museum Natural History, London, United Kingdom.

_____, and J. E. Hill. 1992. The mammals of the Indomalayan region: a systematic review. British Museum Natural History, London, United Kingdom.

Coulter, M. W. 1966. Ecology and management of fishers in Maine. Dissertation, Syracuse University, Syracuse, New York, USA.

De Marinis, A. M., P. Genovesi, and M. Spagnesi. 2000. Pine marten. Pages 158–159 *in* M. Spagnesi, S. Toso, and A. M. De Marinis, editors. 2000 – Italian mammals. Ministero dell'Ambiente, Servizio Conservazione della Natura and Istituto Nazionale per la Fauna

Selvatica A. Ghigi, Roma, Italy.

_____, and M. Masseti. 1993. Pine marten *Martes martes* on the Island of Elba. Small Carnivore Conservation 8:13.

Drew, R. E., J. G. Hallett, K. B. Aubry, K. W. Cullings, S. M. Koepf, and W. J. Zielinski. 2003.Conservation genetics of the fisher (*Martes pennanti*) based on mitochondrial DNA sequencing. Molecular Ecology 12:51–62.

Earle, R. D. 1999. Furbearer winter track counts survey of 1998. Michigan Department of Natural Resources, Wildlife Division Report No. 3288, Federal Aid in Wildlife Restoration, Michigan Project W-127-R, City, Michigan, USA.

_____, and T. F. Reis. 1996. Fisher and marten management in Michigan. Pages 47–58 *in* Abstracts, 14th Midwest Furbearer Workshop, Ironwood, Michigan, USA.

Egan, K. 2003. Team tags reclusive fishers. The Ottawa Citizen, February 8:D1, Ottawa, Canada.

Fayard (Dir.). 1984. Atlas des mammifères de France. Société Française pour l'Etude et la Protection des Mammifères, Paris, France.

Fedyk, S., Z. Gegczynska, M. Pucek, J. Raczynski, and M. D. Sikorski. 1984. Winter penetration by mammals of different habitats in the Biebrza Valley. Acta Theriologica 29:317–336.

Fitzgerald, J. P., C. A. Meaney, and D. M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History and University Press of Colorado, Denver, Colorado, USA.

Flynn, R. W., and T. Schumacher. 1999. Ecology of martens in Southeast Alaska. Alaska Department of Fish and Game, Federal Aid in Wildlife Restoration Research Progress Report W-27-1, Study 7.16, Juneau, Alaska, USA.

Fornasari, L., L. Bani, I. Bonfanti, E. de Carli, and R. Massa. 2000. A spatial analysis of mustelid distributions in northern Italy. Pages 201–215 *in* H. I. Griffiths, editor. Management and conservation aspects of small carnivore:human interactions. Backhuys Publishers, Leiden, The Netherlands.

Forsey, O., J. Bissonette, J. Brazil, K. Curnew, J. Lemon, L. Mayo, I. Thompson, L. Bateman, and L. O'Driscoll. 1995. National recovery plan for the Newfoundland marten. Report No. 14, Recovery of Nationally Endangered Wildlife Committee, Ottawa, Canada.

Fortin, C., M. Julien, and Y. Leblanc. 1997. Geographic variation of American marten in central and northern Québec. Pages 29–39 *in* G. Proulx, H. N. Bryant, and P. M. Woodard, editors. *Martes*: taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Alberta, Canada.

_____, Y. Leblanc, and Y. Garant. 2003. Suivi de l'exploitation et des tendances des populations du pékan (*Martes pennanti*) au Québec de 1984 à 1999. Société de la Faune et des Parcs du Québec, Québec, Canada.

Fredrickson, L. F. 1995. History and management plans for the reintroduced Black Hills marten population. Abstracts, 2nd International *Martes* Symposium, Edmonton, Alberta, Canada.

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

Genovesi, P., and L. Boitani. 1997. Social ecology of the stone marten in central Italy. Pages 110–120 *in* G. Proulx, H. N. Bryant, and P. M. Woodard, editors. *Martes*: taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Alberta, Canada.

Geptner, V. G., N. P. Naumov, and P. B. Yurgenson. 1967. *Martes* (*Martes zibellina* L.) Pages 507–553 *in* Mammals in the U.S.S.R. Volume 2. Vyskaya Skola, Moscow (in Russian), Russia.

Gibilisco, C. J. 1994. Distributional dynamics of modern *Martes* in North America. Pages 59–71 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York,

USA.
Godin, J., and E. Vivier. 1995. Les Mustélidés dans les forêts du Nord de la France – leurs fluctuations d'effectifs de 1975 à 1987. Courrier de l'Environnement de l'INRA no. 25, Paris, France.
Graham, R. W., and M. A. Graham. 1994. Late Quaternary distribution of *Martes* in North America. Pages 26–58 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.
Grakov, N. N. 1994. Kidus- a hybrid of the sable and the pine marten. Lutreola 3:1–4.
Greenwald, D.N., J. Carlton, and B. Schneider. 2000. Petition to list the fisher (*Martes pennanti*) as an endangered species in its west coast range. Center for Biological Diversity, Tucson, Arizona, USA.
Greig, J. C. 1979. Principles of genetic conservation in relation to wildlife management in southern Africa. South African Journal of Wildlife Research 9:57–78.
Grigorov, G. 1986. Distribution, number and use of the stone marten (*Martes foina* Erxl.), the pine marten (*Martes martes* L.) and the badger (*Meles meles* L.) in Bulgaria. Gorskostopanska nauka 5:59–67.
Groombridge, B. 1993. 1994 IUCN red list of threatened animals. The World Conservation Union, Gland, Switzerland.
Groves, C. R., B. Butterfield, A. Lippincott, B. Csuti, and J. M. Scott. 1997. Atlas of Idaho's wildlife. Integrating Gap analysis and natural heritage information. Idaho Department of Fish and Game, Nongame and Endangered Wildlife Program, Boise, Idaho, USA.
Hargis, C. D., and J. A. Bissonette. 1997. Effects of forest fragmentation on populations of American marten in the intermountain west. Pages 437–451 *in* G. Proulx, H. N. Bryant, and P. M. Woodard, editors. *Martes*: taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Alberta, Canada.
Hatt, R. T. 1959. The mammals of Iraq. Museum of Zoology, University of Michigan, Miscellaneous Publication No. 106, Ann Arbor, Michigan, USA.
Hayden, T., and R. Harrington. 2000. Exploring Irish mammals. Dúchas The Heritage Service, Dublin, Ireland.
Helin, S., N. Ohtaishi, and L. Houji. 1999. The mammals of China. China Forestry Publishing House, Beijing, People's Republic of China.
Helldin, J. O. 1998. Pine marten (*Martes martes*) population limitation. Dissertation, Swedish University, Agricultural Sciences, Uppsala, Sweden.
_____. 2000. Population trends and harvest management of pine marten *Martes martes* in Scandinavia. Wildlife Biology 6:111–120.
Helle, E., P. Helle, H. Lindén, and M. Wikman. 1996. Wildlife populations in Finland during 1990–5, based on wildlife triangle data. Finnish Game Research 49:12–17.
Hobson, D. P., G. Proulx, and B. L. Dew. 1989. Initial post-release behavior of marten, *Martes americana*, introduced in Cypress Hills Provincial Park, Saskatchewan. Canadian Field-Naturalist 103:398–400.
Hosoda, T., H. Suzuki, K. Tsuchiya, H. Lan, L. Shi, and A. P. Kryukov. 1997. Phylogenetic relationships within *Martes* based on nuclear ribosomal DNA and mitochondrial DNA. Pages 3–14 *in* G. Proulx, H. N. Bryant, and P. M. Woodard, editors. *Martes*: taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Alberta, Canada.
Jędrzejewski, W., A. Zalewski, and B. Jędrzejewska. 1993. Foraging by pine marten *Martes martes* in relation to food resources in Białowieża National Park, Poland. Acta Theriologica 38:405–426.
Jones, J. L. 1991. Habitat use of fisher in northcentral Idaho. Thesis, University of Idaho,

Moscow, Idaho, USA.
Johnson, R. E., and K. M. Cassidy. 1997. Terrestrial mammals of Washington State. Volume 3 *in* K. M. Cassidy, C. E. Grue, M. R. Smith, and K. M. Dvornich, Editors. Washington State Gap Analysis – Final Report. Seattle Audubon Society Publications in Zoology No. 1, Seattle, Washington, USA.
Kauhala, K., and P. Helle. 2000. The interactions of predator and hare populations in Finland – a study based on wildlife monitoring counts. Annals Zoologica Fennici 37:151–160.
Kebbe, C. E. 1961. Return of the fisher. Oregon State Game Communication Bulletin 16:3–7.
King, C. M. 1977. Pine marten. Pages 323–330 *in* G. B. Corbet and H. N. Southern, editors. The handbook of British mammals. Blackwell, Oxford, United Kingdom.
Kohn, B. E., and J. E. Ashbrenner. 1996. Fisher and marten management in Wisconsin. Page 45 *in* Abstracts, 14th Midwest Furbearer Workshop, Ironwood, Michigan, USA.
Krohn, W. B., S. M. Arthur, and T. F. Paragi. 1994. Mortality and vulnerability of a heavily trapped fisher population. Pages 137–145 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.
_____, K. D. Elowe, and R. B. Boone. 1995. Relations among fishers, snow, and martens: development and evaluation of two hypotheses. The Forestry Chronicle 71:97–105.
_____, C. L. Hoving, D. J. Harrison, D. M. Phillips, and H. C. Frost. 2004. *Martes* footloading and snowfall patterns in eastern North America: implications to broad-scale distributions and interactions of mesocarnivores. Pages 115–132 *in* D. J. Harrison, A. K. Fuller, and G. Proulx, editors. Martens and fishers (*Martes*) in human-altered environments: An international perspective. Kluwer Academic Press, Boston, Massachusetts, USA.
Kryštufek, B. 2000. Mustelids in the Balkans – small carnivores in the European biodiversity hot-spot. Pages 281–294 *in* H. I. Griffiths, editor. Management and conservation aspects of small carnivore:human interactions. Backhuys Publishers, Leiden, The Netherlands.
Kurki, S., P. Helle, H. Lindén, and A. Nikula. 1997. Breeding success of black grouse and capercaillie in relation to mammalian predator densities on two spatial scales. Oikos 79:301–310.
_____, A. Nikula, P. Helle, and H. Lindén. 1998. Abundances of red fox and pine marten in relation to the composition of boreal forest landscapes. Journal of Animal Ecology 67:876–886.
Kyle, C. J., A. Davison, and C. Strobeck. 2003. Genetic structure of European pine martens (*Martes martes*), and evidence for genetic introgression with *M. americana* in England. Conservation Genetics 4:179–188.
Lachat, N. 1991. Stone martens and cars: a beginning war? Mustelid and Viverrid Conservation 5:4–6.
Lachat Feller, N. 1993. Eco-éthologie de la fouine (*Martes foina* Erxleben, 1777) dans le Jura suisse. Dissertation, Université de Neuchâtel, Suisse, Switzerland.
Leonard, R. D. 1986. Aspects of reproduction of the fisher, *Martes pennanti*, in Manitoba. Canadian Field-Naturalist 100:32–44.
Lewis, J. C. 2002. Feasibility study underway for fisher reintroduction in Washington. *Martes* Working Group Newsletter 10:11.
_____, and D. W. Stinson. 1998. Washington State status report for the fisher. Washington Department of Fish and Wildlife, Olympia, Washington, USA.
Libois, R. 1983. Protégeons nos mammifères. Animaux menacés en Wallonie. Editions Duculot, Région Wallone, Gembloux, Belgium.
Lin, L-K. 2000. The status and conservation of Taiwan's mustelids. Pages 331–335 *in* H. I. Griffiths, editor. Management and conservation aspects of small carnivore:human interactions. Backhuys Publishers, Leiden, The Netherlands.

Lindström, E. R., S. M. Brainerd, J.-O. Helldin, and K. Overskaug. 1995. Pine marten-red fox interactions: a case of intraguild predation? Annals Zoologica Fennici 32:123–130.

Long, C. A. 1995. Stone marten (*Martes foina*) in southeast Wisconsin, USA. Small Carnivore Conservation 13:14.

Lucherini, M., and G. Crema. 1993. Diet or urban stone martens in Italy. Mammalia 57:274–277.

Ma, Y., and L. Xu. 1994. Distribution and conservation of sables in China. Pages 255–261 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

Madhusudan, M. D. 1995. Sighting of the Nilgiri marten (*Martes gwatkinsi*) at Eravikulam National Park, Kerala, India. Small Carnivore Conservation 13:6–7.

Mallon, D. 1991. Mustelids in Ladakh, India. Mustelid and Viverrid Conservation 5:9.

Marchesi, P. 1989. Ecologie et comportement de la martre (*Martes martes* L.) dans le Jura suisse. Dissertation, Université de Neuchâtel, Switzerland.

Marshall, D. B. 1992. Threatened and sensitive wildlife of Oregon's forests and woodlands. Audubon Society, Portland, Oregon, USA.

Medway, L. 1978. The wild mammals of Malaya (Peninsular Malaysia) and Singapore. 2nd edition, Oxford University Press, Oxford, United Kingdom.

Messenger, J. E., and J. D. S. Birks. 2000. Monitoring the very rare: pine marten populations in England and Wales. Pages 217–230 *in* H. I. Griffiths, editor. Management and conservation aspects of small carnivore:human interactions. Backhuys Publishers, Leiden, The Netherlands.

_____,_____, and D. J. Jefferies. 1997. What is the status of the pine marten in England and Wales? British Wildlife 8:273–279.

Mickevicius, E., and K. Baranauskas. 1992. Status, abundance, and distribution of mustelids in Lithuania. Small Carnivore Conservation 6:11–14.

Milenkovic, M. 1985. About the distribution of stone marten *Martes foina* Erxleben (Mustelidae, Carnivora) in Vojvodina. Archives Biological Sciences 37 (1–4):3P-4P, Belgrade, Serbia. (in Serbian)

Minkov, S. I., editor. 1998. The sable: Resources conditions and hunting. Kirov City, Russia:VNIIOZ (All-Russia Institute of Hunting and Fur Farming). 207 pages (in Russian).

Mitchell-Jones, A. J., G. Amori, W. Bogdanowicz, B. Kryštufek, P. J. H. Reijnders, F. Spitzenberger, M. Stubbe, J. B. M. Thissen, V. Vohralík, and J. Zima. 1999. The atlas of European mammals. Society Europaea Mammalogica, T. & A. D. Poyser Publishers, London, United Kingdom

Monakhov, V. G. 1983. Filaroises incidence rate in Russian sables of different sex and age. Moscow Bull. MOIP (Bulletin of Moscow Society of Naturalists, Series Biol.), 88 (4):67–69. (in Russian).

_____. 1995. Sable of the Urals, Priobye and the Eniseiskaya Siberia: results and acclimatization. Ekaterinburg: Bank Kul'turnoi Informatsii. (in Russian)

_____. 1999. The ecological structure of sable populations in the nidus of *filaroides* invasion. Russian Journal of Ecology 30:420–427. (in Russian)

_____. 2000. Population analysis of sables in the Ural-Ob Region of the species range. Russian Journal of Ecology 31:422–428.

Moutou, F. 2003. Pests in France. IUCN Small Carnivore Conservation Newsletter 28:18.

Muskens, G. J. D. M., D. J. C. Klees, and S. Broekhuizen. 2000. Dagrustplaatsgebruik van een boommartermannetje *Martes martes* op de zuidoostelijke Veluwe. Lutra 43:81–91.

Newsom, W. 1937. Mammals of Anticosti Island. Journal of Mammalogy 18: 435–442.

Nitta, N. 1982. Winter food habits of the sable in the Hokkaido University forest: the effects on mouse populations and a role of damage prevention in plantations. Unpublished

Dissertation, Hokkaido University, Japan. (in Japanese)
Oli, M. K. 1994. Snow leopards and blue sheep in Nepal: densities and predator:prey ratio. Journal of Mammalogy 75:998–1004.
O'Sullivan, P. J. 1983. The distribution of the pine marten (*Martes martes*) in the Republic of Ireland. Mammal Review 13:39–44.
Ozolinš, J., and V. Pilats 1995. Distribution and status of small and medium-sized carnivores in Latvia. Annals Zoologica Fennici 32:21–29.
Pack, J. C., and J. I. Cromer. 1981. Reintroduction of fisher in West Virginia. Pages 1431–1442 *in* J. A. Chapman and D. Pursley, editors. Worldwide furbearer conference proceedings, Vol. II, Frostburg, Maryland, USA.
Paragi, T. F., W. N. Johnson, D. D. Katnik, and A. J. Magoun. 1996. Marten selection of postfire seres in the Alaskan taiga. Canadian Journal of Zoology 74:2226–2237.
Parker, C. 2001. Marten (*Martes americana*). Utah Division of Wildlife Resources, Wildlife Notebook Series No. 4, Salt Lake City, Utah, USA.
Payer, D. C. 1999. Influences of timber harvesting and trapping on habitat selection and demographic characteristics of marten. Dissertation, University of Maine, Orono, Maine, USA.
_____, and D. J. Harrison. 2003. Influence of forest structure on habitat use by American marten in an industrial forest. Forest Ecology and Management 179:145–156.
Pilgrim, W. 1980. Fisher, *Martes pennanti* (Carnivora: Mustelidae) in Labrador. Canadian Field-Naturalist 94:468.
Pocock, R. I. 1999. The fauna of British India including Ceylon and Burma. Volume II. Taylor and Burma, London, United Kingdom.
Potter, D. N. 2002. Modeling fisher (*Martes pennanti*) habitat associations in Nova Scotia. Thesis, Acadia University, Wolfville, Nova Scotia, Canada.
Potvin, F., L. Bélanger, and K. Lowell. 2000. Marten habitat selection in a clearcut boreal landscape. Conservation Biology 14:844–857.
Powell, R. A. 1977. Hunting behavior, ecological energetics and predator-prey community stability of the fisher (*Martes pennanti*). Dissertation, University of Chicago, Illinois, USA.
_____, and W. J. Zielinski. 1994. Fisher. Pages 38–73 *in* L. F. Ruggiero, K. B. Aubry, S. W. Buskirk, L. J. Lyon, and W. J. Zielinski, editors. American marten, fisher, lynx, and wolverine in the western United States. USDA Forest Service, General Technical Report RM-254, Fort Collins, Colorado, USA.
Prater, S. H. 1971. The book of Indian animals. 3rd edition, Bombay Natural History Society, Delhi, India.
Prescott, J., and P. Richard. 1996. Mammifères du Québec et de l'est du Canada. Editions Michel Quintin, Waterloo, Québec, Canada.
Proulx, G. 2000. The impact of human activities on North American mustelids. Pages 53–75 *in* H. I. Griffiths, editor. Management and conservation aspects of small carnivore:human interactions. Backhuys Publishers, Leiden, The Netherlands.
_____. 2001. Characteristics and management of American marten habitat at stand and landscape levels. Unpublished report, Alpha Wildlife Research & Management Ltd., Edmonton, Alberta, Canada.
_____, D. Bernier, J. M. Heron, and K. A. Paige. 2003. A field guide to species at risk in the Coast Forest Region of British Columbia. International Forest Products Ltd. and British Columbia Ministry of Water, Land, and Air Protection, Victoria, British Columbia, Canada.
_____, and R. Khariz. 2001. Occurrence of American marten and other furbearers in TFL # 30, Prince George Forest District. Unpublished report, Alpha Wildlife Research & Management Ltd., Edmonton, Alberta, Canada.

_____, A. J. Kolenosky, M. J. Badry, P. J. Cole, and R. K. Drescher. 1994a. A snowshoe hare snare system to minimize capture of marten. Wildlife Society Bulletin 22:639–643.

_____, _____, _____, R. K. Drescher, K. Seidel, and P. J. Cole. 1994b. Post-release movements of translocated fishers. Pages 197–203 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.

_____, and R. Verbisky. 2001. Occurrence of American marten within a connectivity corridor. *Martes* Working Group Newsletter 9:4–5.

Pulliainen, E. 1984. Use of the home range by pine martens (*Martes martes* L.). Acta Zoologica Fennica 171:271–274.

Ramakantha, V. 1994. Natural distribution and ecology of mustelids and viverrids in Manipur, north-eastern India. Small Carnivore Conservation 11:16–17.

Raphael, M. G., and L. L. C. Jones. 1997. Characteristics of resting and denning sites of American martens in central Oregon and western Washington. Pages 146–165 *in* G. Proulx,H. N. Bryant, and P. M. Woodard, editors. *Martes*: taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Alberta, Canada.

Robitaille, J.-F. 2000. Management and conservation of mustelids in Ontario and eastern Canada. Pages 77–96 *in* H. I. Griffiths, editor. Management and conservation aspects of small carnivore:human interactions. Backhuys Publishers, Leiden, The Netherlands.

Roy, K. 1990. Cabinet Mountains fisher reintroduction study. Interim Progress Report 1990, Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, Montana, USA.

Ryvarden, L. 2001. La faune et la flore en Norvège. Ministry of Foreign Affairs, Oslo, Norway.

Saint-Girons, M. C. 1973. Les mammifères de France et du Bénélux. Doin, Paris, France.

Santos-Reis, M. 1983. Status and distribution of Portuguese mustelids. Acta Zoologica Fennica 172:213–216.

_____, and F. Petrucci-Fonseca. 1999. Carnivora. Pages 135–165 *in* ICN/CBA, editors. A guide for terrestrial mammals of continental Portugal, Azores and Madeira. Instituto de Conservação do Ambiente, Ministerio do Ambiente, Lisboa, Portugal. (in Portuguese)

_____, M. J. Santos, S. Lourenço, T. Marques, I. Pereira, and B. Pinto. 2004. Relationships between stone martens, genets and cork oak woodlands in Portugal. Pages 147–172 *in* D. J. Harrison, A. K. Fuller, and G. Proulx, editors. Martens and fishers (*Martes*) in human-altered environments: An international perspective. Kluwer Academic Press, Boston, Massachusetts, USA.

Schmidt, G., and R. Baird. 1995. The reintroduction of pine marten and fishers to Riding Mountain National Park. Page 52 *in* Abstracts, 2nd International *Martes* Symposium, Edmonton, Alberta, Canada.

Serafini, P., and S. Lovari. 1993. Food habits and trophic niche overlap of the red fox and the stone marten in a Mediterranean rural area. Acta Theriologica 38:233–244.

Serviço Nacional de Parques Reservas e Conservação da Natureza. 1990. Red data book of terrestrial vertebrates. Vol. I – Mammals, birds, reptiles and amphibians. Serviço Nacional de Parques, Reservas e Conservação de Natureza, Lisboa, Portugal. (in Portuguese)

Skinner, D. L., and A. W. Todd. 1988. Distribution and status of selected mammals in Alberta as indicated by trapper questionnaires in 1987. Alberta Fish and Wildlife Division, Wildlife Management Branch, Occasional Paper No. 4, Edmonton, Alberta, Canada.

Slauson, K. M. 2003. Habitat selection by American martens (*Martes americana*) in coastal northwestern California. Thesis, Oregon State University, Corvallis, Oregon, USA.

Slough, B. G. 1994. Translocations of American martens: an evaluation of factors in success. Pages 165–178 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R.A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca,

New York, USA.
Spiridonov, G., and N. Spassov. 1998. Large mammals (Macromammalia) of Bulgaria. Pages 467–483 *in* C. Meine, editor. Bulgaria's biological diversity: conservation and status needs assessment, Vol. I and II, Washington, D.C., USA.
Storch, I., E. Lindström, and J. de Jounge. 1990. Diet and habitat selection of the pine marten in relation to competition with the red fox. Acta Theriologica 35:311–320.
Storfer, A. 1999. Gene flow and endangered species translocations: a topic revisited. Biological Conservation 87:173–180.
Strachan, R., D. J. Jefferies, and P. R. F. Chanin. 1996. Pine marten survey of England and Wales 1987–1988. Peterborough: Joint Nature Conservation Committee.
Strickland, M. A. 1989. Marten management in Ontario. Pages 155–174 *in* R. Lafond, editor. Proceedings of the Northeast Fur Resources Technical Committee Workshop, Beauport, Québec, Canada.
_____, M. Novak, and N. P. Hunziger. 1982. Marten. Pages 599–612 *in* J. A. Chapman and G. A. Feldhamer, editors. Wild mammals of North America: biology, management, and economics. The Johns Hopkins University Press, Baltimore, Maryland, USA.
Stubbe, M. 1993. *Martes martes* (Linné, 1758) – Baum., Edelmarten. Pages 374–426 *in* J. Niethammer and F. Krapp, editors. Handbuch der Säugetiere Europas. Band 5: Raubsäuger - Carnivora (Fissipedia). Teil I: Canidae, Ursidae, Procyoinidae, Mustelidae. Weisbaden, Aula Verlag.
Tatara, M. 1994. Ecology and conservation status of the Tsushima marten. Pages 272–279 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A. Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.
Templeton, A. R. 1986. Coadaptation and outbreeding depression. Pages 105–116 *in* M. E. Soule, editor. Conservation biology: the science of scarcity and diversity. Sinauer Associates, Sunderland, Massachusetts, USA.
Therrien, S., and D. Eastman. 1999. Analyses of habitat selection by marten in areas of alternative forest practices in the Boreal Mixedwood of Northeastern British Columbia. Interim report – 1998 activities. University of Victoria, British Columbia, Canada.
Thompson, I. D. 1991. Could marten become the spotted owl of eastern Canada? Forestry Chronicle 67:136–140.
_____, and A. S. Harestad. 1994. Effects of logging on American martens, and models for habitat management. Pages 355–367 *in* S. W. Buskirk, A. S. Harestad, M. G. Raphael, and R. A.Powell, editors. Martens, sables, and fishers: biology and conservation. Cornell University Press, Ithaca, New York, USA.
Timm, U. 1991. Sieben eue Saugetierarten in Estland (Eesti). Folia Theriologica Estonica, Tartu:31–34.
Tóth, M. A. 1998. Data to the diet of the urban stone marten (*Martes foina* Erxleben) in Budapest. Opuscula Zoologica Budapest 31:113–118.
Uhler, J. W. 1998. The complete Yellowstone page. U.S. National Park Service Website.
Valentsev, A. S. 1996. Helminth invasion of sable. *Martes* Working Group Newsletter 4:22–24.
Velander, K. A. 1983. Pine marten survey of Scotland, England and Wales 1982–1983. The Vincent Wildlife Trust, London, United Kingdom.
_____. 1991. Pine marten. Pages 368–376 *in* G. Corbet and S. Harris, editors. The handbook of British mammals. Blackwell, Oxford, United Kingdom.
Virgós, E., M. R. Recio, and Y. Cortés. 2000. Stone marten (*Martes foina*) use of different landscape types in the mountains of central Spain. Zeitschrift für Säugetierkunde 63:193–199.
Waechter, A. 1975. Ecologie de la fouine en Alsace. La Terre et La Vie 24:399–457.

Wang, Y. 1986. The study of the consumption of wildlife resources in commercial shops in Taiwan. Council of Agriculture Reports, Taipei, Peoples Republic of China. (in Chinese)

Weir, R. D. 2003. Status of fishers in British Columbia. British Columbia Ministry of Water, Land, and Air Pollution report, Victoria, British Columbia, Canada.

_____, and A. S. Harestad. 2003. Scale-dependent habitat selectivity by fishers in south-central British Columbia. Journal of Wildlife Management 67:73–82.

Williams, R. M. 1963. Trapping and transplanting. Part I – fisher. Federal Aid in Wildlife Restoration, Final Segment Report, Project W 75-D-10, Boise, Idaho, USA.

Williams, R. N., L. K. Page, T. L. Serfass, and O. E. Rhodes. 1999. Genetic polymorphisms in the fisher (*Martes pennanti*). The American Midland Naturalist 141:406–410.

_____, O. F. Rhodes, Jr., and T. L. Serfass. 2000. Assessment of genetic variance among source and reintroduced fisher populations. Journal of Mammalogy 81:895–907.

Yamada, F. 1998. Status of alien mammals and problems caused by them in Japan. Mammalian Science 38: 97–105 (in Japanese).

Yeager, L. E. 1950. Implications of some harvest and habitat factors on pine marten management. Transactions North American Wildlife Conference 15:319–334.

Zalewski, A. 1997. Factors affecting selection of resting site type by pine marten in primeval deciduous forests (Białowieża National Park, Poland). Acta Theriologica 42:271–288.

Zielinski, W. J., J. E. Kucera, and R. H. Barrett. 1995. The current distribution of fisher in California. California Fish and Game 81:104–112.

_____, K. M. Slauson, C. R. Carroll, C. J. Kent, and D. G. Kudrna. 2001. Status of American martens in coastal forests of the Pacific states. Journal of Mammalogy 82:478–490.

_____, R. L. Truex, C. V. Ogan, and K. Busse. 1997. Detection surveys for fishers and American martens in California, 1989–1994: summary and interpretation. Pages 372–392 *in* G. Proulx, H. N. Bryant, and P. M. Woodard, editors. *Martes*: taxonomy, ecology, techniques, and management. Provincial Museum of Alberta, Edmonton, Alberta, Canada.