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An evaluation of fisher (Martes pennanti) introductions in Montana

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AN EVALUATION OF FISHER (*MARTES PENNANTI*) INTRODUCTIONS IN MONTANA

by

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An Evaluation of Fisher (*Martes pennanti*) Introductions in Montana (97 pp)

Committee Chair: Kerry R. Foresman

Abstract:

Translocations can play a crucial role in the conservation and restoration of wildlife populations. I investigated the impact of translocations on the distribution and genetic structure of fisher populations in Montana.

Ten years after the release of 110 fishers from Minnesota and Wisconsin to the Cabinet Mountains of northwestern Montana, I conducted surveys for three winters to document the distribution of fisher. Verifiable detections were made in four of 17 systematically surveyed sampling units. Surveys revealed that fishers are rare, but present and reproducing in an area where they were believed to be absent prior to the introduction.

To establish the occupied range of fisher throughout Montana and examine the evidence for its historic extirpation, I gathered all available records on the species' past and present distribution. Historic records were scarce, but indicate that fisher occurred in western Montana. No fishers were harvested in the state from 1929 to 1959 suggesting that they were extirpated from Montana.

Contemporary occurrence data from harvest, snow tracking, and sightings were used to map fisher distribution statewide. The spatial and temporal distribution of these records demonstrates that translocations have been successful in establishing, and/or augmenting, fisher populations in Montana. Verified fisher records exist in the Bitterroot, Couer D'Alene, Sapphire, Garnet, Mission, Swan, Cabinet, Purcell, Whitefish, Flathead, Livington, and Beartooth ranges.

To investigate the origin of extant populations in Montana, fisher tissue samples from Montana, British Columbia, Minnesota, and Wisconsin were collected and two regions of the mitochondrial DNA genome were examined. Haplotype frequencies differed significantly by region. Source populations had seven non-overlapping haplotypes: four unique to British Columbia, two to the Midwest, and one to west-central Montana. The distribution of these haplotypes in Montana, suggests that fisher populations in the state have multiple origins reflecting their history of translocations and the influence of native populations. Contrary to historic data, analysis of mitochondrial DNA sequence data indicates that fisher may not have been extirpated from Montana and/or Idaho prior to the translocations. West-central Montana fisher populations show evidence of isolation and distinctiveness, suggesting that they are descended in part from remnant native populations.

ACKNOWLEDGEMENTS

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I am indebted to the biologists with Montana, Fish, Wildlife & Parks, past and present, who had the foresight to translocate fishers into the state and keep good records. Fletcher Newby and Richard Weckworth's carefully jotted notes gave me crucial data four decades after the first release of fisher into the state. Brian Giddings initiated this evaluation, provided much of the funding and data for the project, and was always willing to assist me in any way possible.

Bruce Sterling, Jerry Brown, Tim Thier, and Jim Williams, all provided a depth of knowledge about northwestern Montana and its wildlife, and plenty of help along the way. Housing, traps, trucks, and snow mobiles were available thanks to the efforts of these individuals. Bob Henderson and Kevin Coates each loaned me snow machines in a pinch. Neil Anderson's willingness to share tissues allowed us to examine the lineage of Montana fisher.

My committee members: Dr. Kerry Foresman, Dr. Kevin McKelvey, Dr. Daniel Pletscher, Brian Giddings, and Bruce Sterling helped me to shape this project. Kerry's boundless energy, patience, and humor are without comparison. Kevin was generous with his time and intellect. Dan's level headed advice and guidance were always welcome. I benefited from advice by Dr. Fred Allendorf, and students within his lab, on the analysis and interpretation of genetic data.

Personnel at the Rocky Mountain Research Station were a great asset to this project. In particular, Dr. Michael Schwartz and Kristine Pilgrim went the extra mile to educate me on the application of genetic techniques to research and to analyze tissue samples. Their knowledge, skills, and willingness to collaborate were a boon to this project. Nick DeCesare generously provided assistance with GIS.

The Kootenai National Forest provided housing, logistical support, and some funds for this project. Steve Johnsen, Doug Grupenhoff, Joni Gilbert, Leslie Ferguson, Paul Hooper, Jennifer Holifield, and Wayne Johnson all contributed their time and resources to this research. Dan Leavell and Patty Johnson helped me design and plot survey maps.

Tissue samples were delivered to my home from far flung localities thanks to the efforts of Conrad Christianson, John Erb, Gary Meiss, Bruce Kohn, John Irwin, John Gilbert, John Olsen, Wayne Sharpe, Michael Green, and trappers in Montana, British Columbia, Minnesota, and Wisconsin. I appreciate the assistance of the Wisconsin and British Columbia Trapper's Associations.

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Kathryn Mills tolerated odd packages in the refrigerator, late work nights, and assorted other quirks and inconveniences associated with living with a biologist. I am thankful for her love and companionship.

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Chapter 1.

INTRODUCTION

Overview

Carnivores have lived alongside humans and shaped our imaginations since the earliest times (Campbell 1969). We have honored, reviled, and idealized them so much that it is difficult to understand them free of our own perceptions. Paradoxically, humans have come to value species that we once viewed only for utilitarian purposes or were eager to exterminate. An enormous amount of public interest and conservation effort are now focused on understanding and preserving carnivores. Large charismatic species, like grizzly bears (*Ursus arctos*), cougars (*Puma concolor*), and wolves (*Canis lupus*), have captivated us more than other species, but smaller predators are now gaining recognition.

Midsized carnivores are prominent members of the fauna in many biomes and they play key roles in ecosystems like seed dispersal, nutrient cycling, scavenging, and predation (Buskirk 1999). The fisher (*Martes pennanti*) is a midsized forest carnivore that is frequently grouped with marten (*Martes americana*), lynx (*Lynx canadensis*), and wolverine (*Gulo gulo*). Historically forest carnivores were pursued by trappers in upland habitats because they were valued for their supple and luxurious fur (Obbard et al. 1987).

Today these species, most notably marten, are still harvested as furbearers in portions of their range, but the unique ecological roles that these species play have also been recognized. Carnivores assist in the regulation of prey numbers (Estes et al. 1998, Terbough et al. 1999), and have indirect effects on the structure and composition of plant and animal communities (Minta et al. 1999, Ripple and Larsen 2000). Because of their large home ranges and sensitivity to habitat changes, carnivores are sometimes considered to be indicators of ecosystem health (Noss et al. 1996, Carroll et al. 1999).

Trapping, logging, and other anthropogenic changes have diminished and isolated populations of forest carnivores (Weaver 1993, Ruggerio et al. 1994). Marten and fisher are especially sensitive to changes in forest configuration and structure (Soutiere 1979, Thompson 1988, Buskirk and Powell 1994, Bissonette et al. 1997, Chapin et al. 1998).

Role of Translocations in Wildlife Management

Translocations, the intentional movement of individuals from one locale to another to augment or re-establish populations, have been used extensively in conservation efforts across North America. According to Griffith et al. (1989) there were 40 translocations of carnivores, almost half of which were successful, in North America and Australia between 1973 and 1986. Translocations may enhance population persistence by augmenting existing populations or restoring populations to areas from which they have been eliminated. Recovery of strategic subpopulations can serve to increase the viability of a metapopulation (Hanski and Gilpin 1991, Weaver 1993).

Prominent examples of translocations in wildlife management include the dramatic repatriation of wolves to Yellowstone National Park and less successful attempts to return black-footed ferrets (*Mustela nigripes*) to the short-grass prairie. Moving animals from one site to another to promote the expansion of populations can be a productive strategy, but also carries with it risks including the spread of disease, establishment of inbred populations, and disturbance of existing fauna.

Fisher translocations in Montana

By the early part of this century, fishers were extirpated from much of their historical range in the United States, as a cumulative result of unregulated harvest, poisoning, and habitat loss (Powell 1993). The fur of fisher is particularly luxuriant and once commanded very high prices; as a result, trappers went to extreme lengths to take them (Seton 1909). The value of fishers as a predator of porcupines, as a furbearer, and as a native carnivore has resulted in numerous attempts to reintroduce them into portions of their former range (Irvine et al. 1962, Berg 1982, Banci 1989, Roy 1991, Williams et al. 2000). Presumed extirpated by the 1920s, extant fisher populations in Montana and Idaho are thought to be derived from four introductions (Williams 1962, Weckworth and Wright 1968, Roy 1991, Heinemeyer 1993). Since it is unclear if fisher populations were truly extirpated from Montana and Idaho, I will refer to translocations in the region as 'introductions' rather than 'reintroductions'.

An evaluation

Although fishers are managed as a state classified furbearer by Montana, Fish, Wildlife & Parks (2003) and are considered a sensitive species within the western portion of their range by the United States Forest Service (Macfarlane 1994), little information is available on their distribution, origins, and the impact of introductions on the species. To address these questions, I evaluated fisher translocations in Montana. Chapter 1 describes the distribution of fishers in the Cabinet region a decade after an introduction. I used existing records to illustrate the impact of introductions on fisher distribution statewide in Chapter 2. In Chapter 3, I investigated the origin of fisher populations statewide by examining the distribution of mitochrondrial DNA (mtDNA) haplotypes. I summarize, interpret, and highlight the significance of our research for management in the conclusion. To reflect the collaborative nature of this research, I will use the pronoun 'we' hereafter, but as the principal investigator I take responsibility for any and all errors within this thesis.

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Chapter 1. Distribution of Fisher (*Martes pennanti*) in the Cabinet Mountains

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Abstract: Translocations can play a crucial role in the restoration of wildlife populations. We evaluated an introduction of fisher (*Martes pennanti*) into northwestern Montana's Cabinet Mountains ten years after a state translocation program using intensive surveys for three winters (2001 to 2003). Track plates, live trapping, and snow tracking were used to determine whether fishers were present within 29 km^2 sampling units. Substantial effort (1518 track plate nights, 3439 trap nights, and 728 kilometers of track transects) was applied, but fisher detections were infrequent. Fisher presence was verified through physical evidence (captures via live-trapping or track plates visits) in four of seventeen units that were systematically surveyed. Fishers were detected in another three surveyed units, but because of the uncertainty associated with tracking, these detections cannot be verified. Our survey efforts demonstrate that fishers are rare in the study area, but are present and reproducing in a region where the species was believed to be absent prior to the introduction. The introduction of Midwestern fishers to the Cabinets has been successful in establishing a small population, but the long-term viability of this population is uncertain. A variety of factors including deep snows and low habitat quality, as well as behavioral and genetic characteristics specific to the introduced animals may have predisposed this translocation to failure. We urge managers to conduct thorough feasibility studies prior to any introduction program.

INTRODUCTION

With globally increasing human population and resource use, anthropogenic influences degrade more of the earth's landscapes daily. Along with efforts to protect relatively pristine ecosystems, there is increased interest in restoring biological productivity and diversity to habitats that have been homogenized or otherwise altered by human activities. The intentional movement of organisms from one place to another-translocation, is a common method to reintroduce or augment populations of concern (Griffith et al. 1989). Once an introduction has occurred, it is essential to monitor and evaluate the outcome so that future efforts will have the greatest chance of success.

One widely translocated species in North America (Berg 1982, Williams et al. 2000) is the fisher (*Martes pennanti*), a forest dwelling carnivore closely related to the American marten (*Martes americana*). Fishers are found in forested habitats that display extensive physical structure, including snags for dens, multilayered canopies to protect against predation, and course woody debris to provide prey (Douglas and Strickland 1987, Buskirk and Powell 1994, Powell and Zielinski 1994). Moist forested habitats with continuous overhead cover and riparian zones are frequently utilized (Arthur et al. 1989, Jones 1991, Weir 1995). In the western United States, mature and late seral stage coniferous forests contain many of the features that fisher require; as a result, some researchers contend that they are obligate to late successional forests (Harris et al. 1982, Rosenberg and Raphael 1986), but it remains unclear whether old growth forests or simply the structure that they provide is required.

Fisher populations have made an extraordinary comeback, from near extirpation early in the 20th century in the Midwestern and Northeastern United States (Brander and Brooks 1973), but some small isolated populations of fishers in the western United States remain in danger of extirpation (Heinemeyer and Jones 1994, Aubry and Lewis 2003). Western populations of fishers have been petitioned for listing under the Endangered Species Act (ESA) three times in the last decade (Beckwitt 1990, Carlton 1994, Greenwald et al. 2000). The U.S. Fish and Wildlife Service (1991) rejected the first of these petitions because of a lack of information on past or present distribution and the Service's resultant inability to detect a change in status. Currently a one year status review is underway for *Martes pennanti pacifica*, the Pacific subspecies.

The historic distribution of fisher in the northern Rockies is poorly understood. Weckworth and Wright (1968) stated that fishers were present historically, but were extirpated by the 1920s. Hagmeier (1956) included Montana and Idaho in his seminal review of *Martes* distribution.

The current range of fishers in Montana has been influenced by three state led introduction efforts in the region- one in Idaho (Williams 1962) and two in Montana (Weckworth and Wright 1968, Roy 1991, Heinemeyer 1993). On the basis of fur returns, Weckworth and Wright (1968) concluded that the translocation of 36 fishers from British Columbia to three Montana ranges: the Pintler, Swan, and Purcell during 1959 and 1960 resulted in successful reproduction. Between January of 1989 and March of 1990, Roy (1991) moved 32 fishers from Minnesota into the Cabinet Mountains of northwestern Montana. Heinemeyer (1993) continued this translocation effort with the release of 78 Wisconsin animals during the next year and a half. Monitoring of the Cabinet introduction ceased in 1991 and the ultimate success of the effort is unknown.

Evaluation is a critical component of any introduction program (Berg 1982, Proulx et al. 1994, Fontana et al. 1999, Aubry and Lewis 2003), but the ultimate impact of fisher introductions in the state of Montana has not been appraised. Fishers have been managed as a furbearer in the state since 1979 and the Montana Department of Fish, Wildlife & Parks was interested in learning the impact of the introductions. At their request, we conducted intensive field research in the Cabinets between January 2001 and March of 2003 to address this knowledge gap. Our research assesses the success of the 1988-1991 releases and describes fisher distribution in the region a decade after the translocations.

METHODS

Study Area

The Cabinet study area covers a large (~2000 km^2), rugged area of Lincoln and Sanders counties in northwestern Montana. We define the study area as the region circumscribed by Highway 200 to the south, the Idaho/Montana border to the west, and Highway 2 to the north and east (Figure 1, Roy 1991).

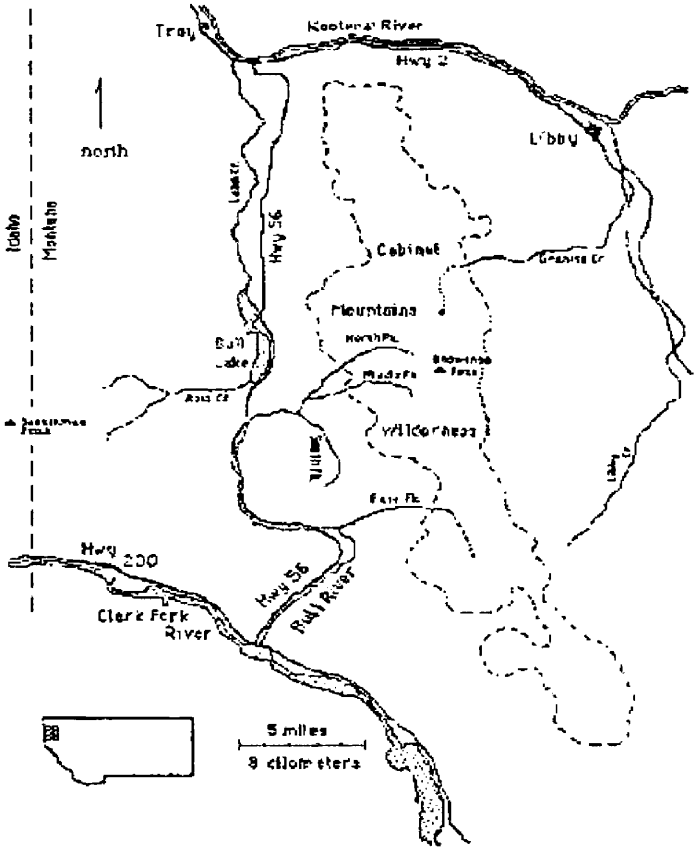

Figure 1. Cabinet study area (Roy 1991). Surveys were conducted between Highway 2, to the north and east, and the Montana/Idaho border.

The craggy peaks of the 381 km^2 Cabinet Mountain Wilderness dominate the skyline and affect the ecology and weather of the region, which is characterized by warm, moist summers and wet, snowy winters. Pacific Maritime air streams influence the climate. Precipitation surpasses that of any other part of Montana; thus, a number of mesic plant species more typical of the Pacific Northwest reside alongside those of drier inland habitats (Cooper et al. 1991). The Cabinets straddle two vegetation zones: the Wet Columbia Mountains and the East Kootenays (Parish et al. 1996).

This interface produces the most botanically diverse region in the state of Montana (Pfister et al. 1977, Leavell 2000). Cottonwood (*Populus trichocarpa*), aspen (*Populus tremuloides*), and willow (*Salix* spp.) adorn the river bottoms. Western red cedar (*Thuja plicata*), grand fir (*Abies grandis*), and western hemlock (*Tsuga hetrophylla*) occupy moist, low elevation drainages like Ross Creek. Mixed upland forests composed of Douglas-fir (*Pseudotsuga menziesii*), lodgepole pine (*Pinus contorta*), and western larch (*Larix occidentalis*) cover mid-elevation areas. Wet, high elevation sites are dominated by subalpine fir (*Abies lasiocarpa*), Engelmann spruce (*Picea engelmanni*), and mountain hemlock (*Tsuga mertensiana*), while, Ponderosa pines (*Pinus ponderosa*) are restricted to xeric sites often on southern or eastern aspects.

The Kootenai National Forest manages most of the land in the area, with significant holdings on the east side of the range belonging to Plum Creek Timber Company. Timber harvest is the predominant land use and has been since the area was first settled. Mining, primarily for silver, has also shaped the history and structure of the landscape. Decades of logging (selective, partial, and clear-cut) and subsequent succession have created multi-storied forests with a high degree of structure and interspersion.

Sampling regime

To establish the distribution of fishers within the Cabinet region, field surveys were completed from the middle of January to late March for three consecutive years (2001-2003). We divided the area into 67 half-township (29 km^2) survey units, because this area approximates the home range size of females in western populations of fishers (Jones 1991, Aubry and Raley 2002) and presents an opportune sampling scale.

Geographic information systems (GIS) were used to select sampling units that allow snowmobile access in the winter and possess the highest proportion of low, mesic forest types preferred by fishers (Heinemeyer 1993, Buskirk and Powell 1994, Weir 1995). Vegetative response units (VRU) for the Kootenai National Forest (USDA Forest Service 1999) were collapsed into two types, wet and dry. We plotted a map illustrating the elevation of terrain within 1.6 kilometers of a winter accessible road or trail (Figure 2), and a map showing the amount of mesic and xeric habitat within each unit (Figure 3). Sampling units were ranked qualitatively according to their proportions of winter accessible terrain, moist forest, and elevation below 1375 meters. After discarding inaccessible areas, 30 potential units remained.

Each winter field season, we chose survey units based on presumptive fisher presence and feasibility of access. Nine survey units on the west and southern sides of the Cabinet range were selected in 2001: the Vermilion River (unit 63), lower Rock Creek (unit 54), upper Rock Creek (unit 50), East Fork Bull River (unit 43), Star Gulch (unit 41), Snake Pass (unit 39), Spar Creek (unit 29), Spar Lake (unit 24), and Keeler Creek (unit 19). In subsequent years, we re-sampled all areas with evidence of fisher, and initiated surveys in new units. Thus in 2002, we repeated surveys in all six units that detected fisher in the previous year, and we also surveyed eight new units: Granite Creek (unit 21), Cherry Creek (unit 26), Snowshoe Creek (unit 31), Dry Creek (unit 36), Bear Creek (unit 38), Miller Creek (unit 44), West Fisher River (unit 48), and Silver Butte (unit 52). During our final season, we repeated six sites: upper Rock Creek, Snake Pass, Dry Creek, Spar Creek, Spar Lake, and Keeler Creek that supported fisher in both prior seasons. In sum

Figure 2. Half-township survey units and elevations within 1.6 km of a winter accessible road or trail.

we conducted systematic surveys in 17 different units during 30 survey periods; another nine units were partially (opportunistically) sampled.

Detection methods

Snow tracking, track plates, and/or live-trapping were used to assess the presence or absence of fisher within each 29 km^2 sampling unit. In a systematic survey, a dozen detection devices (closed track plates or live traps) were placed in a unit, and we

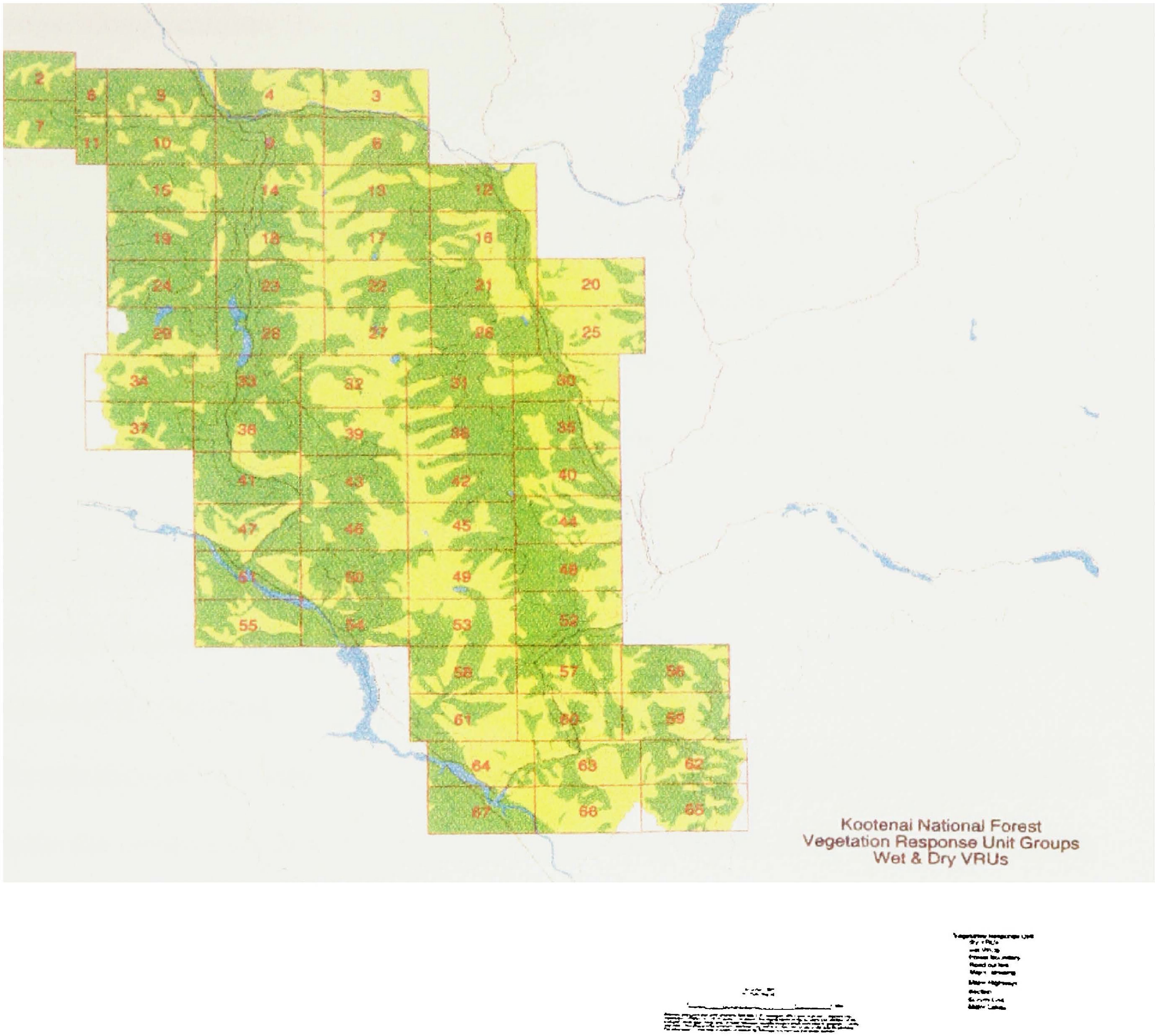

Figure 3. Half-township survey units illustrating the proportion of mesic (green) and xeric (yellow) habitat as classified by Kootenai National Forest vegetative response types (USDA Forest Service 1999).

tried to cover at least 10 km (actually completed: $\bar{x} = 20.97$, $\sigma = 11.88$, range 3.2 - 55.6) of track transects in the unit during a period of 7 to 14 days (survey periods varied between years). We maximized our detection probabilities by using established methods to survey the best presumptive fisher habitat. Traps and track plates were placed at stream crossings, along ecotones, in contiguous stands of mature forest, and in other areas where fishers travel (Banci 1989, Aubry and Raley 1996).

Between January and March 2001, established protocols (Zielinski and Kucera 1995, Foresman and Pearson 1995) were used to place closed track plates at a density of twelve per half-township survey unit. We attempted to distribute detection devices evenly throughout the unit. Our goal was to leave track plates in the field for 14 days, but because of logistical constraints the survey period varied somewhat ($\bar{x}$ =13.68, σ=1.47). We measured *Martes* tracks left on contact paper within the closed track plates, using a digital caliper, and classified them using an algorithm developed by Zielinski and Truex (1995). When marten or fisher tracks were encountered, traps were placed nearby in an effort to capture the animal and verify its identity.

We substituted live-traps for track plates as the detection device in 2002 and 2003 to eliminate the uncertainty associated with distinguishing marten from fisher tracks and to collect tissue samples for genetic analysis (Chapter 3, this thesis). Traps, like track-plates, were placed twelve to a unit. We assessed the age, sex, reproductive status, condition, and physical measures of captured animals using established methods (Wright and Coulter 1967, Johnston et al. 1987, Frost and Krohn 1994, Frost et al. 1999). In 2002, traps were checked for nine days ($\bar{x}$ = 9.23, σ=1.8) before the survey period ended. In 2003, most traps were out seven days ($\bar{x}$ = 6.8, σ= 1.49). To facilitate comparison between units, sampling effort was summarized by method within unit and across years.

Three units were sampled simultaneously when using track plates; however, only two units were sampled at a time when live-trapping because of the need to check each trap daily. Occasionally, areas were surveyed with less than a dozen detection devices, or additional traps were placed in a unit; this extra effort was considered to be 'opportunistic' and was tallied within each unit. Opportunistic detections deviated from the survey protocol, so we noted them separate from systematic efforts.

Snow tracking played an integral role in our survey regime. Track transects were run, via snow mobile or snowshoes, from a clearly defined start point to an end point at under 10 kilometers per hour. We ran transects between 24 and 72 hours after snowfall because tracking conditions are best at this time (Foresman and Pearson 1995). Total kilometers covered in a survey period were tallied. We recorded data on the species, location, snow-tracking quality (STQ- Halfpenny et al. 1995), and track reliability for all marten, fisher, lynx, and wolverine tracks encountered along a track transect and while in transit between traps. Photos as well as multiple measurements of track stride, straddle, group, length, and width were collected. Plaster casts were taken when conditions allowed.

Snow tracking presents an expedient method to find species, but proper identification of tracks requires a high degree of skill and good snow conditions. We established the identity of tracks using track measurements and observations of gait, pattern, gestalt, and behavior (Stokes and Stokes 1986, Rezendes 1992, Halfpenny et al. 1995, Halfpenny and Biesiot 1996). Distinguishing marten and fisher tracks can be difficult because strong sexual dimorphism in fishers (Powell 1993) can result in overlap between the sizes of female fisher and male marten tracks. All suspected fisher tracks were backtracked at least 100 meters. We used multiple conservative criteria (Appendix A), including a track width of over 6.5 cm and a straddle over 12 cm, to distinguish the species. Our conservative approach may have resulted in some fisher tracks being classified as marten. All tracking effort (systematic and opportunistic) was tallied by season.

We evaluated the evidence of a species in a unit by ranking fisher detections as verified, unverified- reliable, and unverified- unreliable. Trapped animals and those captured via track plates, constituted 'verified' sightings (McKelvey et al. 2000), and confirmed the presence of fisher in a survey unit. Units with only snow tracks were classified as 'unverified'. Based on a qualitative appraisal of evidence including measurements, photographs or casts, STQ, and observer, unverified detections were split into unverified- reliable or unverified- unreliable. All (n=8) unverified- unreliable records were discarded from further consideration. Survey units without captures or tracks were scored as absent. We summarized the evidence fisher in each unit for all sampling seasons and totaled all forest carnivore detections.

Latency to detection

We computed the latency to detection (Foresman and Maples 1996) in a survey unit/year for marten and fisher when using either track plates or traps. We determined how long it takes to first detect a species within a survey unit, when a species is first captured at an individual track plate or trap and the average numbers of days in a unit before encountering the track of a species.

RESULTS

Survey Effort

Our total systematic survey effort per year, as measured by track-plate nights, trap nights, and kilometers of track transects, was comparable between the first and second years (Table 1- 2001: 1479 nights, 275 kilometers, 2002: 1566 nights, 272 kilometers). A shorter field season in 2003, allowed for sampling in only six units and resulted in an effort of 615 trap nights and 142 kilometers of track transects. Opportunistic sampling in

Table 1. Systematic detection efforts in survey units by year. The method of detection, measured by trap and track plate nights, as well as kilometers of transect is specified.

	Track-plates	**Traps**		**Track Transects**			**Total unit effort across seasons**	
Unit	**2001**	**2002**	**2003**	**2001**	**2002**	**2003**	**Nights**	**Kilometers**
63	198	114	-	14.6	17.7	-	*312*	*32.3*
54	142	-	-	27.7	-	-	*142*	*27.7*
52	-	137	-	-	11.7	-	*137*	*11.7*
50	144	116	69	43.7	16.4	22	*329*	*82.1*
48	-	132	-	-	23.6	-	*132*	*23.6*
44	-	112	-	-	15.4	-	*112*	*15.4*
43	168	-	-	25.1	-	-	*168*	*25.1*
41	159	-	-	22	-	-	*159*	*22*
39	167	98	90	55.6	5.6	12.9	*355*	*74.1*
38	-	103	-	-	34.3	-	*103*	*34.3*
36	-	99	96	-	10.5	20.7	*195*	*31.2*
31	-	98	-	-	20.9	-	*98*	*20.9*
29	176	114	96	49.7	20.9,11.7[a]	14.5	*386*	*96.8*
26	-	122	-	-	3.2,4.2[a]	-	*122*	*7.4*
24	170	104	79,92[a]	15.3	18.5,8.5[a]	25.7,20.9[a]	*445*	*88.9*
21	-	109	-	-	25.7	-	*109*	*25.7*
19	155	108	93	21.5	23.2	25.7	*356*	*70.4*
Total	**1479**	**1566**	**615**	**275.2**	**272**	**142.4**	***3660 nights***	***689.6 kilometers***

[a] - Multiple entries in a cell indicate that the unit was sampled in two survey periods.

all years substantially boosted our effort (Table 2- 2001: 926 nights, 37 kilometers, 2002: 163 nights, 8 kilometers, 2003: 37 nights, 5 kilometers). Together, systematic and opportunistic sampling efforts produced 4957 trap/track plate nights and 740 kilometers of track transects. Logistical exigency, varying survey periods, and inconsistent snow conditions resulted in uneven sampling within and between survey units.

Fisher Detections

Verified fisher detections occurred in Star Gulch, Spar Creek, Spar Lake, Keeler Creek, and Angel Island (unit 28, Table 3). Track-plates registered hits by fisher in all of these units, except Angel Island where two fisher kits were live-trapped opportunistically.

Table 2. Opportunistic detection efforts in survey units by year. The method of detection measured by trap and track plate nights, as well as kilometers of transect is specified.

	Track-plates	**Traps**			**Track Transects**			**Total unit effort across seasons**	
Unit	**2001**	**2001**	**2002**	**2003**	**2001**	**2002**	**2003**	**Nights**	**Kilometers**
63	-	130	-	-	-	-	-	*130*	-
61	39	25	-	-	-	-	-	*64*	-
58	-	-	-	-	11.25	-	-	-	*7*
54	-	82	-	-	-	-	-	*82*	-
50	-	104	-	-	-	-	-	*104*	-
48	-	-	32	-	-	-	-	*32*	-
43	-	29	-	-	-	-	-	*29*	-
41	-	44	-	-	-	-	-	*44*	-
39	-	4	12	-	-	-	-	*16*	-
38	-	-	17	-	-	-	-	*17*	-
36	-	87	-	28	20.1[b]	-	-	*115*	*20.1*
34	-	-	-	50	-	-	-	*50*	-
33	-	57	-	16	5.15	-	4.8	*73*	*9.95*
31	-	-	10	-	-	-	-	*10*	-
29	-	108	86	20	-	-	-	*214*	-
28	-	12[b]	-	-	-	-	-	*12*	-
24	-	86	12	12	-	-	-	*110*	-
19	-	76	16	37	-	-	-	*129*	-
18	-	22	-	-	-	-	-	*22*	-
15	-	7	-	-	-	-	-	*7*	-
10	-	14	-	-	-	-	-	*14*	-
8	-	-	23	-	-	8	-	*23*	*8*
Total	**39**	**887**	**208**	**163**	**36.5**	**8**	**4.8**	***1297 nights***	***38 kilometers***

[b] - Indicates non-systematic survey efforts that resulted in detections.

An adult male (3/18/01) and an adult female (3/7/01, 3/20/01, 3/27/02) were live-trapped near Spar Creek. Our overall trap success in 2001 was 0.006 fisher captures per night.

In mid-June of 2001, a lactating female fisher and a kit were killed on Highway 56 near Angel Island; shortly thereafter we received reports of fisher kits in the Dorr Skeels campground. Three days of live-trapping resulted in the capture of two kits on June 26, 2001. Given a parturition date of late March (Powell 1993), these kits were approximately 12 weeks old and still dependent upon their deceased mother. The kits

Table 3. Fisher detections and classification by survey unit and year. Verified units had physical evidence of fisher: either a track plate hit or live-trapped animal. Unverified units had reliable tracks. Absent indicates that no sign of fisher was found. In units with multiple detections we have reported all the evidence below.

SURVEY UNIT	**2001**	**2002**	**2003**	**COMBINED-** ***classification and evidence***
63 – Vermilion	*Unverified*	*None*	*Not sampled*	*UNVERIFIED – tracks(2)*
54 – Lower Rock Ck	*None*	*Not sampled*	*Not sampled*	*ABSENT*
52 – Silver Butte	*Not sampled*	*None*	*Not sampled*	*ABSENT*
50 – Upper Rock Ck	*None*	*None*	*None*	*ABSENT*
48 – West Fisher	*Not sampled*	*None*	*Not sampled*	*ABSENT*
44 – Miller Ck	*Not sampled*	*None*	*Not sampled*	*ABSENT*
43 – East Fork Bull	*None*	*Not sampled*	*Not sampled*	*ABSENT*
41 – Star Gulch	*Verified*	*Not sampled*	*Not sampled*	*VERIFIED – track plate(1), track(1)*
39 – Snake Pass	*None*	*Unverified*	*None*	*UNVERIFIED – track(1)*
38 – Bear Ck	*Not sampled*	*None*	*Not sampled*	*ABSENT*
36 – Dry Ck	*Unverified*[b]	*None*	*Unverified*	*UNVERIFIED – tracks(6)*
31 – Snowshoe Ck	*Not sampled*	*None*	*Not sampled*	*ABSENT*
29 – Spar Ck	*Verified*	*Verified*	*Unverified*	*VERIFIED – trap(4), track plate(1), tracks(7)*
28 – Angel Island	*Verified*[b]	*Not sampled*	*Not sampled*	*VERIFIED – trap(2)*
26 – Cherry Ck	*Not sampled*	*None*	*Not sampled*	*ABSENT*
24 – Spar Lk	*Verified*	*Unverified*	*None*	*VERIFIED – track plate(2), tracks(2)*
21 – Granite Ck	*Not sampled*	*None*	*Not sampled*	*ABSENT*
19 – Keeler Ck	*Verified*	*None*	*None*	*VERIFIED – track plate(1)*

[b] - Indicates non-systematic survey efforts that resulted in detections.

were immediately brought to Wildlife Return, a wildlife rehabilitation center in Kalispell, where they were kept until liberation in the Ross Creek drainage on August 22, 2001. Upon release the female was adult size (2.75 kg); the 4.2 kg juvenile male was of typical weight for an animal of its age (Banci 1989, Aubry and Raley 2002). The male survived until December 25, 2002 when a trapper harvested it at Silver Butte Pass, 21 air miles southeast of Ross Creek, on the east side of the Cabinet divide. The fate of the female is unknown.

The number and method of fisher detections within each unit are depicted in Table 4. Unverified records from snow tracking, account for 19 of our 30 detections. Repeated track detections across years occurred at Dry Creek, Spar Creek, and Spar Lake. Distinct fisher tracks were only encountered during one season in the Star Gulch, Vermilion River, and Snake Pass survey units. In upper Rock Creek possible fisher tracks were encountered on three separate occasions across three years, but because track quality was poor these putative detections have been omitted. Fisher tracks were observed during all three winters in the Spar Creek unit. Eighty (24 of 30) percent of all detections occurred in the West Cabinets.

Table 4. Fisher detections in survey units, by season and capture method. A zero indicates that the unit was surveyed without a detection, while a dash means it was not surveyed. Only reliable tracks included. (We omitted 5 tracks in Rock Creek, and 3 in Snake Pass because they were of unreliable quality.)

Survey Unit	**2001 track-plates**	**2001 trapped**	**2002 trapped**	**2003 trapped**	**2001 tracks**	**2002 tracks**	**2003 tracks**	**Total detections**
63	*0*	*0*	*0*	*0*	*2*	*0*	-	*2*
41	*1*	*0*	-	-	*1*	-	-	*2*
39	*0*	*0*	*0*	*0*	*0*	*1*	*0*	*1*
36	-	*0*	*0*	*0*	*4*[b]	*0*	*2*	*6*
29	*1*	*3*	*1*	*0*	*5*	*1*	*1*	*12*
28	-	*2*[b]	-	-	-	-	-	*2*
24	*2*	*0*	*0*	*0*	*1*	*1*	*0*	*4*
19	*1*	*0*	*0*	*0*	*0*	*0*	*0*	*1*
Total	**5**	**5**	**1**	**0**	**13**	**3**	**3**	***30***

[b] - Indicates non-systematic survey efforts that resulted in detections.

Marten, wolverine, and lynx detections

Although our survey effort was focused on assessing the presence of fisher at a half-township scale, we also gathered secondary information on marten, wolverine, and lynx.

Marten detections are detailed in Table 5, wolverine and lynx tracks are compiled in Appendix B. Forest carnivore detections were patchily distributed. In 2002, forest carnivore detections on the east front of the Cabinets were scarce. Marten were detected in Granite Creek (unit 21), Bear Creek (unit 38), and in the West Fisher (unit 48), but were not found in Cherry Creek (unit 26), Snowshoe Creek (unit 31), Miller Creek (unit 44), or Silver Butte (unit 52). None of the seven east-side units detected fisher, lynx, or wolverine. We noted the presence of one or more forest carnivores in every unit in the western portion of the study area as well as in the Vermilion (unit 63) to the south, but fisher, wolverine, and lynx sign was unusual.

Table 5. Marten detections in survey units, by season and capture method. A zero indicates that the unit was surveyed without detection, while a dash means it was not surveyed. Only reliable tracks included.

Survey Unit	2001 track-plates	2001 trapped	2002 trapped	2003 trapped	2001 tracks	2002 tracks	2003 tracks	Total detections
54	*0*	*0*	-	-	*1*	-	-	*1*
50	*1*	*0*	*0*	*0*	*5*	*0*	*1*	*7*
48	-	-	*0*	-	-	*2*	-	*2*
43	*3*	*0*	-	-	*4*	-	-	*7*
39	*3*	*1*	*0*	*0*	*2*	*0*	*0*	*6*
38	-	-	*1*	-	-	*0*	-	*1*
36	-	-	*0*	*0*	-	*0*	*1*	*1*
29	*2*	*4*	*2*	*4*	*12*	*1*	*2*	*27*
24	*9*	*3*	*6*	*25*	*10*	*3*	*5*	*61*
21	-	-	*0*	-	-	*1*	-	*1*
19	*1*	*0*	*4*	*4*	*2*	*0*	*1*	*12*
Total	**19**	**8**	**13**	**33**	**36**	**7**	**10**	*126*

West of the Cabinet divide, marten were absent from the low elevation units, Vermilion, and Star Gulch (unit 41), but present elsewhere. Marten detections were verified in four of seven western units. Snow tracks (n= 50) and live-captures (n=53) indicate that marten are relatively common in the western portion of the study area with seventy-one percent of marten detections occurring in the West Cabinets.

Latency to Detection

Latency to detection across years is not directly comparable because the survey periods varied (Appendix C- 2001: $\bar{x} = 13.68$, 2002: $\bar{x} = 9.23$, 2003: $\bar{x} = 6.8$), but examination of 'capture' records shows that live-traps detected *Martes* more rapidly than track plates. Many of the track plate hits (9 of 20) occurred after day ten; while, most of the trap captures occurred before day five (24 of 41). The average number of days necessary to detect the first track of a fisher ($\bar{x} = 5.36$, $\sigma = 3.48$), marten ($\bar{x} = 5.58$, $\sigma = 3.7$), or wolverine ($\bar{x} = 5.67$, $\sigma = 3.88$) was approximately five. The only lynx track encountered was on day seven.

DISCUSSION

Survey effort

We intended to keep survey periods equal throughout the study, but changes in our survey methods and unanticipated field constraints forced us to vary the period between seasons. After 2001, we substituted traps for track plates because they allowed for the collection of tissue samples and we reduced our survey period to nine days in 2002, and then to seven days in 2003. This variability of effort confounds comparison between units, but is mitigated by the fact that the majority of detections in all years occurred in seven days or less.

Carnivore detections

We assigned fisher presence to eight units (Table 6), but these detections should not be viewed equally. The frequency of detections as well as their reliability is important. Verified detections occurred in five units. In the Spar basin, where captures verified fisher presence, we detected fishers by multiple means in all survey years. In contrast at Snake Pass and Star Gulch, we found reliable fisher tracks on only one occasion in one year. We observed five possible fisher tracks in the Rock Creek drainage during three consecutive years, but since the tracks were poor quality we omitted them from consideration and must score Rock Creek as absent.

Table 6. Overall classification of fisher detections in survey units.

Absent	Unverified	Verified
54 – Lower Rock Creek	*63 – Vermilion River*	*41 – Star Gulch*
52 – Silver Butte	*39 – Snake Pass*	*29 – Spar Creek*
50 – Upper Rock Creek	*36 – Dry Creek*	*28 – Angel Island* [b]
48 – West Fisher River		*24 – Spar Lake*
44 – Miller Creek		*19 – Keeler Creek*
43 – East Fork Bull River		
38 – Bear Creek		
31 – Snowshoe Creek		
26 – Cherry Creek		
21 – Granite Creek		

[b] - Indicates non-systematic survey efforts that resulted in detections

All of our verified records come from the West Cabinets and half of all fisher detections originate in the Spar basin. Heinemeyer (1993) found that released animals settled at lower elevations with less snow and of more gradual slope than their release sites. In light of fishers' difficulties traveling in deep snow (Raine 1983, Krohn et al. 1997) it is not surprising that they selected lower elevation habitats. Perhaps the preponderance of low elevation, riparian habitat available in the West Cabinets is preferable to the high elevation release sites selected in the Cabinet range. Most marten, fisher and wolverine detections occurred in the West Cabinets, suggesting that this area encompasses important carnivore habitat with a high conservation value.

Wolverine tracks were identified with high confidence on six occasions: twice in the Keeler drainage, twice in the Spar basin, once in Rock Creek, and once at Snake Pass; we found one plausible lynx track in Upper Rock Creek (Appendix C). These infrequent and widely separated encounters are indicative of a low density, widely ranging species.

The paucity (we detected marten four times) of forest carnivore detections on the east face of the Cabinets was surprising. It may reflect our lesser survey effort in the region or the fact that snowfall was extremely variable from January to March of 2002. The winter began with little snow and a firm crust, which tracks did not register on. In late February and early March a series of storms brought a great deal of fresh powder, which obscured tracks and hindered movement.

Comparison with harvest, sighting, and telemetry data

Fisher records collected from other sources provide additional insights into the distribution of the Cabinet population. We have included these data for comparison with our survey results, but our determination of presence on a half-township scale is tied to our survey effort. When state harvest records from 1991 to 2002 are overlaid on our half-township distribution map (Figure 4) there is good correspondence. The harvest records show fishers in some areas where we did not survey or detect them, but there is considerable overlap. An adult female that was harvested in the East Fork of the Bull River, during December of 2001, was taken in a portion of the unit that we did not access during our survey of the unit a year earlier. Animals harvested in December of 2002, came from Silver Butte Pass, where we failed to detect fisher the prior spring, and Spar Lake where we documented fisher presence.

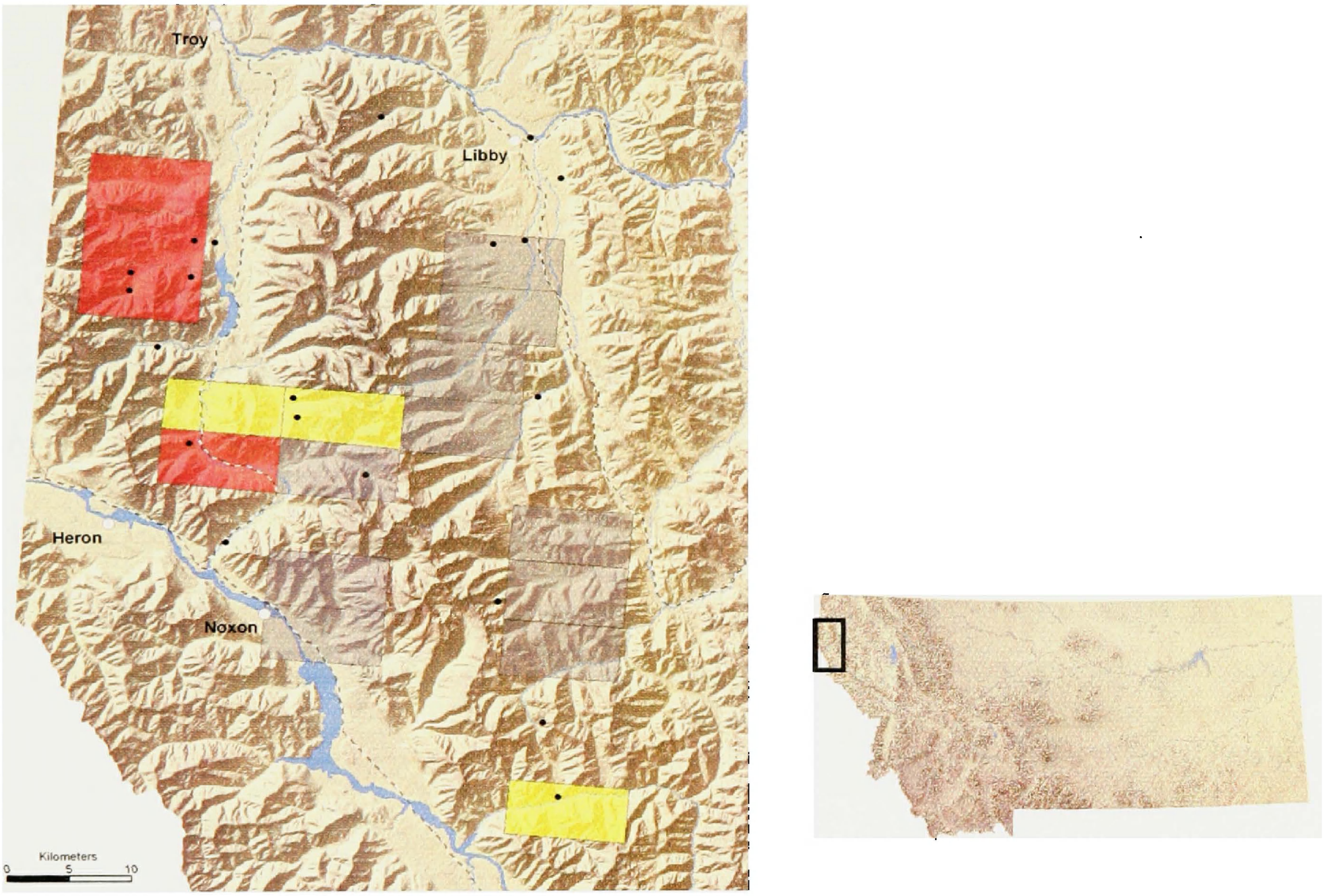

Figure 4. Presence or absence of fisher within systematically sampled survey units based on cumulative detections (2001-2003). Dots represent locations where fishers have been harvested since 1991. 🟥 = verified presence 🟨 = unverified presence ⬜ = absent

A photograph of a fisher at a remote camera station taken on April 17, 2002 (S. Johnsen, pers. comm.) and tracks observed by a state biologist (B. Sterling, pers. comm.) in the same year support our track detection of fisher in the Snake Pass area. Radio-telemetry locations (R. Vinkey, unpublished data) also concur with our survey data. Home ranges of a radio-collared adult male (Keeler Creek to Spar Creek) and a collared adult female fisher (Ross Creek to Spar Lake) fit with our detections in those areas.

Assessment of detection methods

Like Foresman and Pearson (1995), we found that when conducting a systematic survey using track plates it took fewer days on average to detect marten presence (4.8 days) in a unit than fisher (8 days). With one exception (due to the known presence of fisher kits at Dorr Skells in 2001) more rapid detection of marten occurred regardless of the year or detection method. This is a logical result given marten's higher densities.

Our results also support Foresman and Pearson's (1998) suggestion that track plates be checked for 14 days to maximize the chance of detecting a species. We found no new *Martes* detections after day 14, but four of 20 detections occurred on day 14. Our data on latency to detection (Appendix C) intimate that traps may detect *Martes* before track plates; however, a study comparing latency to detection, under equal survey periods, is needed to establish the relative effectiveness of these techniques. If traps have a shorter latency to detection, shortening survey periods would increase the number of survey units that can be covered in a field season.

Live-traps provide a number of benefits including a high degree of specificity, rapid placement, conclusive identification of species, and the opportunity to collect tissue samples as well as other physical data. *Martes* in particular are noted for their susceptibility to trapping. However live-trapping is time intensive, requires skilled personnel, and involves risk to the animal, because of these factors it is rarely employed across expansive areas. In contrast, track plates have been used to systematically sample carnivore populations across the entire Sierra Nevada as part of long-term monitoring efforts (Zielinski and Stauffer 1996, Carroll et al. 1999, Zielinski et al. 1999).

Track plates are non-invasive, inexpensive, and effective to employ en masse. Regrettably, track impressions may not register clearly for a variety of reasons (we observed that snow and cold affected track registration, especially for marten) and detections may be inconclusive. Ivan (2000) estimated that the probability of detecting an individual (POD_{ind}) was very small. He theorized that low POD_{ind} resulted from individuals' reluctance to enter closed track plates, rather than their inability to locate the devices, and therefore track plates may not be effective at low population densities. Foresman and Pearson (1995) also found that marten were hesitant to enter closed track plates. On two occasions we observed fisher tracks that approached but did not enter track plates, perhaps the residual scent of propane acts as a deterrent; whatever the case, we found that with similar effort we derived less ambiguous data from live-trapping.

Numerous authors have described both the utility and shortfalls of snow tracking for species detection (Bull et al.1992, Halfpenny et al. 1995, Foresman and Pearson 1998, Coffin et al. 2002). We used multiple conservative criteria to separate fisher from marten tracks and discarded all unreliable tracks from our data, but were still frustrated by our inability to derive *absolute* confirmation of species distribution via tracking. Snow tracking will always rely on snow conditions and skilled personnel, but provides an expedient method to assess presence and can supplement other detection efforts. Our tracking data was important because it substantiated evidence of fisher in three verified units and was the only method to result in detections in another three units. Also tracks allowed us to target good areas to place either track plates or live-traps.

Live-traps provided us with better information, than closed track-plates, during a winter survey of low-density fisher population. Given the high monetary and political costs (Thomas and Pletscher 2002) associated with large-scale surveys for carnivores, we recommend that researchers adopt techniques that result in verifiable data. Researchers cognizant of the need for impeccable information have adopted census techniques using molecular genetics to 'mark' and identify individuals (Foran et al. 1997). In fact, techniques are currently being developed to collect genetic samples from snow tracking bouts (Ulizio 2003) and modified track plates (Schlexer and Zielinski 2003).

Cautionary notes

Presence data are useful because they can provide coarse scale information about species distribution across the landscape, but it should not be treated as surrogates for population density or estimation. Also survey results must be interpreted with caution because failure to detect a species may reflect sampling error rather than actual absence. We strived to avoid false positives by repeating sampling in units with evidence of fisher, but false negatives are possible given our inability to re-sample all units without detections. Given the scarcity of fisher in the area our power ($1-\beta$), the probability of correctly rejecting a false hypothesis (Taylor and Gerrodette 1993), to detect them was low. A number of explanations exist for why we may have failed to find fisher in a unit when they were present: 1) fisher may not have been present in the subset of area we sampled, 2) our detection methods may have been inappropriate, or 3) environmental conditions, like heavy snows, may have inhibited detection.

Evaluation of the Cabinet introduction

Our survey data in tandem with harvest, tracking, and sighting records (Figure 5) show that the Cabinet region provides most of the verified records of fishers in northwestern Montana. Fisher records are clustered around the Cabinet translocation and in the Whitefish range approximately 20 km northeast of Pink Creek where nine fishers from British Columbia were released in 1959 (Newby and Hawley 1959). The proximity of records, in space and time, to the release sites demonstrates that translocations into northwestern Montana have shaped extant populations.

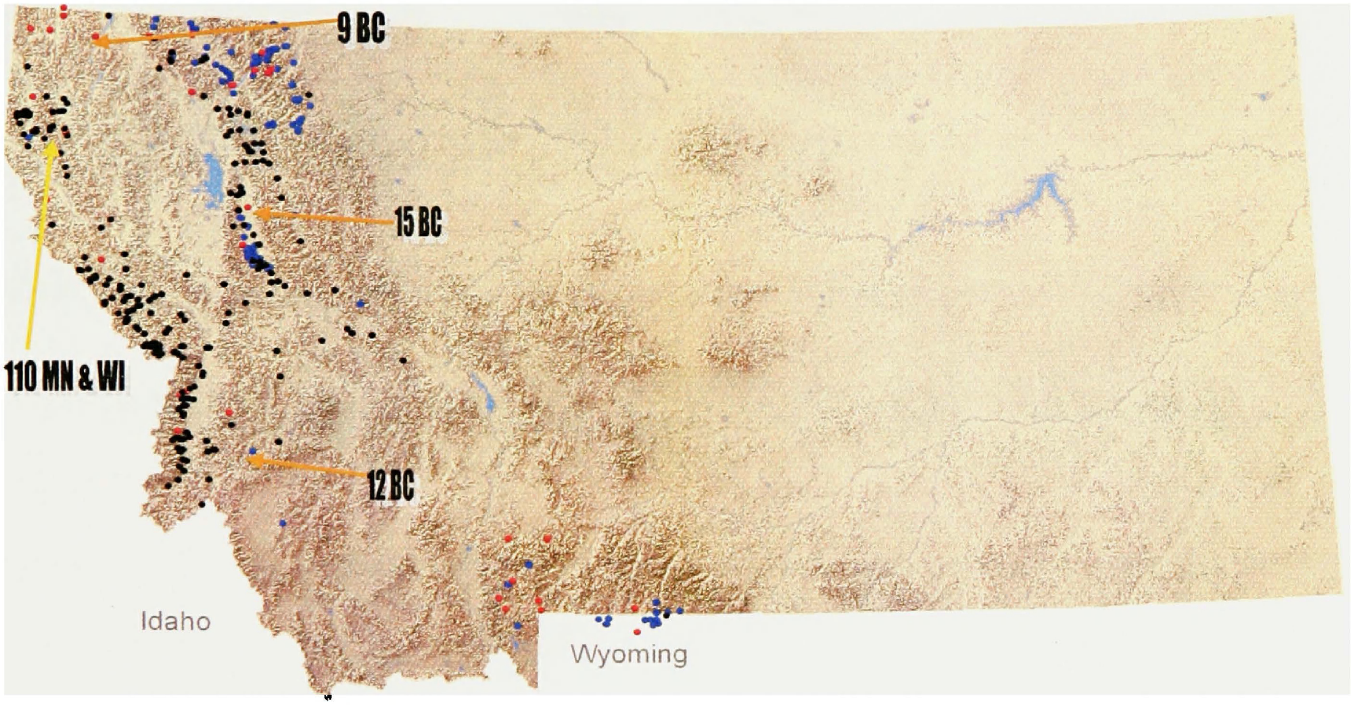

Figure 5. Distribution of fisher in western Montana (1968-2003) and introduction sites.

● = verified record 🔵 = track locations 🔴 = sightings

Prior to 1991 there were no verified records of fisher in the Cabinets study area, but shortly after the release a pulse of captures began that continues to the present (Figure 6). Montana Fish, Wildlife, and Parks records 24 fishers harvested in northwestern Montana since 1991, all of these animals, except for two dispersers from translocations, came from the Cabinet region (Table 7).

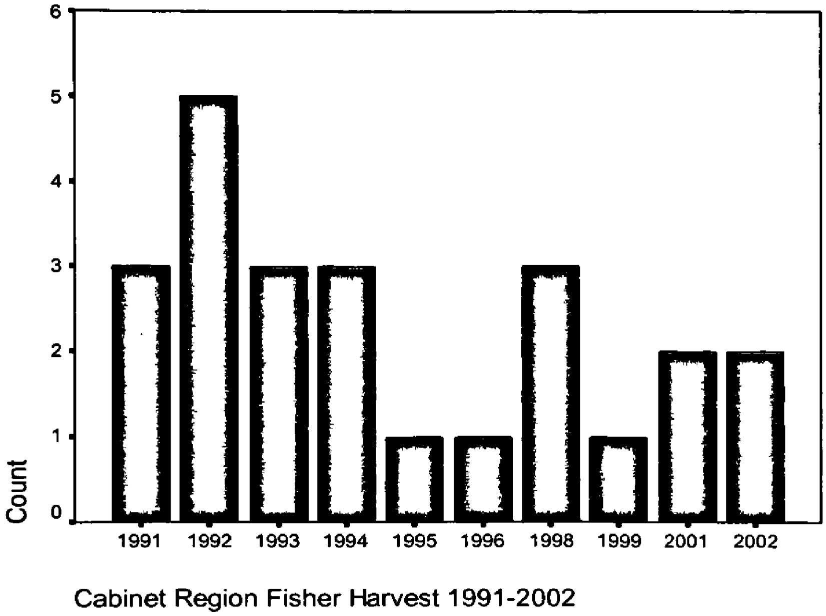

Figure 6. Number of fishers trapped by year in the Cabinet region 1991-2002 (n= 24).

A marked juvenile female, harvested on Stryker Ridge in the Whitefish range (12/14/96), immigrated into Montana from the Kootenay transplant in southern British Columbia (Fontana et al. 1999). The carcass of a radio-collared and ear-tagged fisher, recovered north of Spokane Washington on May 25 1994, apparently came from the Cabinets over 150 km east of the recovery site (B. Giddings, pers. comm.). Although fishers are not considered to be long distance dispersers (Arthur et al. 1993), these animals made long movements that would have necessitated crossing significant waterways and Highways.

The recovery of eight marked fishers up to three years after the Cabinet release indicates that some of the Midwestern animals survived long enough to reproduce. Given the ages of animals harvested it clear that some fishers taken in the Cabinets represent reproduction from the transplants or immigrants. For example, a juvenile fisher (less than a year old) harvested in December 1994 (three years after the last release) and 14

Table 7. Verified fisher in the Cabinet region, 1991-2002.

RECOVERY DATE	RELEASE DATE	LOCATION	MOUNTAINS	SEX	AGE	CAUSE OF DEATH, NOTES
1991?	After 1/1/89	CABINETS	CABINETS	NA	NA	Origin unknown
1991?	After 1/1/89	CABINETS	CABINETS	F	3	Trapped, area unknown
5/16/89	1/1/89	HORSE MOUNTAIN	CABINETS	M	NA	Exposure, Roy's kit
1/21/91	After 10/25/90	CABINETS	CABINETS	F	7	Predation, *lft15/rt14*
5/28/91	After 10/25/90	SIMMS CREEK	CABINETS	M	NA	Trapped, *lft29/rt30*
12/4/91	After 10/25/90	CEDAR CREEK	CABINETS	F	1.5	Trapped, *lft17/rt16*
12/31/91	NA	GRANITE CREEK	CABINETS	M	2.5	Trapped
2/22/91	After 10/27/90	BULL RIVER	CABINETS	F	3	Trapped, *lft19/rt18*
12/3/92	NA	SWEDE MOUNTAIN	CABINETS	M	NA	Trapped
12/3/92	After 10/23/90	CABINETS	CABINETS	F	4	Road-kill, *lft168/rt169*
12/12/92	NA	STANLEY CREEK	W. CABINETS	F	3	Trapped
12/26/92	NA	SPAR LAKE	W. CABINETS	M	0.5	Trapped, Cabinet reproduction?
12/15/93	After 10/18/91	SNAKE PASS	CABINETS	M	4.5	Trapped, *rt60*
12/26/93	After 10/18/91	STANLEY CREEK	W. CABINETS	F	3.5	Trapped, *rt82*
12/31/93	NA	SOUTH FORK BULL RIVER	CABINETS	F	2.5	Trapped
12/17/94	NA	BEAR CREEK	CABINETS	F	2.5	Trapped, in vitro in Midwest?
12/19/94	After 10/18/91	LIBBY CREEK	CABINETS	M	4.5	Trapped, *tattoo & split ear*
12/23/94	NA	TEEPEE CREEK	CABINETS	M	0.5	Trapped, Cabinet reproduction
1/17/95	NA	GRANITE CREEK	CABINETS	M	NA	Trapped
12/11/96	NA	ROSS CREEK	W. CABINETS	F	2.5	Trapped
2/14/98	NA	BEAR CREEK	CABINETS	M	2.5	Trapped
12/6/98	NA	BULL RIVER	CABINETS	F	4.5	Trapped
12/9/98	NA	GEIGER	CABINETS	F	3.5	Trapped
1/13/99	NA	SPAR LAKE	W. CABINETS	F	2.5	Trapped incidentally
3/18/01	NA	SPAR LAKE	W. CABINETS	M	ADULT	Keeler Ck male, radioed
6/23/01	NA	ANGEL ISLAND	CABINETS	F	ADULT	Angle Island female, road-kill
6/26/01	NA	ANGEL ISLAND	CABINETS	M	0.5	Angle Island kit, road-kill
6/26/01	NA	ANGEL ISLAND	CABINETS	F	0.5	Angle Island kit, radioed
12/11/01	NA	E FORK BULL RIVER	CABINETS	F	2.5	Trapped
12/18/01	NA	KILBRENNAN LAKE	PURCELLS	M	4.5	Trapped
12/21/02	NA	SPAR CREEK	W. CABINETS	F	2.5	Trapped, Ross Ck female, radioed
12/25/02	NA	SILVER BUTTE PASS	CABINETS	M	1.5	Trapped, Angel Island kit, radioed

fishers harvested after 1995 almost certainly represent in situ reproduction. Another juvenile fisher live-trapped in 1995 near Trestle Creek, on the Idaho side of the West Cabinets was presumably descended from the Midwestern transplant (S. Tomson, pers.

comm.). Our discovery of a road-killed lactating female and her kits in June of 2001 also confirms that fishers are reproducing in the Cabinets.

Most significantly, the presence of mitochondrial DNA haplotypes: 1, 5, and 10, typical of animals from Minnesota and Wisconsin, in fishers from the Cabinet region (chapter 3, this thesis), strongly suggests that the translocation of fishers from the upper Midwest has been successful in establishing a reproducing population in the Cabinets. Presence however does not guarantee the long-term persistence of a population. It is unknown if a sufficient number of individuals exist to sustain the population across the full range of environmental and demographic stochasticity (Schneider and Yodzis 1994).

Although we can not estimate population size based on this research, fishers are by no means abundant in the study area. In fact, two of three fishers harvested in the Cabinets, during this study, were animals that we had marked (n= 4). While this limited sample does not represent a statistically valid mark recapture effort, the high proportion of recaptures in concert with a paucity of detections (28 in 25 survey weeks with 4957 trap/track plate nights and 740 kilometers of track transects) suggests that the population is small and limited in distribution. Over the long-term small populations may or may not persist, but it is unlikely that this population will expand greatly.

We can only speculate on the most likely reasons why the introduction of 110 fishers from Minnesota and Wisconsin to the Cabinets has not met with greater success. A habitat feasibility study was never conducted in the region, and some local conditions, most notably deep snows (Krohn et al. 1997), are incompatible with fisher success. In fact, there is no evidence fisher were present in the Cabinets historically. Weir et al. (2003) conducted an assessment of a fisher translocation that occurred in a similar environment (75 km to the north in the Canadian East Kootenays) and warned that a self-sustaining fisher population may not be achievable. Fisher distribution in the Cabinets may be patchy because individuals are surviving in the best available habitats, but opportunities for expansion are limited.

The use of Midwestern fisher, a subspecies (*M. p. pennanti*) with different behavioral and genetic make-up than fishers native to the Rockies (*M. p. columbiana*) may also have handicapped this effort. Fishers from Minnesota and Wisconsin were not prepared to deal with a novel predator and prey complex, and introduced animals suffered very high losses (~ 40% within six months of release- Heinemeyer 1991) from predation.

Some handling and release procedures used by Heinemeyer and Roy may have been disadvantageous to released fisher. Minnesota fishers were kept in captivity for weeks and were overweight upon release (Roy 1991, Heinemeyer 1993). This may have jeopardized their survival. Soft-releases in the Cabinets occurred at high elevations in winter and ungulate carcasses were left on site. Fishers are not well adapted to the deep snows characteristic of this region in winter and some individuals remained on site nearby the carcasses; this no doubt led to mortality as native carnivores investigated the release sites and encountered recently released fisher.

To assure the success of future translocations it is critical that managers conduct a feasibility study that at a minimum addresses whether or not the species is native to the area where it is to be introduced, the habitat quality of the release region, and the genetic composition of introduced animals.

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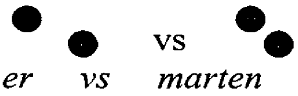
Appendix A. Fisher track identification criteria

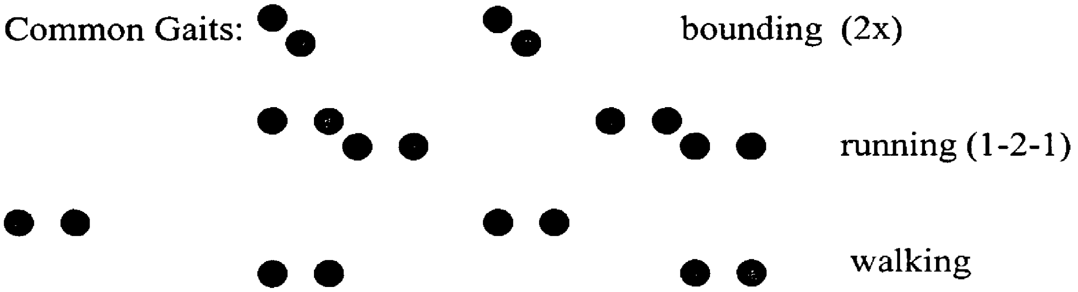
✓ Five pointed toes (often only 4 register), semicircular heel pad (*chevron shaped-inverted V*), metacarpal pad registers rarely
✓ Toes show *1-3-1* spacing, outer toes separated from middle three, arc of toes (inside to outside) appears rounded, largest toe is on inside of track
✓ Claws may show
✓ *Subtle-* back foot slightly larger than front foot
✓ Track has asymmetric impression- more *wide* than long
✓ *Conservatively-* length 2 ½ " x width 2 ½"
✓ Straddle > 4½"
✓ Stride generally over 20", under 40"
✓ *Gestalt-* more *round* (fisher) than *oval* (marten)
✓ Varied gait- often running (1-2-1) *middle tracks may overlap giving the appearance of a three legged animal (3x)*, and walking, in contrast to marten usually bounding (2x)
✓ Look for meandering tracks at an angle to the direction of travel:

✓ When bounding tracks appear more widely spaced than marten



Subtle, exaggerated in image

✓ Common Gaits:



✓ Frequently confused with marten (*fisher: more varied gait larger tracks, wider straddle*)
✓ And confused with bobcat (*bobcat: symmetric round tracks, lobed pad, four toes*)

✓ *Overall: look for a varied gait that displaying 2x and a robust asymmetric track over 2 ½"*

Compiled by R.Vinkey from Halfpenny and Biesiot 1986, Stokes and Stokes 1986, Halfpenny et al. 1995, and interviews with biologists and trappers.

Appendix B. Wolverine (*GUGU*) and lynx (*LYCA*) track detections in survey units.

SURVEY UNIT	DATE	SPECIES	UTM N	UTM E	RELIABILITY
39 – Snake Pass	1/27/01	*GUGU*	5333298	592335	good
24 – Spar Lake	3/2/01	*GUGU*	5347486	579021	good
50 – Upper Rock Ck	2/24/02	*GUGU*	5320558	597430	good
50 – Upper Rock Ck	2/24/02	*LYCA*	5320899	596238	moderate
29 – Spar Ck	3/3/02	*GUGU*	5345536	577609	good
19 – Keeler Ck	3/28/02	*GUGU*	5352685	571154	good
19 – Keeler Ck	2/17/03	*GUGU*	5354042	576570	moderate

Appendix C. Latency to detection and mean times to first capture.

Table I. Latency to detection (LTD) *in a survey unit* for marten and fisher.

Species	Detection Method	Mean Number of Days	Standard Deviation	Number of Samples
Mape	*Track-plate*	*8*	*2.16*	*4*
Maam	*Track-plate*	*4.8*	*3.03*	*5*

Total survey nights 2001: 11-17, $\bar{x}$ =13.68, σ= 1.47

Table II. Latency to detection (LTD) *in a survey unit,* 2002 & 2003.

Species	Detection Method	Mean Number of Days	Standard Deviation	Number of Samples
Mape[2]	*Trap*	*8*	*0*	*1*
Maam[2]	*Trap*	*4*	*3.46*	*5*
Mape[3]	*Trap*	-	-	-
Maam[3]	*Trap*	*2.5*	*2.38*	*4*

[2] – 2002: Total survey nights 2-17, $\bar{x}$ = 9.23, σ = 1.8

[3] – 2003: Total survey nights 3-9, $\bar{x}$ = 6.8, σ = 1.49

Table III. Average time to capture *at a track plate* for marten and fisher.

Species	Detection Method	Mean Number of Days	Standard Deviation	Number of Samples
Mape	*Track-plate*	*9.6*	*2.88*	*5*
Maam	*Track-plate*	*8.53*	*4.19*	*15*

Total survey nights 2001: 11-17, $\bar{x}$ =13.68, σ= 1.47

Table IV. Average time to capture *at a trap* for marten and fisher, 2001-2003.

Species	Detection Method	Mean Number of Days	Standard Deviation	Number of Samples
Mape[1]	*Trap*	*3.6*	*1.52*	*5*
Maam[1]	*Trap*	*4.43*	*2.94*	*7*
Mape[2]	*Trap*	*8*	*0*	*1*
Maam[2]	*Trap*	*5.12*	*3.44*	*8*
Mape[3]	*Trap*	-	-	-
Maam[3]	*Trap*	*4.18*	*2.24*	*22*

[1] – 2001: Total survey nights 2-13, $\bar{x}$ = 7.72, σ = 3.15

[2] – 2002: Total survey nights 2-17, $\bar{x}$ = 9.23, σ = 1.8

[3] – 2003: Total survey nights 3-9, $\bar{x}$ = 6.8, σ = 1.49

Table V. Average number days in a survey unit before encountering a track, 2001-2003.

Species	Detection Method	Mean Number of Days	Standard Deviation	Number of Samples
Gugu	*Track*	*5.67*	*3.88*	*6*
Lyca	*Track*	*7*	*0*	*1*
Mape	*Track*	*5.45*	*3.47*	*11*
Maam	*Track*	*5.58*	*3.7*	*19*

Chapter 2. Distribution of Fisher (*Martes pennanti*) in Montana

Abstract: Fisher (*Martes pennanti*) populations once covered a broad band of the northeastern United States from Maine to Minnesota, with western extensions from Canada as far south as Wyoming in the Rockies and the southern Sierra Nevada along the Pacific Coast. Unregulated trapping pressure and habitat alteration impacted their range so dramatically that by the early part of the 20th century fishers were extirpated from many locales. We document what is known about the historic range, presumed extirpation of, and current distribution of fisher in Montana to assess the success of fisher introductions into the state. Although historic records are scarce, available records demonstrate that fishers were found in western Montana prior to their apparent extirpation in the 1920s. Existing data (n=425) from Montana Department of Fish, Wildlife & Parks, the United States Forest Service, the National Park Service, and independent researchers were used to document the contemporary (1968-2003) distribution of fishers in Montana. Introductions have been successful in establishing populations, but remnant populations may have also contributed to the recovery of the species. Verified fisher records (n=248) can be found in the Bitterroot, Coeur D'Alene, Sapphire, Garnet, Mission, Swan, Cabinet, Purcell, Whitefish, Flathead, Livingston, and Beartooth ranges. In the Pioneer, Madison, Gallatin, and Absaroka ranges fisher presence has not been verified. The majority of records are found along the Idaho border in the Bitterroot Range. Occurrence records are widely distributed, but without better data on population sizes or trends, our ability to make inferences about the status of the species is limited.

INTRODUCTION

Biologists must learn as much as possible about the spatial extent of populations because knowledge of a species' distribution is essential to understand it. Comparison of past and present range allows for assessment of a species' status, but requires accurate information on the spatial and temporal extent of populations (Gilibesco 1994, McKelvey et al. 2000, Zielinski et al. 2000). Unfortunately, reliable data on species' distribution, past or present, are sometimes unavailable.

Animals with limited distributions or specialized habitat requirements may need special forbearance and stringent measures to conserve their populations. The

Endangered Species Act (ESA) was created to authorize federal protection of species threatened with extinction as a result of anthropogenic causes. Significant concern exists about the status of fisher in the western portion of its range and some populations have been petitioned for listing under ESA (Beckwitt 1990, Carlton 1994, Greenwald et al. 2000, Aubry and Lewis 2003).

Historically, fishers were distributed across central Canada, with three peninsular extensions into the United States (Seton 1909, Hagmeier 1956, Hall 1981, Powell 1993). In the East they ranged from Maine to Minnesota and as far south as Kentucky (Graham and Graham 1994). The range of fisher in the West was constrained to two narrow bands of forests: one running along the Rocky Mountain chain maybe as far south as Utah and another in the Pacific states stretching from the Coast Range, through the Cascades and into the southern Sierra Nevada (Gilibesco 1994). Fishers were found in western Montana and in the Yellowstone Ecosystem (Hoffmann and Pattie 1968).

A combination of factors, including over unregulated harvest, predator poisoning, logging, conversion of forested habitats to agriculture, and large wildfires, acting in concert resulted in severe contractions of fisher range during the 19th century (Douglas and Strickland 1987, Powell and Zielinski 1994). Trapping effort was especially intense because fisher pelts, especially females, brought one of the highest returns of all North American furbearers (Seton 1927, Thomas 1954, Obbard et al. 1987, Lewis and Aubry 1997). In Montana and Idaho, over a million acres of mature coniferous forest burned in the early part of the 20th century (Pyne 1982) and the coincident loss of habitat played a role in the decline of fisher populations (Williams 1963a). By the 1930s, fisher populations had been decimated in many regions of the United States and extirpated from some areas altogether (Brander and Books 1973, Powell 1993). The species was considered extinct in Montana when trapping was closed in 1930 (Hawley 1968, Hornocker and Hash 1979).

In the latter part of the 20th century, the regeneration of forests, the restriction of trapping via closed seasons and regulation of harvest, and reintroductions have allowed fisher to re-colonize large portions of their former habitat. In fact, fisher recovery in the upper Midwest and Northeast, where numerous transplants have occurred, has been dramatic (Irvine et al.1962, Peterson et al. 1975, Berg 1982, Krohn et al.1993, Williams et al. 2000). Almost a thousand animals are trapped annually in both Minnesota and Wisconsin, fishers are common in most of New England, and translocations continue with a recent introduction occurring in West Virginia.

The future of fisher populations is less certain in the western United States. A discontinuity in the range of fisher in California has isolated the species and the long-term viability of this population is uncertain (Zielinski et al. 1995, Zielinski et al. 1999). Aubry and Lewis (2003) concluded that native populations in the Pacific Northwest are extinct and reintroduced animals have not expanded their range greatly. Preliminary planning has begun to assess the possibility of reintroducing fisher to Washington (Lewis 2002, Weir 2002).

Two introduction efforts have occurred in Montana. Thirty-six fishers from central British Columbia were released at three sites in western Montana between 1959 and 1960 (Hawley 1959, Hawley 1960). Weckwerth and Wright (1968) noted that both marked and unmarked individuals were trapped in the vicinity of the releases subsequent to the translocation. On the basis of these returns, they concluded that at least one transplant was successful.

Between 1989 and 1991, 110 fishers were live-trapped in Minnesota and Wisconsin, transported to Montana, and released in a cooperative effort between the Montana Department of Fish, Wildlife & Parks, the University of Montana, and the Kootenai National Forest (Aderhold 1988, Foresman 2001). Many of these animals perished after their release, but Roy (1991) found evidence of reproduction and Heinemeyer (1993) observed that some individuals established home ranges. The translocation succeeded in establishing a small population of fisher in the region (Chapter 1, this thesis).

A number of researchers in California (Zielinski et al. 1999, Carroll et al. 1999), Washington, and Oregon (Slauson and Zielinski 2001) have documented the distribution of fisher using extensive surveys and non-intrusive techniques (Zielinski and Kucera 1995). Other researchers have synthesized existing records (Yocom and McCollum 1973, Aubry and Houston 1992, Aubry and Lewis 2003) and used genetic analysis (Drew et al. 2003) to describe the species' status in the Pacific states.

Despite concerns about the status of the species in the inland northwest (Carleton 1994, Heinemeyer and Jones 1994, Ruggerio et al. 1994, Gaillard and Folger 2002) there has not been any comprehensive effort to determine the distribution of fisher in Montana or Idaho. Detailed information on fisher distribution will facilitate our assessment of introductions and evaluations of the species' status. We compiled existing records on fisher in the state of Montana and described their current and historic distribution.

METHODS

We collected all available records pertaining to the species' distribution in the state to compare the geographic extent of fisher in Montana prior to and following translocation efforts. Information was derived from existing databases, publications, reports, unpublished documents, agency files, and notes. Both 'historic' records, which we define as records prior to the introduction of fisher in 1959, and contemporary records (1968-2003) were gathered. Because Weckwerth and Wright (1968) reported data on fisher distribution for the period 1960-1968, we elected to not include these already published records in our dataset. Our dataset begins in 1968.

Contemporary records come primarily from data on furbearer harvest, snow tracking, and sightings provided by Montana Fish, Wildlife & Parks (Giddings 2003). We split these records into two time periods that reflect the history of translocations to Montana: 1959-1988 and 1989-2003. In addition to data available from the state, we collected occurrence information from United States Forest Service biologists, National Park Service biologists, independent researchers, and museum curators.

Verified records, most of them from harvest, constituted the bulk of the records (n=248). Track records (n=141) and sightings (n=36) made up the remainder. We sorted occurrence records by reliability (verified and unverified) as well as time period. As per McKelvey et al. (2000) records with physical evidence: trapped animals, specimens, photographs, and sooted track-plate impressions were classified as 'verified', while sighting and track observations were classified as 'unverified'.

To assure the veracity of records we adopted multiple conservative criteria for inclusion of records in our database. Information on the location (to sub-drainage-usually within a kilometer of the harvest), date (month/year), and collector was required for each record included in this analysis. Sightings that did not come from experienced individuals or provide a detailed physical description were discarded. Tracks were only included when they came from skilled observers who provided measurements with a track width greater than 2.25" (5.7 cm) and straddle over 4.50" (11.4 cm) (Halfpenny et al. 1995). All records were checked for accuracy, edited, and compiled in a spatially explicit database. Maps were drawn in GIS (Arc8) showing the distribution of fisher in two periods (1968-1988 and 1989-2003) based on verified and unverified records.

RESULTS

Historic distribution in Montana

Even though hundreds of thousands of furs passed through forts on the upper Missouri in the 19th century and Montana was prominent in the fur trade for almost a century, published early accounts and records of fisher in Montana are sparse. The earliest record we found was of 128 fisher pelts shipped on July 29, 1875 from Fort Benton by John C. Gowey and Company (Williams and Muich 1998). Despite the fact that fur was transported widely before arrival at tanneries or ports of export, it is likely that some of these pelts were derived from Montana.

Our request to 71 North American natural history museums, for fisher specimens, produced only one Montana animal taken before 1959. The Smithsonian museum holds the first and only fisher specimen (USNM 61835) collected in Montana prior to the species' 'extirpation' and subsequent 'reintroduction'. This specimen was collected in 1898 from an unspecified Montana locality. The Harvard Museum of Comparative Zoology indicated that they hold a skin and skull of a fisher (MCZ B 6964) that was taken in Idaho in 1896. Merriam (1891) records another early specimen from Idaho taken at Alturas Lake in 1890. Seton (1909) trailed a fisher in the Bitterroots.

Bailey and Bailey (1918) recorded that a few animals were trapped in Glacier National Park in the early part of the 20th century. Archival information from Glacier National Park for the years between 1938 and 1964 suggests that a small population of fishers may have been present. Unfortunately the data, notes on a dozen tracks and sightings, is not detailed enough to evaluate and must be judged as unreliable. Park Service records from this era list fisher as rare in Glacier and Yellowstone National Parks (Glacier National Park Archives 2003).

Based on vegetation patterns and a synthesis of previous research, Hagmeier (1956) included western Montana and Yellowstone National Park in his seminal map of fisher distribution. However he stressed, "Only three records are known to me.... Newby... says that these records are so unreliable as to be unauthentic" (Hagmeier 1956:156). Despite the lack of historic records, most authors before (Seton 1909, Nelson 1918, Goldman 1935) and after Hagmeier (Cahalane 1961, Hall 1981, Gibilisco 1994), included the Rockies as far south as Wyoming in their map of historic fisher distribution. Hoffmann et al. (1969:596) explained, "The fisher apparently was extirpated from most localities in Montana and adjacent states before any specimens were preserved, and its *presumed* occurrence is based on the reports of early trappers."

According to Bud Moore (pers. comm.) fishers were largely trapped out of the Selway-Bitterroot by the turn of the century. During his time trapping in Idaho's Lochsa country he never saw a fisher or its tracks, but he was aware that Frank Bretschneider killed one near the South Fork of Lolo Creek in the mid-1920s. The rarity of

Bretschneider's capture made it well known and the fur reputedly drew a high price on the black-market. Richard Kenck trapped the last known native fisher in Montana, around 1927 near the headwaters of the Sun River. He stated that it was the "only one I [ever] saw sign of" (University of Montana, Mansfield Library 1981).

Despite substantial trapping pressure (Newby 1956, Novak et al. 1987, Moore 1996) and research effort (Newby and Wright 1955, Hawley and Newby 1957) there is no verified evidence of fisher again until 1960 after the first translocation of fisher into Montana (Newby and McDougal 1963). A state biologist did report seeing fisher tracks on Lower Whale Creek in the winter of 1943 (Thompson 1945), but this observation and others from Glacier are all unverified. A marten project was run on Anaconda Creek along the Northfork of the Flathead River from 1952 to 1957 (Jonkel 1959, Newby 1957, Weckwerth and Hawley 1962). None of the researchers reported fisher captures or tracks in the area. Newby emphasized, "We have no *authenticated* records of fisher in Montana" (Newby and Hawley 1954:461). In their compilation of furbearer harvests for North America, Novak et al. (1987) are unable to document any harvest of fisher in the state prior to 1984.

Contemporary distribution in Montana

Only two unverified records exist prior to 1989 and because their authenticity is questionable we did not map them. Montana Fish, Wildlife & Parks did not consistently catalogue fisher harvest until after the trapping season was re-opened in 1979, but we were fortunate to find 48 harvest records going back to 1968 in agency files. Verified records (222 from harvest) make up the majority of our data, with a total of 248 points beginning in 1968 (122 prior 1989, 126 post). Photographs from remote cameras, live-captures, road-kills, and treed fisher also constitute verified records. Visual observations begin in 1981 and tracking data begins in 1993. In total, 425 records show the distribution of fisher from 1968 to 2003.

We mapped records prior to 1989 (Figure 1) and after 1989 (Figure 2) separately to show the impact of the two introductions independently. All records combined are displayed in Figure 3, which shows the distribution of fisher in Montana using 35 years of harvest, sighting, and tracking data. Figure 4 overlays the location of release sites and number of animals released on all data from 1968-2003.

Occurrence data document fisher along the western fringe of the state- throughout the Bitterroot range, as far north as the Purcell range, and from south of Roger's Pass to the northern end of the Whitefish range. A juvenile male fisher was harvested just outside of Glacier National Park to the north of Two Medicine Lake on January 27, 1989. Unverified records from Glacier include 64 tracks and 5 sightings from within the Park's boundaries. A remotely triggered camera photographed a fisher in the Beartooths near Republic Creek on January 9, 1995 (Gehman 1995). Snow track surveys by Gehman and Robinson (2000) document fisher within Yellowstone National Park (n=12) and on the Gallatin National Forest (n=10).

Sighting records are often coupled with clusters of verified records, but animals are also reputed in locales where harvest was scarce (the Purcells and the Livington range [Glacier National Park]) or absent altogether (the Madison, Gallatin, and Absaroka ranges). Sightings were purportedly made of a fisher in the West Cabinets (6/11/81) and in the Yaak (6/28/81) well before the Cabinet introduction. Like sighting records, tracks are found near verified locations and in areas where presence cannot be substantiated.

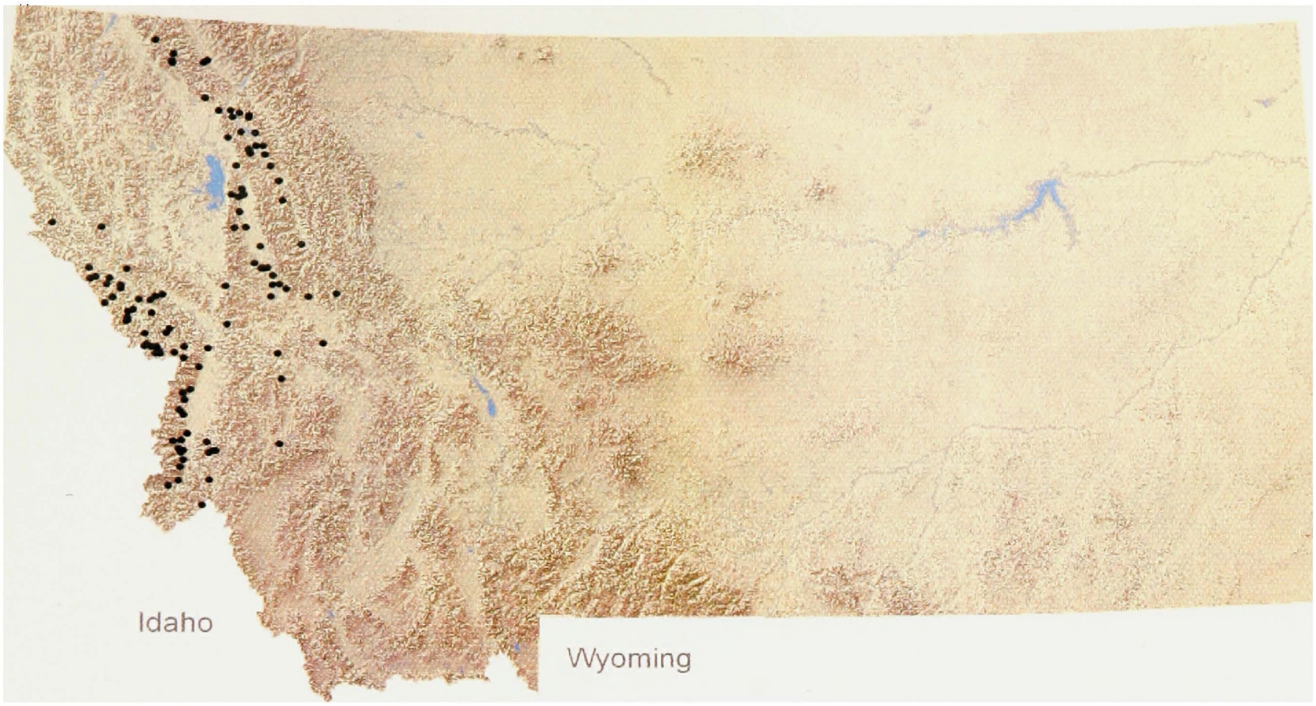


Figure 1. Verified fisher records in the state of Montana (1968-1988).

Figure 2. Verified and unverified fisher records in the state of Montana (1989-2003).
● = verified record ● = track locations ● = sightings

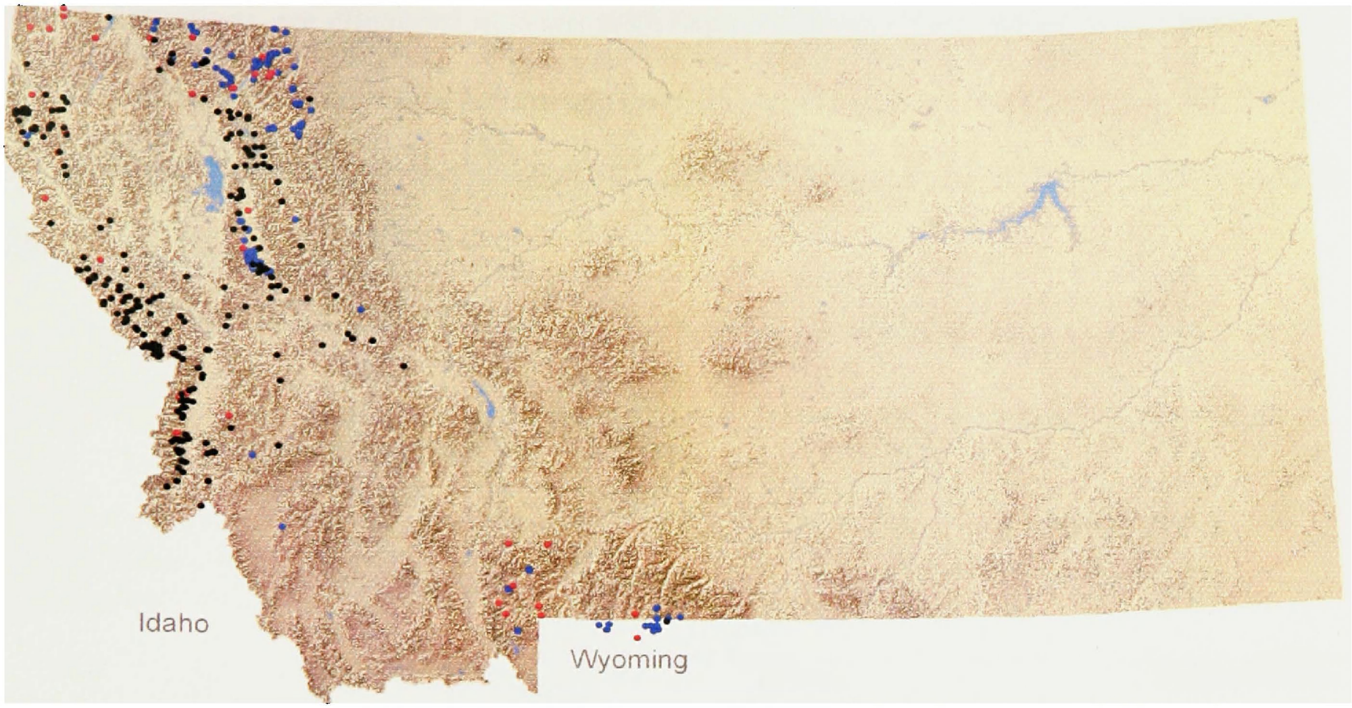


Figure 3. All fisher locations in the state of Montana (1968-2003).

● = verified record ● = track locations ● = sightings

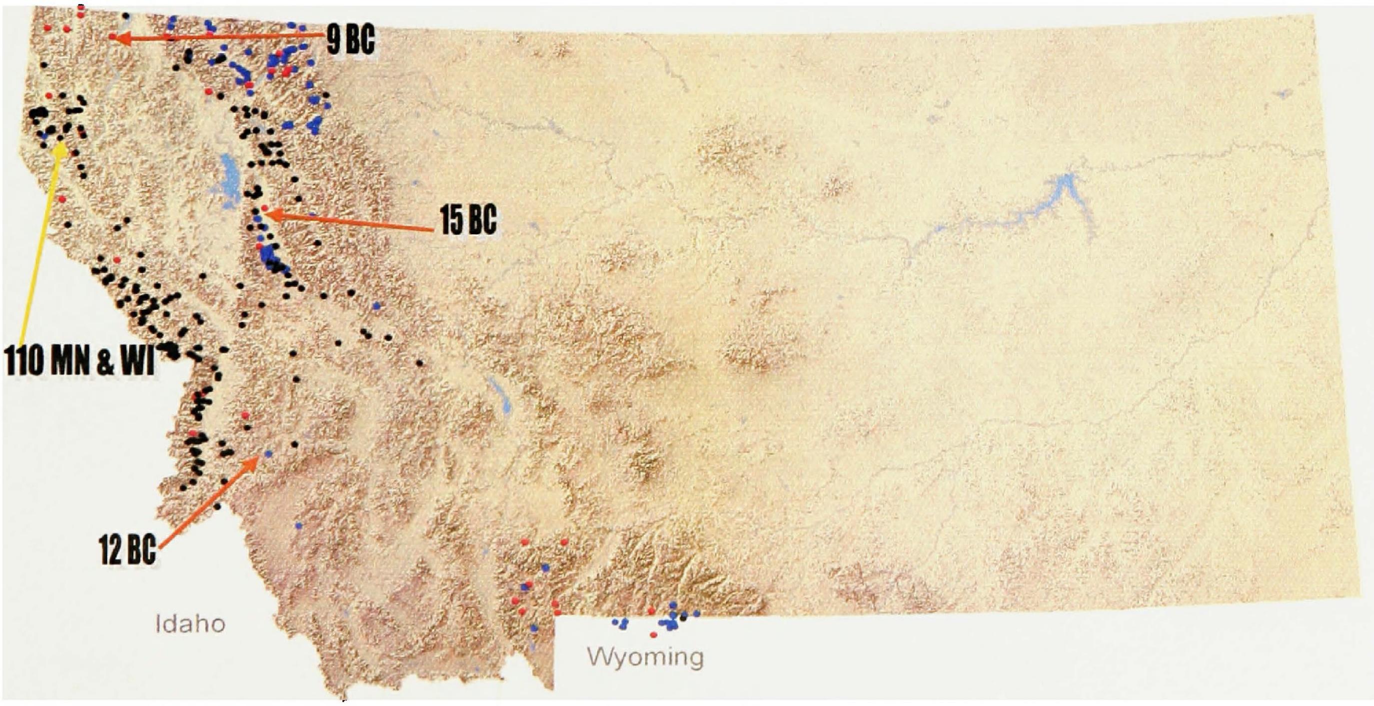


Figure 4. All fisher locations in the state of Montana (1968-2003) and introduction sites. BC= British Columbia, MN= Minnesota and WI= Wisconsin

● = verified record ● = track locations ● = sightings

Track detections are clustered in areas with high tracking effort. Most of our track detections are associated with intensive carnivore tracking bouts conducted in the Swan (Parker 2003), the Greater Yellowstone Ecosystem (Gehman and Robinson 2000), and in Glacier National Park (Hahr 2001).

We provide detailed information on the dates, localities, and composition of fisher introductions in Table 1. Observation of the distribution map incorporating all records

Table 1. History of fisher introductions in Montana and Idaho. (Hawley unpublished notes, Weckwerth and Wright 1968, Williams 1962, Williams 1963b, Roy 1991, Heinemeyer 1993).

Date	Release location	Source	Number & Sex
3/9/59	Pink Creek- Purcell range	Central British Columbia[1]	6 (2M, 4F)
3/26/59	Pink Creek- Purcell range	Central British Columbia[2]	3 (2M, 1F)
4/19/59	Holland Lake- Swan range	Central British Columbia[3]	3 (2M, 1F)
1/15/60	Holland Lake- Swan range	Central British Columbia[4]	12 (6M, 6F)
2/18/60	Moose Lake- Pintler range	Central British Columbia[5]	12 (4F, 8F)
3/8/62	Chamberlain Basin- landing strip	Central British Columbia	14 (5M, 6F, 3 kits)
12/14/62	Red River- 5.5 mi east of Ranger Station	Central British Columbia	10 (*unknown*)
12/14/62	Mountain Meadow- 8 mi east of Station	Central British Columbia	7 (*unknown*)
2/15/63	Savage Pass- 4 mi southeast of Powell	Central British Columbia	11 (5 M, 6 F)
1989-91	Multiple locations in Cabinet Region	*Minnesota & Wisconsin*	*110 total*
1/1/89	*Unspecified locations in:*	*Minnesota- Red Lakes NWR*	12 (5M, 7F)
1/1/90	East Fork Bull River	*Minnesota- Red Lakes NWR*	15 (7M, 8F)
3/9/90	South Fork Bull River	*Minnesota- Red Lakes NWR*	5 (1M, 4F)
10/1/90	*Unspecified locations in:*		*in total:*
to	South & East Forks Bull River	*Wisconsin- Nicolet NF*	78 (34M, 44F)
8/30/91	Main drainages in the West Cabinets	*Wisconsin- Nicolet NF*	
	Main drainages east side of the Cabinets	*Wisconsin- Nicolet NF*	

[1] *trap locality: Mile 200 Alaska Hwy, Mile 232 Alaska Hwy, Prince George, Clearwater (2), Kamloops*
[2] *trap locality: East Pine, Chief Lake (2)*
[3] *trap locality: East Pine, Mile 232 Alaska Hwy, Chief Lake*
[4] *trap locality: Prince George (5), Clearwater (6), Vanderhoof*
[5] *trap locality: Clearwater (11), Prince George*

and introduction sites (Figure 4) shows that translocations are associated with occurrence records. Multiple verified and unverified records exist in the vicinity of the releases. In particular, inspection of Figures 1 and 2 shows that the Swan and Cabinet introductions, respectively, have numerous records linked to them. The majority of verified occurrence records are found in the Bitterroots, where the closest translocation was 39 fishers, released in 1961 and 1962, across the border in Idaho (Williams 1962, Williams 1963a, Williams 1963b).

DISCUSSION

Historic Distribution and Extirpation in Montana

Assessing the historic distribution of a species is difficult. Typically only a few accounts of species exist within a region and these records, derived from early naturalists, trappers, and explorers, may contain inaccuracies. Fur harvest as documented by trading companies like the Hudson Bay Company can provide useful data on the abundance and extent of harvested populations. Regrettably, in the United States there is a paucity of harvest data prior to 1934 and until the last few decades harvest data was not consistently collected (Novak et al. 1987). Like previous researchers, our attempt to investigate the historic extent of fisher populations in Montana was hampered by fragmentary evidence. Fishers probably occupied some mesic coniferous forests in the western portion of the state and maybe within the Greater Yellowstone Ecosystem (Hoffman and Pattie 1968), but there is no evidence to suggest that they were ever widespread.

Habitat loss and direct mortality most likely affected fisher populations in Montana. Extensive areas of the state were deforested to provide agricultural land and timber. The high value of fisher pelts in the early part of the 20th century (Douglas and Strickland

1987, Davis 1997) and vulnerability of fisher to trapping has been well documented (Banci 1989, Lewis and Zielinski 1996). Presumably fishers also perished as a result of the widespread use of poisons in predator control (Williams 1963a). Unregulated trapping pressure in Montana was intense for almost a century and as a result existing fisher populations may have been eliminated or reduced to small remnants vulnerable to extinction. Although fishers were assumed to be extinct when the trapping season was closed in 1930 the possibility that remnant populations persisted cannot be ruled out.

Contemporary Distribution in Montana

The Bitterroot region possesses the most verified records both before and after 1989, and appears to be the stronghold of fisher populations in Montana. However it is unclear how this population arose. The closest Montana translocation occurred 40 kilometers to the east in the Pintlers at Moose Lake, where a dozen animals from the Frazier River watershed were released on February 18, 1962. The most likely explanation is that 39 British Columbia fishers introduced into Idaho's Selway-Bitterroot region in 1962 (Williams 1962) and 1963 (Williams 1963b) reproduced and they or their progeny colonized adjacent habitat in the Bitterroots.

Although numerous authors (Davis 1939, Rust 1946, Williams 1954, DeReus 1957, Koehler and Hornocker 1979) described the fisher as very rare or absent from Idaho's fauna it is not inconceivable that some individuals remained in central Idaho's remote and abundant wild lands. If they existed, these remnant native populations may also have contributed to the resurgence of fisher in the Bitterroot region.

The timing, proximity, and quantity of fishers trapped from 1960 to 1989, strongly suggests that the 1960s transplants were successful. Twenty-one fishers, seven tagged and 14 untagged, were harvested from 1960 to 1968 (Hawley 1968). An additional 122 verified fisher records exist from 1968 to 1989. For over thirty years there was no record of fishers in Montana (Newby and McDougal 1963), but following the releases a pulse of captures began. Records from the Mission/Swan, Sapphire, and Whitefish ranges are especially informative. After the translocation of 15 fishers to Holland Lake, at least 26 fishers were harvested in the vicinity. Captures in the Whitefish range and the Sapphires are within 20 and 40 kilometers of the Pink Creek and Moose Lake releases respectively. Weckwerth and Wright (1968) observed that carcasses showed evidence of reproduction and inferred that untagged animals were descendents of the transplants.

Oddly, there are few verified records of fisher in the Mission/Swan, Sapphire, or Whitefish range after 1989. This may reflect sampling effort, perhaps there are fewer trappers in these areas now, or actual distribution. Recently established populations may have vanished as a result of habitat alteration, direct mortality, random demographic and environmental events, or a combination of these factors. In the Mission/Swan there is some evidence to suggest that extensive logging and/or trapping may have adversely impacted the population. Twenty-six fishers were harvested in the area prior to 1989, but only three have been taken since 1989. Researchers conducting snow track surveys in the valley since 1998 found fisher tracks on only five percent of their transects (Parker 2003).

Prior to the translocation of 110 fishers from Minnesota and Wisconsin to the Cabinets, there were only 10 verified fisher records in northwest Montana. These records, from the Whitefish range, are likely related to the Pink Creek release in 1959. Two sightings, made in 1981, precede the introduction, but these observations from Callahan Creek in the West Cabinets and Williams Creek in the Yaak were most likely made in error. The presence of fisher cannot be confirmed in southeastern British Columbia (Fontana et al. 1999) or the Cabinets (Hash 1987) during this time.

The spatial and temporal distribution of fisher records in northwestern Montana fits closely with the region's introduction history. Releases in the Purcells (Pink Creek), in the Cabinets, and in the East Kootenays have all contributed individuals to northwestern Montana. After the 1989-1991 releases a plethora of records appear in the Cabinets. It is clear that the introduction was responsible for the establishment of fisher in the area. The presence of Minnesota and Wisconsin haplotypes in 11 of 13 samples from the Cabinet region confirms that this population is descended from the transplant (Chapter 3, this thesis). Two fishers taken in the 1990s near the Canadian border dispersed from the East Kootenay translocation in southeastern British Columbia (Fontana et al. 1999).

The frequency of records found in a region is a function of search effort expended in that region. The abundance of track records in the Greater Yellowstone Ecosystem and Glacier National Park reflect intensive research efforts. In contrast, there are no harvest records from within the boundaries of the National Parks. Even though the quantity of fisher sightings and tracks suggest fisher presence, we emphasize that only one verified record exists in Yellowstone and one on the eastside of Glacier Park.

It is unfortunate that the bulk of detections in Yellowstone and Glacier are unverified. We were conservative in our inclusion of data, but sightings remain notoriously unreliable because their accuracy depends upon the experience of the observer. Snow track data are also difficult to judge. A skilled observer is necessary to interpret tracks and track quality is widely variable depending on weather and snow conditions. Researchers in both regions attempted to minimize error by taking careful measurements of potential fisher tracks. Hahr (2001) and co-workers applied a 2.25" (5.7 cm) width to distinguish *Martes* tracks; while, Gehman and Robinson (2000) labeled tracks of greater than 2.50" (6.4 cm) width as fisher.

The Yellowstone country is separated from the translocation sites in western Montana by over 200 km including great stretches of open, dry habitat inhospitable to fisher; so, fishers in the area may represent a native lineage (Buskirk 1999). If a genetically distinct remnant population were identified in this region it would lend credence to the argument that fisher were never extirpated from the state. Fisher in Glacier may also represent a remnant population. More verified records are needed in both regions to conclusively confirm the presence of fisher. If animals are captured, genetic analysis could be used to describe the lineage of fisher in Glacier and Yellowstone.

Based on our research, it is apparent that occupied fisher habitat is considerably more limited than potential habitat as outlined by previous researchers (Hagmeier 1956, Heinemeyer and Jones 1994, Hart et al. 1998). These authors suggest that fishers inhabit (or have the potential to inhabit) a relatively uniform band of forested habitat throughout western Montana, but neither fisher habitat nor distribution is continuous across the western portion of the state. The contemporary distribution of fisher in Montana has been shaped by the availability of quality habitat (closed canopy mature coniferous forest- Buskirk and Powell 1994), the history of translocations, and by the presence of remnant populations (Chapter 3, this thesis).

Multiple, recent verified occurrence records indicate that fishers occupy the Bitterroot, Coeur D'Alene, Mission, Swan, Cabinet, and Whitefish ranges. A handful of verified records exist in the Sapphires, Purcells, Garnets, Flathead range, on Glacier's

East front, along the Continental Divide near Lincoln, and on the Beartooth Plateau, but we are unable to verify the presence of self-sustaining populations in these areas. Fisher presence in the Pioneers, the Gallatin, and Madison ranges has not been confirmed and we found no credible records in the dry forests of the Rocky Mountain Front, the Salish, or Flint mountains.

Presence is not an appropriate index to population density, but data on a species' distribution is fundamental to our understanding of its status. Our distribution map includes records gathered over 35 years and consequently may not reflect current occupied habitat. Despite the fact that fisher records are found in a dozen mountain ranges in Montana, carnivore research conducted in many of these locales (Gehman and Robinson 2000, Giddings 2000, Hahr 2001, Parker 2003) has demonstrated that the species is one of the lowest density carnivores in the state. For example, during three winters (2001-2003) of fieldwork in the Cabinets and West Cabinets we collected only 11 verified records of fisher (Chapter 1, this thesis).

It is clear that introductions from central British Columbia and the upper Midwest have played a crucial role in re-establishing Montana fisher populations. However, it is unclear if fisher were actually extirpated from Montana and Idaho. Extant populations may be derived solely from transplants or may be derived from a combination of native and transplanted animals that have interbred. Analysis of mtDNA haplotypes (Chapter 3, this thesis) supports the latter view.

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CHAPTER 3. Origin of Montana fisher (*Martes pennanti*) populations.

Abstract: Montana fisher populations were allegedly extirpated by the 1920s and extant populations are believed to be descended from three reintroduction efforts. These translocations introduced 75 British Columbia fishers into Montana and Idaho, between 1959 and 1962, and another 110 fishers from Minnesota and Wisconsin into northwest Montana between 1989 and 1991. To learn the impact of these introductions and establish if fisher were in fact extirpated from Montana, we gathered 133 tissue samples from fisher harvested in British Columbia, the upper Midwest, and Montana. We sequenced two regions of the mitochondrial DNA genome (the control region and cytochrome-b) and compared the distribution and frequency of haplotypes between populations. Haplotype frequencies differed significantly between populations. Source populations had six non-overlapping haplotypes. Four haplotypes were unique to British Columbia (4,6,9,11), two were found exclusively in the Midwest (5,10), and two were present in both populations (1,7). The presence of haplotypes from British Columbia and the Midwest in Montana fishers shows that populations in the state have multiple origins, which reflect the history of introductions. In northwestern Montana, fishers share haplotypes with populations from Minnesota, Wisconsin, and British Columbia. In west-central Montana, we detected haplotypes characteristic of British Columbia populations (4,6,7) and two haplotypes (12 in the control region and haplotype B in cytochrome B) that were not found in any other population. The high frequency of these novel haplotypes in west-central Montana, in spite of their absence from other populations, suggests that this population has undergone isolation and subsequent genetic drift, probably as a result of a bottleneck. Fisher populations in west-central Montana show evidence of a distinct, native lineage apparently unrelated to translocations in the region.

INTRODUCTION

Application of genetics to conservation

Genetic analysis has revolutionized many fields and wildlife science is no exception. Critical questions with bearing on the conservation of species that were indecipherable a generation ago can now be answered. Novel insights into phylogeny, genetic variation, and population structure have been generated using recently pioneered genetic tools and techniques (Sunnucks 2000).

Genetic techniques can be used to identify species and individuals, determine effective population size, estimate population size, and ascertain the genetic origin of a population (Paetkau et al. 1995, Foran et al. 1997, Schwartz et al. 1998, Mills et al. 2000, Hansen et al. 2001). Information derived from genetic analysis can be instrumental in setting conservation priorities by defining species, populations, and connectivity.

Allozymes, mitochondrial DNA (mtDNA), and nuclear DNA (nDNA) are all molecular markers that have been used to investigate population structure. Mitochondrial DNA is a maternally inherited genome of up to 16,000 base pairs (bp), with a high rate of mutation, and low rate of recombination (Avise 1994). Since mtDNA only reveals the maternal portion of the genome it is sensitive to drift (Avise 1994). MtDNA is highly conserved as a marker, yet it has a rapid rate of sequence divergence. These properties make mtDNA, a useful marker to evaluate spatial structuring across time and as a result it has been utilized extensively in phylogenetic studies (Masuda and Yoshida 1994, Hosada et al. 1997, Johnson et al. 1998, Knowles 2001, Templeton 2001).

Translocations and the origins of Montana fisher

We apply genetic techniques to investigate the origin of fisher populations in Montana. Fishers are lithe, swift moving predators evolved to hunt in woody debris, thick brush, and in the trees (Buskirk and Powell 1994). In the western United States fishers are found in moist coniferous forests with high structural complexity at low to mid elevations (Banci 1989, Jones 1991, Heinemeyer and Jones 1994, Powell and Zielinski 1994). A valuable furbearer, they were nearly extirpated from much of their range in the United States by the 1920s (Powell 1993). They are the one of the most widely reintroduced carnivores in North America (Berg 1982, Williams et al. 1999).

Translocations in the Northeast and upper Midwest have resulted in viable, expanding populations (Kohn et al. 1993), but translocations in the western portion of their range have been less successful (Aubry and Lewis 2003) and there is concern about the survival of populations in the western United States. There have been three petitions to list western populations of fisher as threatened under the Endangered Species Act (ESA) in the last decade (Beckwitt 1990, Carlton 1994, Greenwald et al. 2000). The United States Fish and Wildlife Service rejected the first two of these petitions (USFWS 1991, USFWS 1996), but in light of new information on the distribution and origins of fisher in the Pacific Northwest, the third petition, which calls for the listing of Pacific coast fisher populations as endangered, is now undergoing a 12-month review (USFWS 2003).

Montana fisher populations have been impacted by three introductions (Williams 1963, Weckworth and Wright 1968, Roy 1991, Heinemeyer 1993), but it is unclear how these translocations have shaped population structure. The genetic composition of the population depends upon the contribution of British Columbia animals, animals from the Midwest, and of remnant populations, if they exist. Fishers in the state may represent a hybrid between the Midwestern and western subspecies (*Martes pennanti pennanti* and *Martes pennanti columbiana*), but no research has been done to ascertain their origin. If populations of native fishers have persevered and remained isolated from introduced fishers (Buskirk 1999), these populations may represent distinct population segments (Waples 1991, USFWS and NMFS 1996).

Morphologically based subspecies accounts for the fisher have fostered controversy. Goldman (1935) described three subspecies of fisher in America: *M. p. pennanti* in the central and eastern part of the continent, *M. p. columbiana* in the Rockies, and *M. p.*

pacifica on the Pacific coast. Hagmeier (1959) elected to lump this phenotypic variation under a single variety.

Based on microsatellite data, Kyle et al. (2001) concluded that the species shows evidence of isolation by distance. After examining mtDNA control region sequences, Drew et al. (2003) also found signs of population subdivision. We retain the subspecies differentiation, as it is apparent that regardless of the rationale population level genetic structuring has influenced fisher in North America.

METHODS

Tissue collection

We collected and sequenced 133 tissue samples to compare the genetic composition of Montana fishers with source populations from which they may be descended in British Columbia, Minnesota, and Wisconsin. Sixty-three fishers harvested in Montana between 1993 and 2003 as well as six samples collected, in 2001 and 2002, as part of a research effort in the Cabinet Mountains (Chapter 1, this thesis) were included in our analysis. Tissue from harvested animals was cut from a major muscle group or when necessary from the pelt; samples from live-captured animals came from ear punches. Tissue samples were stored at - 20° C, until use.

In British Columbia, Minnesota, and Wisconsin, our reference samples came from many of the same localities as translocated fisher (Newby 1960, Roy 1991, Heinemeyer 1993). Tissue from the Midwest came from animals harvested in Minnesota (n=11) and Wisconsin (n=11) during the winter of 2002 as well as from eight fishers born in the upper Midwest that were translocated to and died in northwestern Montana (Roy 1991, Heinemeyer 1993). Minnesota samples were taken from the counties of: Lake of the

Woods, Beltrami, Roseau, and Koochiching. All Wisconsin samples came from Oneida County. British Columbia samples (n=34) were collected from animals trapped in 2003: 18 were taken within 100 km of Williams Lake in south-central British Columbia with the remainder coming from Prince George (n=1), Chetwynd (n=6), Fort St. John (n=1), Burns Lake (n=3), Smithers (n=1), Anahim Lake (n=2), and unknown localities (n=2).

Mitochondrial DNA sequencing and analysis

Genomic DNA was extracted from tissues using standard protocols for tissues (DNeasy Tissue Kit, Qiagen Incorpated). Two regions of mtDNA were amplified and sequenced using the polymerase chain reaction (PCR) and appropriate primers. We sequenced 301 bp of the control region using species-specific primers MP-F' and MP-R' (Drew et al. 2003). Our protocol followed that of Drew et al. (2003) with the following modifications: PCR reactions were run in a total volume of 50μl with 2.5mM $MgCl_2$ and 1.5 U Taq polymerase (Applied Biosystems).

We also sequenced 428 bp of the cytochrome-b (cyt-b) regions for all individuals. Primers CanidL1 and H15149 were used (Kocher et al.1989, Paxinos et al. 1997). PCR reactions were run in a total of 50μl containing 50-100 *ng* DNA, 1x reaction buffer (Applied Biosystems), 2.5 mM $MgCl_2$, 200μM each dNTP, 1μM each primer, 1 U Taq polymerase (Applied Biosystems). The PCR program was 94°C/5 min, [94°C/1 min, 50°C/1 min, 72°C/1 min 30s] x 34 cycles, 72°C/5 min.

PCR products were purified using the QIAquick PCR Purification Kit (Qiagen) and directly sequenced. Sequencing of the control region was performed using primers MP-F' and MP-R4 (Drew et al. 2003). Strands were sequenced using the Thermo Sequencase Cycle Sequencing Kit (USB) and run on a Li-Cor 4200 DNA imager with *Li-Cor* Eseq sequencing software. Sequence editing and alignment was completed with *AlignIR*. We documented nine of the twelve haplotypes observed by Drew et al. (2003) and two novel haplotypes within cytochrome b. We assigned each sample a haplotype at each region.

Data analysis

A minimum spanning network was created to illustrate the relationships among haplotypes and show the relative frequency of each within the population. Samples were assigned to one of four categories describing their place of origin: British Columbia, Midwestern (Minnesota and Wisconsin), northwest Montana (west of the Mission and Livington ranges), or west-central Montana (south of Flathead Lake and west of the Continental Divide). We grouped mtDNA control region haplotypes into four categories based which source populations they were specific to: British Columbia (4,6,9,11), the Midwest (5,10), British Columbia and the Midwest (1,7), and Montana (12).

To determine if haplotype observed is dependent on the population from which the tissue was derived, we ran a chi-square test (χ^2) of homogeneity for all populations combined and for populations on a pairwise basis (Ott 1993). We collapsed our data into the four previously described categories to ensure that expected cell counts did not fall below one and invalidate our test. A power analysis was conducted using the binomial distribution: $(1-p)^n$, where p= haplotype frequency and n=sample size. The likelihood of detecting a haplotype, one or more times, as either haplotype frequency or sample size varies was plotted. All analyses were completed in SPSS v11.5.

RESULTS

Within the mtDNA control region we observed nine haplotypes, 0.07 haplotypes per individual. Montana tissues (n=66) were mapped with a symbol indicating the presumed origin of their control region haplotype (see Figure 1). We identified a novel polymorphism within the cytochrome-b region. A transversion (adenine or cytosine) at base pair 117 produces haplotype A or B. Overall sequence divergence was low. The minimum spanning network (Figure 2) demonstrates that most adjacent haplotypes differ by a single base pair change, usually a transition, as is characteristic of mtDNA (Avise 1994). A histogram was drawn to show the distribution and frequency of control region haplotypes sampled in each the four populations sampled (Figure 3). Inspection of this histogram reveals striking differences in both the presence and frequency of haplotypes found in each population.

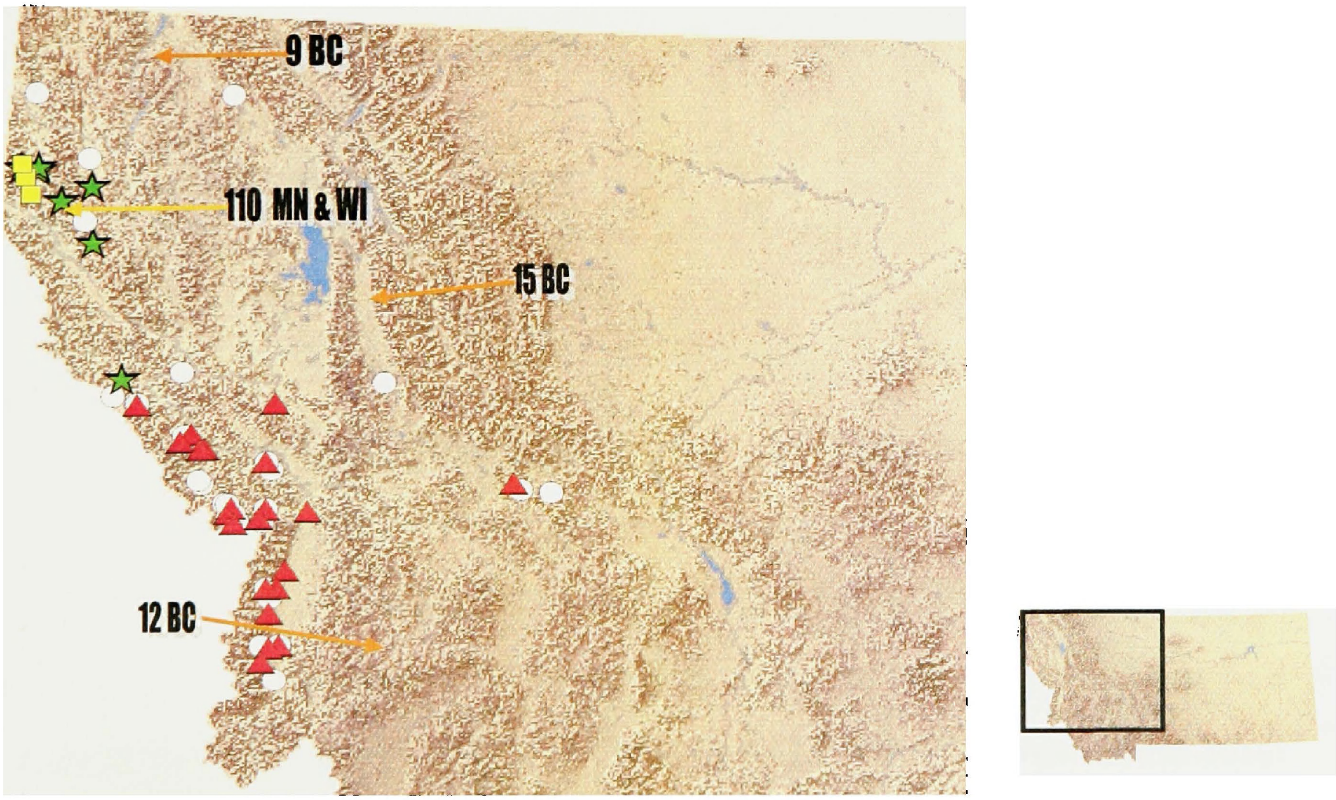

Figure 1. Locations of control region haplotypes sampled in Montana by presumed origin. Introduction sites, number and origin of released fisher are indicated by arrows.

▲=12 (Montana) ○= 4,6 (British Columbia) 🟨=5,10 (Midwest)
★=1,7 (Minnesota and British Columbia)

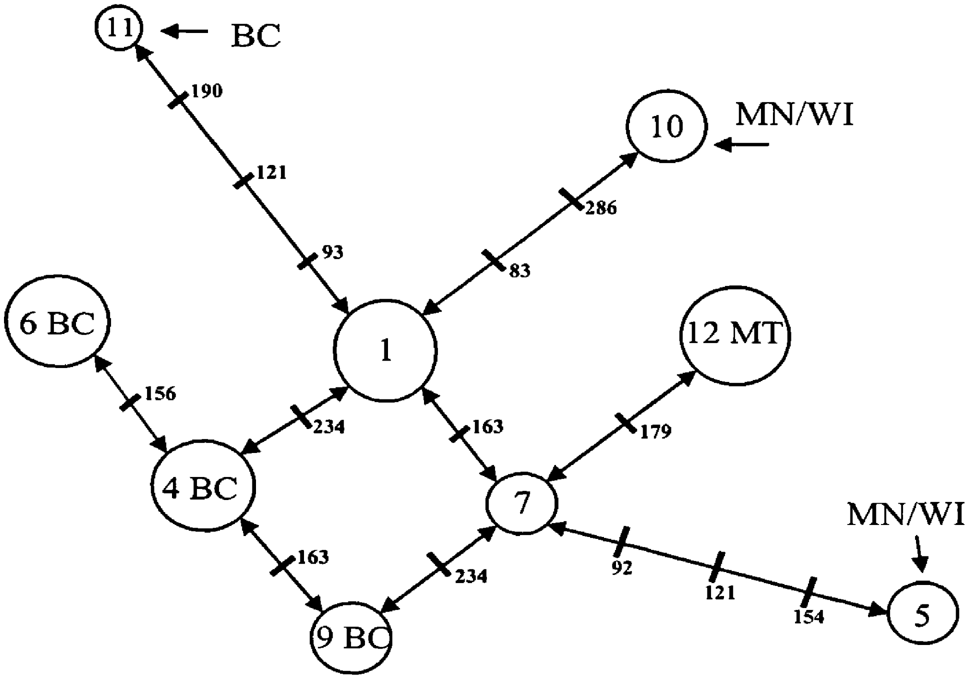

Figure 2. Proposed minimum spanning network for nine haplotypes sampled. Haplotypes are assigned to the region of their presumed origin. The size of circles indicates the relative frequency of a haplotype our sampling population (n=131). Sites that result in differences between haplotypes are shown, for example 7 differs from 12 by a single substitution at bp 179.

A chi square test for homogeneity confirmed that haplotype frequencies are strongly associated (χ^2= 138.72, p<.0001) with population. Four haplotypes found in British Columbia (4,6,9,11) were not documented in the Midwest, and two haplotypes found in the Midwest (5,10) were not seen in British Columbia. Two haplotypes (1,7) are shared by both populations in inverse proportions.

Viewed together, Montana samples display the greatest diversity of haplotypes, but this diversity is partitioned by region. When conducting pairwise comparisons, we found that for *all* tests the proportion of haplotype frequencies observed differed significantly (χ^2, p<.05) between regions. Midwestern populations were the most similar to northwestern Montana: (χ^2=5.51, p<.02), but least similar to west-central Montana: (χ^2=76.86, p<.0001). Inspection of Figure 3 shows that northwestern Montana shares

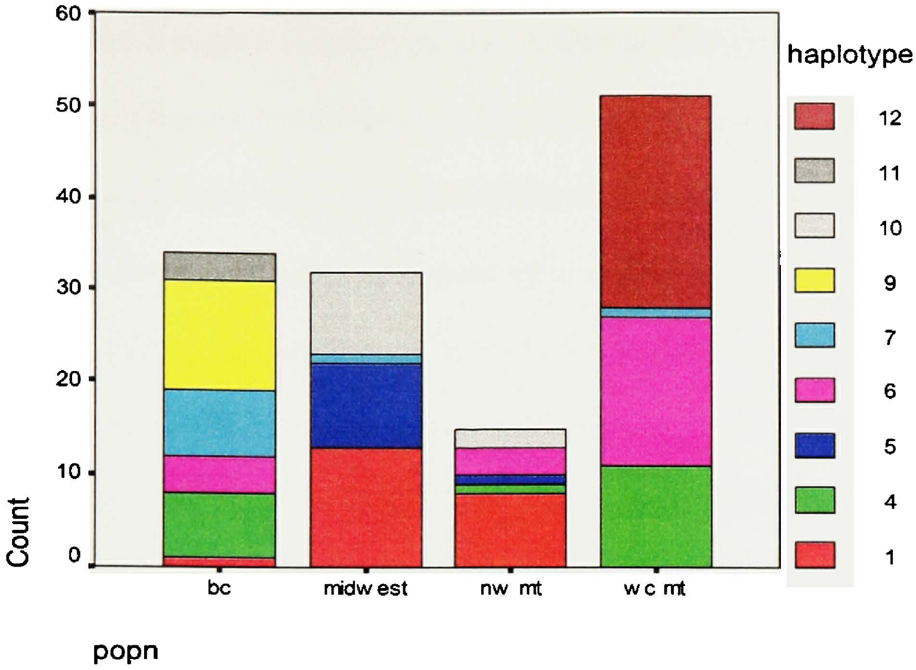

Figure 3. Distribution and frequency of control region haplotypes in fisher populations. BC= British Columbia, Midwest= Minnesota and Wisconsin, nw MT= northwest Montana, wc MT= west-central Montana

three haplotypes each with Midwestern (1,5,10) and British Columbia (1,4,6) populations. Haplotype 1, however, is quite common in the Midwest (43%) and very rare in British Columbia (3%). It is therefore likely that haplotypes 1, 5, and 10 were introduced to Montana from Midwestern transplants.

West-central populations have three haplotypes in common with British Columbia (4,6,7), but only share haplotype 7 (detected once in Minnesota) with Midwestern fisher. Pairwise comparisons reveal that British Columbia fisher are more similar to west-central Montana populations (χ^2= 21.89, p<.0001), than they are to northwest Montana populations (χ^2=27.89, p<.0001). Remarkably almost half of the samples in west-central Montana are composed of haplotype 12, which is novel to this region.

We also discovered that haplotype 12 is linked to a polymorphism within the cytochrome-b region (haplotype B). Although this polymorphism cannot be considered independent because mtDNA behaves as a single locus (Allendorf and Luikart 2001), the occurrence of haplotype 12 with haplotype B means that individuals possessing both these haplotypes are more divergent than would be indicated by the 301 bp control region sequence alone. Cytochrome-b is four times more conserved than the control region (Hosada et al. 1997) so a base-pair difference in this region is especially significant.

We compare our results by state, or province, with those of Drew et al. (2003) in Table 1. This comparison draws into focus the fallibility of small sample size. Despite

Table 1. Distribution and frequency of control region haplotypes in *Martes pennanti* populations, tissues grouped by subspecies. Numbers in parenthesis reflect the findings of Drew et al. 2003.

	M.p. columbiana[1]			***M.p. pennanti***		**Total**
Haplotype	nw MT[2]	wc MT[2]	BC	MN	WI	*M.p. pennanti*[3]
3	-	-	-	-		- (17)
8	-	-	-	-		- (7)
10	2	-	-	9 (16)		9 (16)
11	-	-	3	- (1)		- (1)
5	1	-	-	1	6	7 (4)
7	-	1	7 (5)	1		1 (5)
4	1	11	7 (3)	-		-
6	3	16	4 (13)	-		-
12	-	23	-	-		-
9	-	-	12 (8)	-		-
1	8	-	1 (1)	3	10	13
2	-	-	-	-		-
N	15	51	34 (30)	14 (17)	16	30 (50)
# haplotypes	5	5	6 (5)	4 (2)	2	4 (6)

[1] Although Montana populations fall within the historic range of *M.p. columbiana,* introductions of *M.p. pennanti* within the state confound subspecies designation.

[2] Three Montana samples of unknown origin, had haplotypes 4, 5, and 7.

[3] *M.p. pennanti* samples were derived from Minnesota and Wisconsin in this analysis, while Drew et al.'s samples came from Minnesota and New Brunswick.

similar sampling effort in Minnesota, only the most common haplotype (10) was detected by both parties. We documented three haplotypes (1,5,7) not observed by Drew et al. (2003); yet, they noted haplotype 11 undetected by our sampling. In British Columbia our results were parallel, but we identified one additional haplotype.

The probability of detecting a specific haplotype within a region depends on the spatial extent of the sampling, sample size, and the frequency of the haplotype in the population. Our power analysis (Figure 4a and b) illustrates the positive relationship between sample size, haplotype frequency, and probability of detection. As frequency or sample size increases so does the probability of detection. With a sample size of 30, or frequency of 0.20, only one in twenty trials will fail to detect a given haplotype. Still, very rare haplotypes may go undetected with extensive sampling and inadequate sampling may miss common haplotypes.

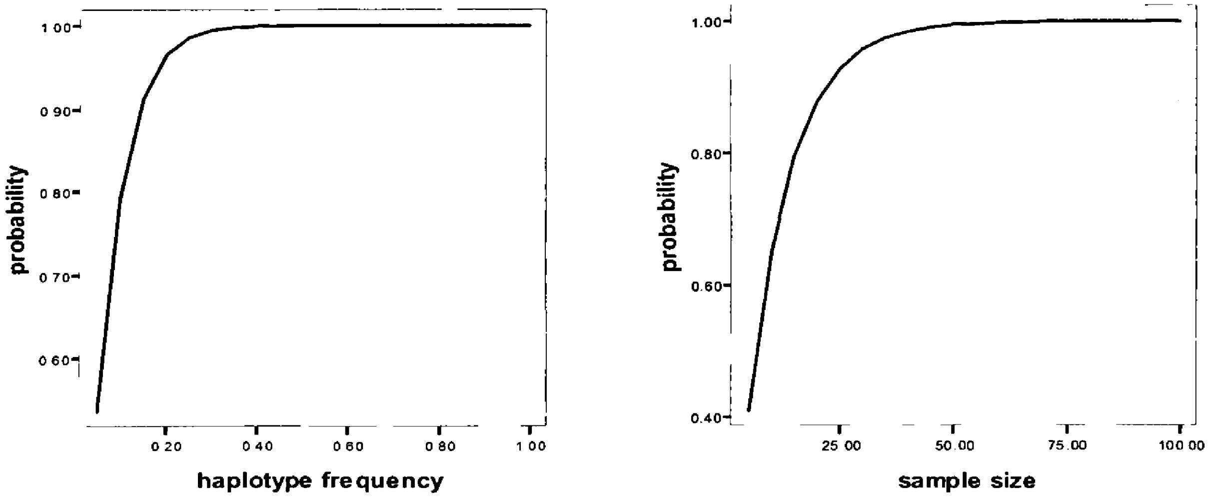

Figure 4 a) Probability of detecting a haplotype frequency increases when sample size=15 b) Probability of detecting a haplotype as sample size increases when frequency= 0.1

DISCUSSION

Our results support Drew et al.'s (2003) assertion that translocations in Montana were augmentations and not reintroductions. Although Midwestern fisher share two haplotypes with populations in British Columbia, the presence of six non-overlapping haplotypes, the reciprocal frequency in which they share haplotypes 1 and 7, and the absence of haplotype 12 from either population allows us to infer the origin of populations in Montana with confidence. The physical proximity, frequency of, and presence of haplotypes from these two introduced populations suggests that fisher populations in Montana have multiple origins related to the point of release.

We have no tissue samples from Montana fisher prior to the introductions so it is impossible to rule out the possibility that all seven haplotypes observed in the state are native to the region, but this is unlikely. Presumably native Montana fisher shared haplotypes with populations in British Columbia, but not with more distant populations. The distinctiveness of haplotypes 5 and 10 and the fact that they were not detected in 64 samples from British Columbia indicates that if they are present in *M. p. columbiana* they exist in very low frequencies. Pairwise comparison (χ^2=56.22, p<.00001) of Midwestern (*M.p. pennnanti*) and British Columbia (*M.p. columbiana*) animals shows that the populations differ strongly in haplotype frequencies and variation is partitioned on a scale consistent with subspecies designation.

Haplotype 12 and haplotype B are most likely a native haplotypes. Their presence indicates that fisher may not have been extirpated. If our sequence data is pooled with that of Drew et al. (2003) sample sizes in our reference populations increase to the point that only an extremely rare haplotype would be missed. Even in northwest Montana where our sample size was limited to 15, a haplotype found in 10% of the population would be detected 79% of the time. Examination of the minimum spanning network shows that haplotype 12 is only one transition away from haplotype 7, which occurs in 21% of samples from British Columbia. The low rate of mtDNA sequence divergence across time (Carr and Hicks 1997), as well as the novelty, and high frequency of haplotypes 12 and B in the population (45%) imply that mutations occurred *in situ*, become fixed together, and drifted to high frequency across time.

Like elsewhere in 19th century America, harvest pressure and habitat alteration in western Montana and Idaho probably resulted in severe contractions of fisher range (Douglas and Strickland 1987, Powell and Zielinski 1994). Given the extreme scarcity of the species in the region, fishers were so rare that they were believed to be extinct (Davis 1939, Williams 1954, Newby and Hawley 1954, Hoffmann et al. 1969); it is likely that the population faced a genetic bottleneck. Since mitochondrial haplotypes behave as a single linked locus (Rand et al. 1994, Hey 1997), haplotype B is not independent of haplotype 12, but the association of the two haplotypes does validate our claim of a distinct, remnant lineage. Haplotype B appears to be fixed at this locus, which is consistent with a population that has emerged from a bottleneck.

The spatial separation of haplotypes associated with *M. p. pennanti* from remnant populations of *M. p. columbiana* suggests discrete populations that have not interbreed, but mtDNA is not an appropriate marker to investigate hybridization because it only shows a single locus, and is maternally inherited. In light of the disproportionate genetic contribution that introduced males can make in introduced populations (Forbes and Allendorf 1991) data from the nuclear genome would be helpful. However, given the rarity of fishers in the Cabinets (Chapter 1, this thesis), the genetic contribution of *M. p. pennanti* to Montana populations may be limited in extent. Observation of Figure 1 is consistent with this hypothesis. In contrast, haplotypes specific to *M. p. columbiana* (including we assume Montana natives) were found in both northwest and west-central Montana. Remnant populations, introduced animals, and/or immigrants have contributed these haplotypes to Montana fisher populations.

Fishers display more genetic structure than marten (*Martes americana*) or wolverine (*Gulo gulo*) (Kyle et al. 2001). This structuring may be a product of fishers' life history characteristics. Unlike marten, fisher distribution is limited by snowpack (Raine 1983, Krohn et al. 1995, Krohn et al. 1997). Fishers' specialized habitat needs predispose them to the effects of fragmentation because their habitat is naturally patchy and is often further fragmented by human activities, like logging of late-seral forests (Buskirk and Powell 1994). The low reproductive rates and low densities of fisher can also contribute to isolation, since small populations will grow slowly and are not likely to have many dispersers (Buskirk and Ruggiero 1994). Lastly it is clear that although fisher are capable of moving long distances, their avoidance of open areas (Powell and Zielinski 1994) may preclude dispersal between ranges, particularly in arid environments.

Our research, like that of a number of previous investigators (Williams et al. 2000, Kyle et al. 2001, Drew et al. 2003) shows that fisher introductions have left a genetic legacy throughout the species' range in North America. Translocations can be an effective tool in wildlife management (Griffith et al. 1989), but managers must be cognizant of the genetic consequences of moving individuals between populations including reduced genetic variability (founder effects) and the introgression of genes from distant populations (outbreeding depression) (Leburg 1990). It is important to understand the genetic composition of existing populations, before introducing animals from outside populations. When translocations are implemented a large, diverse pool of animals, drawn from populations that possess a similar genetic composition to native populations in the area of the transplant, should be used (Powell and Zielinski 1994).

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Conclusions and Management Recommendations

Our research on fisher distribution and lineage in Montana has important conservation and management implications. Fishers occur in many mountain ranges in the western part of the state and possibly within the Greater Yellowstone Ecosystem. Populations appear to be descended from introduction efforts, but there is also evidence of a distinct, remnant population in the west-central part of the state. It is difficult to establish the historic distribution of fisher in Montana, but the lack of historic records and the genetic distinctiveness of native animals may indicate that fisher were never widespread and have been isolated from Canadian populations for a long time.

Translocations from British Columbia and the upper Midwest have been successful in establishing fisher in some locales, but fishers remain scarce in the state. Occurrence records are associated with releases at Moose Lake, Holland Lake, Pink Creek, and in the Cabinets; however, it is unclear if introductions in these localities will persist in the long-term. There are few records from the Sapphires, the Mission/Swan, or Whitefish Range in the last decade, and survey work in the Cabinets suggests that the population there is very limited. The apparent stronghold of fisher populations in Montana is on the border with Idaho in the Bitterroot Mountains. Analysis of mtDNA haplotypes suggests that this population is descended from British Columbia transplants to Idaho's Selway-Bitterroot Wilderness and from remnant native populations.

We can only speculate as to why introductions to this area have been more successful, but habitat type, the presence of con-specifics, and the inaccessibility of the region to trappers may have all played a role. The Bitterroots, like the Mission and Swan ranges, have a high proportion of the mesic forest types preferred by fisher. In addition the Selway-Bitterroot contains extensive areas of remote mature forest. Fishers require habitats with high structural diversity to provide shelter from the elements and an adequate diversity of prey (Arthur et al.1989, Powell and Zielinski 1994). In the western United States, abundant course woody debris and tree cavities to rest and den in are most prevalent in mature forests, and fishers cannot exist without some older forest components (Buck et al. 1983, Jones and Garton 1994, Aubry and Raley 2002).

We do not believe that harvest pressure is the primary factor impacting the outcome of translocations (Montana Fish, Wildlife & Parks only allows a quota of two per year in Region 1 and five in Region 2), but it is important to understand the impact of trapping on fisher. Many authors (Hamilton and Cook 1955, Luque 1983, Krohn and Elowe 1993, Lewis and Zielinski 1996) have observed that fishers are vulnerable to harvest pressure from targeted and incidental trapping, and trapping mortality on adult fisher appears to be additive rather than compensatory (Strickland 1994). As a result of their low reproductive potential (Douglas and Strickland 1987) small changes in harvest mortality may be enough to drive locally isolated fisher populations extinct (Powell 1979).

Refugia can play an important role in the survival of *Martes* by providing an unexploited population from which dispersers may stock adjacent lands (de Vos 1951, Quick 1953, Weaver 1993). Unexploited core habitats may function as islands within a metapopulation and dispersers can provide opportunities for harvest as well as demographic support for populations on the periphery of occupied habitat.

Information available on the size and distribution of fisher populations in Montana is scarce; so, prudent management strategies for fisher will be conservative. Forests managed with fisher in mind will provide a high degree of connectivity, especially along riparian corridors, between mature forest types and will maintain large trees and snags, dense multistoried canopies, and a mosaic of habitat patches (Heinemeyer and Jones 1994). Populations can sustain some harvest mortality, but given the species' vulnerability to incidental trapping harvest quotas should be minimal.

Translocations can be an effective conservation tool, but they are by no means a panacea. Introductions of *Martes* have been successful in establishing and augmenting populations (Berg 1982, Proulx et al. 1994, Slough 1994), but translocations in western North America have meet with mixed results. It remains unclear to what degree habitats in Montana supported fisher historically and fisher distribution here may have always been patchy. The translocation of British Columbia fisher into the Selway-Bitterroot appears to be the most successful of efforts conducted in Montana and Idaho, but this conclusion is confounded by presence of native fisher. Releases in the Swan and Cabinet Ranges established populations, whose prospects for long-term survival remain uncertain.

To maximize the success of fisher introductions we suggest that a thorough feasibility study is initiated before releasing individuals. Introduced animals should be drawn from source populations in British Columbia, which are most similar genetically and ecologically to Montana populations. Midwestern fishers (*M.p. pennanti*) are genetically distinct from British Columbia fisher (*M.p. columbiana*) and have introduced novel haplotypes into Montana. While, it appears that populations in northwest and west-central Montana have not mixed, we are unable to determine the degree to which hybridization has, or has not occurred, and warn against the future introduction of genetically distinct subpopulations into the state.

Records from previous translocations show that some fishers were injured during transport to Montana (Newby 1960). Every effort should be made to minimize transport time and injury to individuals. Measures should be taken to minimize trapping mortality in recently introduced populations; closure of fisher trapping following translocation is important to allow populations to become established (Weckworth and Wright 1968, Berg 1982, Kohn et al. 1993). Translocations are expensive and all practical measures should be taken to ensure the survival of introduced animals and subsequent success of the effort. One option to reduce trapping mortality among introduced fisher is the use of a marten trap modified to exclude fisher (Weir et al. 2003).

The success of any translocation effort depends to a large degree on careful planning and consideration of all factors involved. It is essential to determine the habitat suitability of the target area prior to any introduction. Good fisher habitat will have plenty of structure, little snow, and a diverse and productive prey base. Slough (1994) found that the habitat quality of the target area and number of animals released were the most important predictors of success in marten translocations. Successful fisher translocations will provide quality habitat (Banci 1989), sex ratios that favor females (Berg 1982), and use summertime releases (Proulx et al. 1994). We recommend against leaving food at release sites because of the potential to draw in predators.

Adequate monitoring and evaluation of translocations post-release is vital to the success of future introductions. Translocations can be an effective tool, but are always a gamble- it is the responsibility of managers to maximize the probability of success by carefully considering all factors involved.

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