Winter habitat selection and population status of pine marten in southwest Montana
by Quentin John Kujala

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University

Abstract:
The pine marten (Martes americana) has been considered as an indicator species for old growth forests. A study of marten habitat use in southwest Montana in 1991-92 indicated that marten utilized old growth timber but also utilized younger but mature stands of native conifers. Mesic conditions, size of deadfall, well-developed canopy covers associated with mature trees, and pine marten prey were important habitat variables influencing pine marten use of an area. Fur trapper returns and comments suggested that pine marten populations on the study areas were at relatively low numbers during the study. Trappers responded to these low marten numbers by decreasing trapping effort at the Big Hole site but not at West Yellowstone. Untrapped areas adjacent to study sites evidently served as reservoirs for restocking trapped areas. Most of the marten on the trapped study sites were live-trapped and/or harvested, but immigration continued throughout the study, evidently from reservoir areas.

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ABSTRACT

The pine marten (Martes americana) has been considered as an indicator species for old growth forests. A study of marten habitat use in southwest Montana in 1991-92 indicated that marten utilized old growth timber but also utilized younger but mature stands of native conifers. Mesic conditions, size of deadfall, well-developed canopy covers associated with mature trees, and pine marten prey were important habitat variables influencing pine marten use of an area. Fur trapper returns and comments suggested that pine marten populations on the study areas were at relatively low numbers during the study. Trappers responded to these low marten numbers by decreasing trapping effort at the Big Hole site but not at West Yellowstone. Untrapped areas adjacent to study sites evidently served as reservoirs for restocking trapped areas. Most of the marten on the trapped study sites were live-trapped and/or harvested, but immigration continued throughout the study, evidently from reservoir areas.

INTRODUCTION

The United States Forest Service (USFS) has attempted to develop management models which rely on indicator species in order to gauge the ecological health of forests on federal lands (Warren 1989). The pine marten (Martes americana), often associated with mesic (spruce/fir) as well as old growth situations (Buskirk et al 1989b), is under consideration as an indicator of healthy old growth forests.

The Montana Department of Fish, Wildlife, and Parks (MDFWP) is charged with management of Montana’s furbearer populations. As attacks on trapping methods, seasons, and the concept of trapping increase at local, state, national, and international levels, MDFWP is under increasing pressure to demonstrate that its furbearer management policies do not place pine marten and other species in jeopardy. Untrapped reservoirs (deVos 1951, Quick 1956), timing of trapping (Quick 1956), and intensity of trapping (Archibald and Jessup 1984) have all been suggested as important factors to consider when setting harvest regulations for pine marten.

This project was initiated to gather information that would allow the USFS and MDFWP to manage the pine marten in southwest Montana. My study represents the second in a 3-year series of studies. Field work was conducted between September 1990 and August 1991. Objectives for the study were to: 1) describe population characteristics for the study areas; 2) evaluate the impact of current harvest levels on populations; 3) describe marten habitat use patterns; 4) document relationships between pine marten and their seasonal prey bases in different habitat types; and 5) determine the relative population densities of local marten populations in southwest Montana.

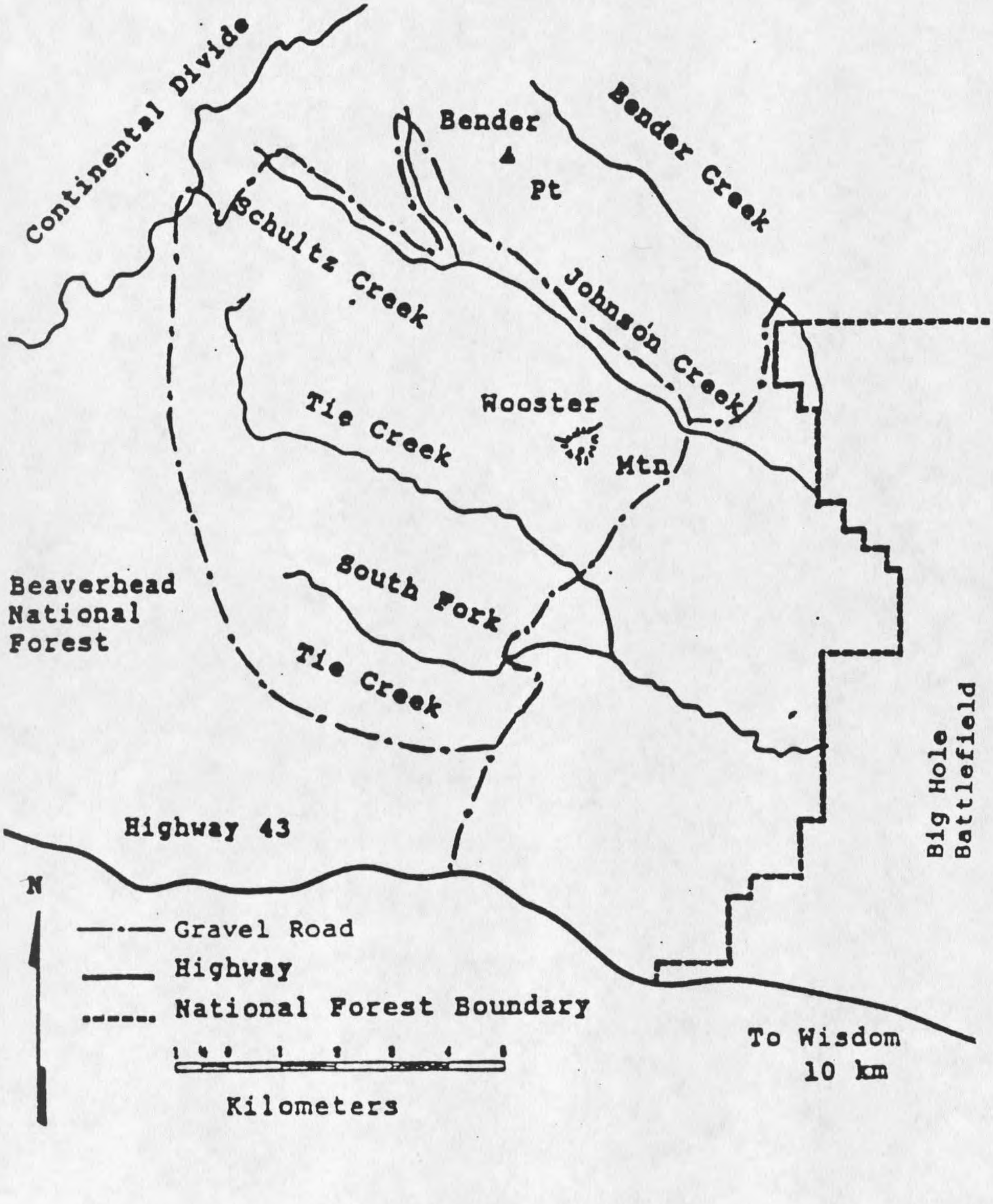
STUDY AREAS

Three study areas representing a range of habitat variables and land use patterns in southwest Montana were selected.

Big Hole

The upper Big Hole study area, on the Wisdom district of the Beaverhead National Forest, encompassed approximately 153 square kilometers (km^2) of the Anaconda mountain range adjacent to and immediately south of the Continental Divide (Fager 1991). The southern edge was essentially the north boundary of the Big Hole National Battlefield. Major drainages included Tie, Bender, Johnson, and Schultz Creeks (Fig. 1).

Figure 1. Boundaries and drainage patterns on the Big Hole study area (reprinted from Fager 1991).



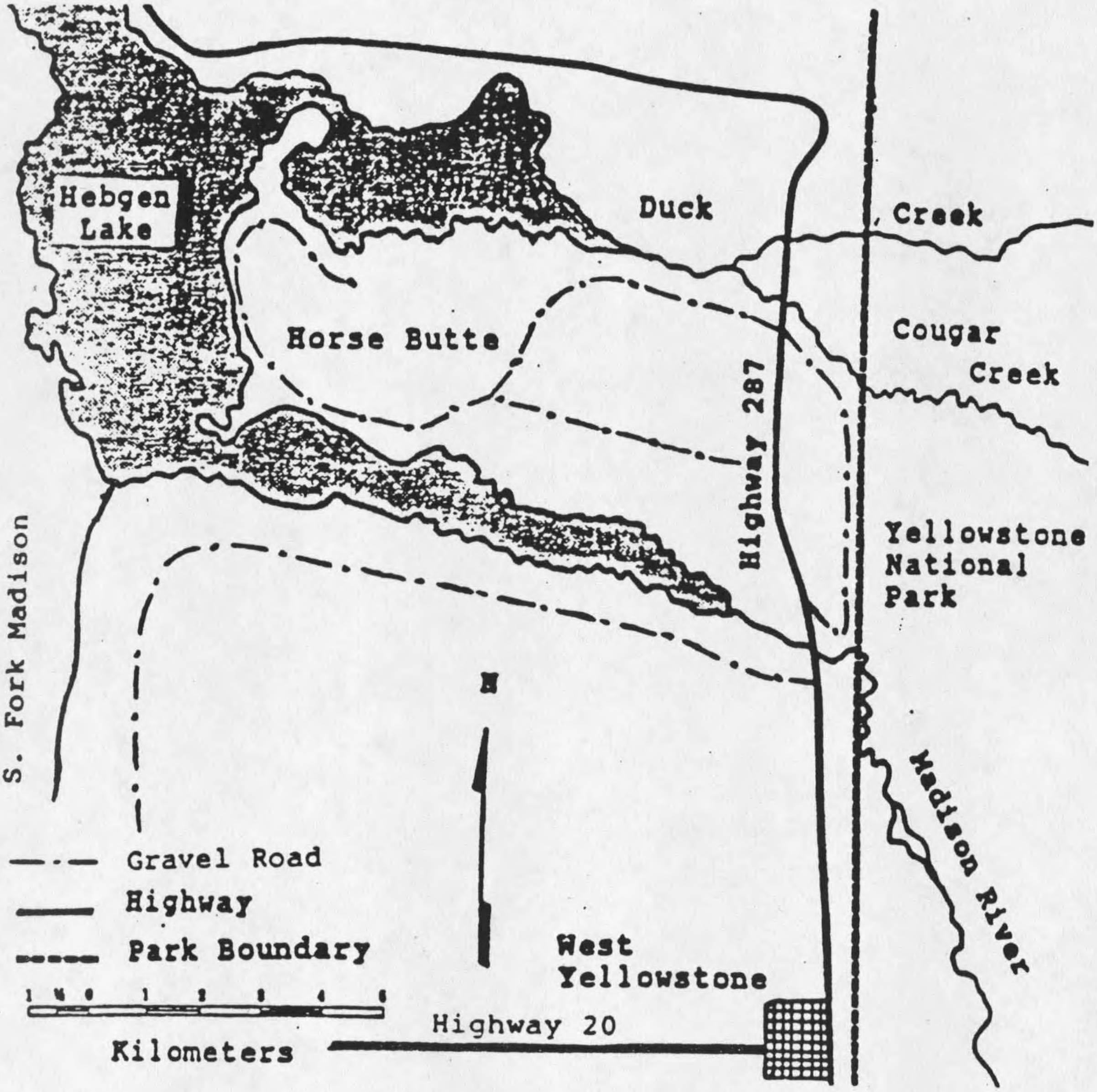
Elevation in this study area ranged from approximately 1,950 to 2,500 meters (m). Precipitation in nearby Wisdom averages 30 centimeters (cm) with an average January temperature of -10.3 C and an average July temperature of 14.4 C (Fager 1991). Dominant tree species on the Big Hole study area were lodgepole pine (Pinus contorta) and Douglas-fir (Pseudotsuga menzesii) in the lower elevations with Engelmann spruce (Picea engelmanni) and subalpine fir (Abies lasiocarpa) dominating the wetter bottoms and higher elevations.

Logging activity, primarily clear-cutting, had occurred throughout the study site. At the time of the study, approximately 15% of the area had been cut. The oldest clearcuts had been cut late in the 1950’s with new cuts occurring during the study.

Flats

The second study site was located near West Yellowstone. The 64 km^2 West Yellowstone Flats area was situated on the Hebgen Lake Ranger District of the Gallatin National Forest directly west and north of the town of West Yellowstone. The boundaries were Hebgen Reservoir to the west and north, Highway 20 to the south, and Yellowstone National Park to the east (Fig 2). A minimal amount of work was conducted inside the park itself. Cougar Creek and the Madison River were the major drainages on the study area.

Figure 2. Boundaries and drainage patterns on the Flats study area (reprinted from Fager 1991).



The mean elevation of this study area was approximately 2,000 m. The highest point was Horse Butte at 2,120 m. Precipitation averages 56.7 cm in West Yellowstone with an average January temperature of -11.3 C and an average July temperature of 15.6 C (Fager 1991).

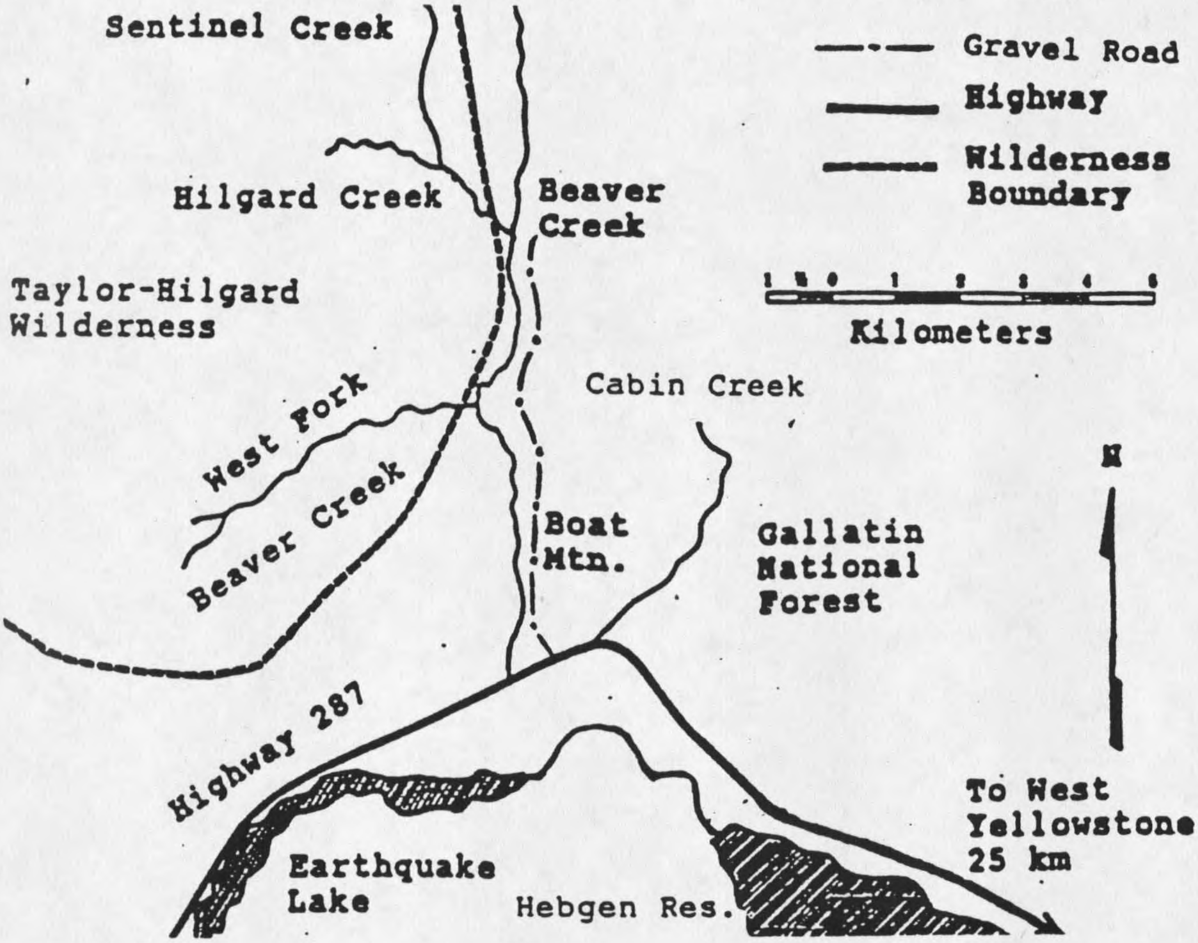
The main cover type on the West Yellowstone Flats was a rather unique lodgepole pine/bitterbrush (Purshia tridentata) community. The north side of Horse Butte was the only area with Douglas-fir and subalpine fir components. Willow (Salix spp.) communities were scattered throughout the study area along perennial streams.

Major land uses during 1990-91 included firewood gathering, recreational uses, and some logging. At the time of the study, approximately 37% of the area had been clear-cut. Logging began in the late 1950's. Some logging operations continued during the study. The Yellowstone fires of 1988 did not burn through the study area although portions of the Park just inside the Park boundary did burn extensively.

Beaver Creek

The third site, also located on the Gallatin National Forest, was across Hebgen Reservoir and 14 km northwest of the Flats study site (Fig. 3). The Beaver Creek study area consisted of approximately 32 km^2 along Beaver Creek. It was unroaded except for one 7.5-km road in the drainage. The topography of the Beaver Creek study area was much steeper than the other study areas. Much of the west side of the drainage was within the Lee Metcalf Wilderness. Elevations ranged from approximately 2,000 to 2,800 m.

Figure 3. Boundaries and drainage patterns on the Beaver Creek study area (reprinted from Fager 1991).



Spruce and subalpine fir dominated the creek bottom and much of the steep valley sides. Douglas-fir was common. Lodgepole pine occurred in successional stands of Douglas-fir and subalpine fir habitat types.

Land uses included logging and recreation. Logging was limited to several clearcuts on the east side of the drainage. Approximately 6% of the area was clear-cut at the time of the study. Big game hunting and hiking/camping were the dominant recreational activities.

METHODS

Live-trapping

Beginning in September 1990, marten were live-trapped with single-door Tomahawk live traps (15.2 cm x 15.2 cm x 45.7 cm and 17.8 cm x 17.8 cm x 53.3 cm). Trapping was conducted alternately at the Big Hole, Flats, and Beaver Creek study areas. This trapping effort was continued until March 2, 1991 on the Big Hole study area, mid-May 1991 on the Flats study area, and mid-February 1991 on the Beaver Creek study area. Access to traps was gained from roads or snowmobile trails although some could be reached only after a walk of 1-2 km. Baits (antelope, deer, elk hide/meat, fish, fowl, jams, and suet) and scents (cinnamonaldehyde, annis, and sable oil) were used to attract martens to traps. All traps were covered with deadfall and/or evergreen boughs and checked daily.

All captured marten were lightly anesthetized (0.1-0.4 cc/marten) with ketamine hydrochloride (100 mg/ml). Usually, the animal was awake and its blinking reflex unimpaired during handling. Ophthalmic ointment was applied in most cases as a precaution. Most of the marten were mobile within 5-10 minutes of handling.

All marten were classified by sex and as juvenile or adult based on sagittal crest development (Marshall 1951). Eartags were placed on all marten. Radio transmitters (AVM

Instrument Co., Livermore, CA or Telonics, Mesa, AZ) were placed on 18 of 31 captured marten. These collars had a projected life of 7-9 months and transmitted in the 148 mgHz frequency range. They were not equipped with a mortality signal.

Home Ranges and Daily Movements

Marten home ranges were determined using the minimum convex polygon technique (Mohr 1947) and the computer program TELDAY (Lonner and Burkhalter 1992). Location points used in home range calculation included point locations from ground searches, triangulation locations, and locations obtained from fixed-wing aircraft.

In an effort to index marten movement, daily straight line distances between locations were calculated from UTM coordinates of locations. Only locations from consecutive days were utilized.

Small Mammal Live-trapping

In an effort to determine the availability of small mammals as food in all study areas across several habitat types, Sherman live traps baited with peanut butter and rolled oats were placed in different cover types in the fall of 1990 just before winter snow cover and again in the spring of 1991 after snowmelt. The traps were set in a single line of 50 or 2 parallel lines of 25. Each trap was placed approximately 5 m from the last trap. The traps were kept open for 3 consecutive nights and checked every morning. Animals were identified to species and toe-clipped for future identification.

There were 3 different trap sites during the fall on the Big Hole study area. Included were a dry lodgepole pine upland site, a spruce/fir creek bottom, and a recent clearcut with little regeneration over 50 cm. The same 3 sites were trapped in the spring as well as a higher elevation spruce/fir/beargrass (Xerophyllum tenax) site.

There were 4 sites trapped on the West Yellowstone Flats during the fall of 1990. The first was a lodgepole pine/bitterbrush upland site. Other sites included a known marten foraging site in a dry lodgepole depression lacking bitterbrush, a recent clearcut very similar in structure to the clearcut on the Big Hole study area, and a wet bottom near the Madison River (once an actual bed of the river). These 4 sites were trapped again in the spring as well as a site on the north side of Horse Butte (at the approximate center of a marten home range).

No sites were trapped on the Beaver Creek study area during the fall of 1990 but a line was established and trapped on the floodplain itself during the spring effort.

Habitat Evaluation Using Radio Telemetry Locations

Site characteristics at all confirmed marten locations flagged during September 1990 to August 1991 were measured during May to August 1991. Data collected in 1991 followed procedures developed in 1990 by Fager (1991) for marten locations and random plots. In an effort to determine use and availability of habitat features, random plots measured by Fager (1991) on the Big Hole study area were compared to Big Hole marten locations from the 1990-91 field season. I was unable to measure sets of random plots near radio-collared animals on the Flats or in Beaver Creek due to time constraints.

Fager's procedure was based on a modified timber stand exam procedure (United States Department of Agriculture 1985). Tree density on a variable radius plot was determined using a basal area factor of 20. Tree species and diameter at breast height (DBH) were recorded for every tree in the variable radius plot. Age was determined by coring the largest tree of every species on the plot. A 20-m transect running due east from plot center was used to evaluate the number and size of deadfall intercepts. Habitat type (Pfister et al. 1977) was determined at every site. In addition to these standard USFS measurements, I declared a site either mesic or xeric according to Warren (1989) and counted total snags >12.7 cm DBH within a 0.04 ha plot (Fager 1991). All locations were classified as old growth or non-old growth using Forest Service old growth criteria (Table 28, Appendix).

Habitat Evaluation Using Long (3-8 km) Track Transects

Four long (3-8 km) track transects, 1 in the upper Big Hole and 3 near West Yellowstone, were established and examined 3-5 times each over the winter. The intent was to compare habitat characteristics at track locations with the same habitat characteristics at sites placed at even intervals (0.2 km) along the transect. Measurements taken at marten track locations and at 0.2-km intervals included number of trees on a variable plot using a 20 basal area factor, DBH of the largest tree, number of snags in a 0.04 ha plot, number of deadfall interceptions on a 20 m line, diameter of the largest deadfall intercept, and habitat type.

The Lily Lake trail in the upper Big Hole (4 km) ran from a sagebrush (<u>Artemesia</u> spp.)/Douglas-fir community at approximately 1,950 m to a spruce/subalpine fir habitat type along the lake shore at 2,200 m. The Tepee Creek transect near West Yellowstone ran along Little Tepee Creek at elevations of 2,160 to 2,400 m. It began in a relatively dry Douglas-fir/lodgepole pine zone and graded into a predominately subalpine fir/whitebark pine (<u>Picea glauca</u>) zone. The second long transect in the West Yellowstone area, Specimen Creek, ran 4 km into Yellowstone Park. This covered a mixture of lodgepole pine and subalpine fir. Elevation ranged from 2,100 to 2,250 m. The third transect, Cougar Creek, ran for 2.9 km east into Yellowstone Park. It ran through a lodgepole cover type and stayed at a constant elevation of approximately 2,000 m.

Population Monitoring Using Short (1 km) Track Transects

A set of 1-km transects was established at each study site (5 on the Wisdom study area, 4 on the West Yellowstone Flats, and 4 on the Beaver Creek study area) in 1989-90 (Fager 1991). I examined each transect for tracks 12-48 hours after a snowfall. These transects were run in an effort to determine the efficiency of track transects as a marten density index (Thompson et al. 1989).

RESULTS

Live-trapping

Fifteen animals were live-trapped from September 1990 to March 1991 in the Big Hole (Table 1). Seven were live-trapped from September 1990 to May 1991 on the Flats and 9 from September 1990 to February 1991 in Beaver Creek. Two adult males and 2 adult females were live-trapped in Beaver Creek after the trappers had moved out of the area as was 1 juvenile male on the Flats. The majority of animals on all 3 study sites were classified as adult. Females outnumbered males on the Big Hole and Flats study areas (Table 1). Chi-square analysis revealed no significant differences ($p>0.05$) with respect to age and sex composition between seasons, sites, and years (1989-90 results from Fager 1991).

Table 1. Results of live-capture and radio-collaring efforts on the 3 study areas.

Age/sex group	Big Hole	Flats	Beaver Creek
Adult males	5 (3)*	1 (1)	5 (4)
Adult females	4 (1)	3 (2)	2 (2)
Juvenile males	2 (2)	2 (2)	0 (0)
Juvenile females	4 (0)	1 (1)	2 (0)
Total	15 (6)	7 (6)	9 (6)

* The number of radio-collared individuals are given in parentheses.

There were several seasonal and spatial differences in live-trapping success rates (Table 2). Chi-square analysis suggested significant differences ($p<0.05$) between fall trapping success on the Big Hole and Flats (chi-square=4.40, df=1, p=0.036), fall trapping success in Beaver Creek and on the Flats (chi-square=4.40, df=1, p=0.036), winter trapping success on the Big Hole and in Beaver Creek (chi-square=7.17, df=1, p=0.0075), and winter success in Beaver Creek and on the Flats (chi-square=4.87, df=1, p=0.027). No significant differences ($p>0.05$) existed between years (1989-90 data from Fager 1991) with respect to live-trapping success rates.

Table 2. Seasonal success rates (trap nights per marten) of live-trapping efforts on the 3 study areas.

Study area	Total marten caught	Fall success rates (September -November)	Winter success rates (December -March)	Overall success rates
Big Hole	15	103	254	133
Flats	7	456	199	283
Beaver Ck.	9	93	50	74

Fur-trapping

Flats

Four trappers were active on the Flats study area. Some trappers ran lines with up to 7 traps per km while other trappers had single traps set in 1 or 2 places along the highway that could be checked daily with little effort.

Of the 6 marten that were live-trapped on the Flats before and during the trapping season, 2 were harvested by trappers (Table 3). Both of the harvested marten were juveniles, 1 male and 1 female. Total trapper harvest was 7 marten. The 2 marked marten represented 29% of the total harvest. A simple Peterson index estimate (using numbers of animals marked and harvested) of the marten population on the 64 km^2 study area would be 21 animals during the trapping season (assuming no ingress or egress).

Table 3. 1990-91 harvest of marked and unmarked marten on the Flats and Beaver Creek.

Study area	Marten harvested	Marked marten	Marked marten harvested	% of harvest
Flats	7	6 (1AM, 3AF, 1JM, 1 JF)*	2-3 (1JM, 1JF, poss. 1AF)	29-43%
Beaver Creek road	6 (4M, 2F)	4 (3AM, 1JF)	3-4 (3AM, 0-1JF)	50-67%
Beaver Creek trail	9	1 (1JF)	0-1 (0-1JF)	0-11%

* M=male, F=female, AM=adult male, AF=adult female, JM=juvenile male, JF=juvenile female.

The female that was identified as having been live-trapped was harvested 5.4 km from her live-capture site. I was unable to accurately identify trap locations of the other marked marten due to insufficient trapper return data. Sex ratio of the harvest was not accurately reported.

Beaver Creek

The Beaver Creek study area was trapped by 2 trappers. One trapper ran a trapline with 9 traps per km along the entire roaded portion of the drainage. The second trapper placed 7 traps per km along 4.2 km of trail starting at the end of the road.

Of the 4 marten that had been marked along the roaded portion of Beaver Creek before the trapping season (Table 3), the 3 adult males were harvested. A total of 6 marten were harvested along the roaded portion of Beaver Creek.

The 3 marked marten made up 50% of the harvest. Peterson index estimates based on these numbers were 8 in the roaded portion of the drainage. Distances between live capture points and harvest points for the 3 males were 1.4, 1.6, and 0.6 kilometers. Chi-square analysis revealed no significant differences ($p>0.05$) between the composition of males and females in the Beaver Creek harvests of 1989-90 (Fager 1991) and 1990-91.

One juvenile female was eartagged along the trail in the unroaded portion of the drainage prior to the trapping season (Table 3). Nine marten were legally harvested in this area (Table 3). The trapper did not accurately report sex ratios or condition of the ears on harvested marten so it is not known if the juvenile female was harvested.

Home Ranges and Daily Movements

Over half of the radios malfunctioned or disappeared from the study areas before adequate numbers of locations for home range calculations could be collected. Home ranges and consecutive day movements were calculated for 7 marten with 225 total locations (Table 4). Consecutive day movements tended to increase as home range size increased ($r=0.88$, $p<0.05$). The number of resting sites used more than once also appeared to be related to home range size (Table 4). A negative relationship between home range size and repeat rest locations was found ($r=-0.9533$, $p<0.05$).

Table 4. Home ranges and movements of radio-collared marten on the Big Hole, Flats, and Beaver Creek study areas.

	Consecutive day movements	Area (km^2)	ratio of repeat to total rest locations
Big Hole adult male 636	2.2 km (n=12)	8.5 (n=26)	6:21 (29%)
Big Hole adult female 261	1.4 km (n=14)	8.8 (n=25)	2:8 (25%)
Big Hole juvenile male 221	2.25 km (n=11)	9.7 (n=27)	5:20 (25%)
Big Hole juvenile male 613	1.0 km (n=20)	3.3 (n=35)	13:26 (50%)
Flats adult female 587	0.5 km (n=33)	1.3 (n=58)	19:37 (51%)
Beaver Creek adult female 280	1.1 km (n=21)	6.9 (n=41)	13:31 (42%)
Flats adult female 528	0.7 km (n=1)	1.7 (n=13)	6:10 (60%)

Small Mammal Live-trapping

Big Hole

Small mammal trapping during the fall at 3 sites on the Big Hole study area (150 trap nights/site) resulted in captures of 8 animals of 3 species (Table 5). Total rodent capture success was 1.8 captures/100 trap nights (Table 6) while red-backed vole (Clethrionomys gapperi) capture success was 1.3 captures/100 trap nights (Table 7).

Spring trapping (150 trap nights at each of 4 sites) resulted in captures of 22 animals representing 3 species. There were no recaptures of animals originally caught during the spring effort. Total rodent capture success was 3.7 captures/100 trap nights while red-backed vole capture success was 0.7 captures/100 trap nights. During both fall and spring, red-backed voles were most frequently captured at the more mesic sites.

Table 5. Small mammal trapping results from the Big Hole study area, 1990-91.

	Dry lodgepole pine	Spruce/fir riparian	Clearcut	Spruce/fir /beargrass
Fall (11/1/90-11/4/91)	1 DM *	5 RBV	1 RBV, 1 MP	not trapped
Spring (6/14/91-6/17/91)	1 GM, 1 RBV	1 RBV, 3 YP	6 YP	2 RBV, 8 YP

* DM=deer mouse (<u>Peromyscus maniculatus</u>), RBV=red-backed vole (<u>Clethrionomys gapperi</u>), MP=mountain phenacomys (<u>Phenacomys intermedius</u>), GM=golden-manteled ground squirrel (<u>Citellus lateralis</u>), and YP=yellow pine chipmunk (<u>Eutamias amoenus</u>).

Table 6. Total rodent trapping success rates (captures/100 trap nights) during fall and spring on the Big Hole, Flats, and Beaver Creek study areas.

Study area	Fall success	Spring success	Total success
Big Hole	1.8	3.7	2.9
Flats	9.0	8.9	9.0
Beaver Creek	not trapped	9.3	9.3

Table 7. Red-backed vole (Clethrionomys gapperi) trapping success rates (captures/100 trap nights) during fall and spring on the Big Hole, Flats, and Beaver Creek study areas.

Study area	Fall success	Spring success	Total success
Big Hole	1.3	0.7	1.0
Flats	0.3	1.3	0.9
Beaver Creek	not trapped	2.7	2.7

Flats

Small mammal trapping on the Flats produced captures of 54 animals representing 4 species during the fall effort (150 trap nights at each of 4 sites) (Table 8). The total rodent capture rate was 9.0 captures/100 trap nights (Table 6) while the red-backed vole capture rate was 0.3 captures/100 trap nights (Table 7).

The spring effort (150 trap nights at each of 5 sites) resulted in captures of 67 animals representing 4 species. There were 18 recaptured deer mice. The total rodent capture rate was 8.9 captures/100 trap nights. The red-backed vole capture rate was 1.3 captures/100 trap nights. Red-backed voles were most abundant on the more mesic sites with deer mice being captured at all sites except on Horse Butte.

Table 8. Small mammal trapping results from the Flats, 1990-91.

	Lodgepole pine/bitter brush	Lodgepole pine dry bottom	Clearcut	Lodgepole pine wet bottom	Douglas-fir/subalpine fir
Fall (10/25/90-10/28/90)	13 DM *	10 DM, 2 RBV, 1 S	24 DM, 1 YP	1 DM, 2 S	not trapped
Spring (5/23/91-5/26/91)	9 DM (5 recap.), 4 YP	13 DM (3 recap.), 1 YP	18 DM (9 recap.), 5 YP	2 DM (1 recap.), 2 S, 3 YP	10 RBV

* DM=deer mouse (*Peromyscus maniculatus*), RBV=red-backed vole (*Clethrionomys gapperi*), YP=yellow pine chipmunk (*Eutamias amoenus*), and S=shrew (*Sorex* sp.)

Beaver Creek

Small mammal trapping in Beaver Creek (done only from 5/23/91 to 5/26/91 with 150 trap nights at 1 site) produced 10 deer mice and 4 red-backed voles. Total rodent capture success was 9.3 captures/100 trap nights (Table 6). Red-backed vole capture success was 2.7 captures/100 trap nights (Table 7). The trap site, as was most of the Beaver Creek study area, was predominately mesic.

Differences between total rodent capture success rates existed in the fall between the Big Hole and Flats (chi-square=21.68, df=1, $p<0.01$), in spring between the Big Hole and Flats (chi-square=13.24, df=1, $p<0.01$) and in spring between the Big Hole and Beaver Creek (chi-square=7.42, df=1, $p<0.01$). Differences between red-backed vole capture success rates were not apparent ($p>0.05$) except during the spring between the Big Hole and Beaver Creek (chi-square=4.40, df=1, p=0.04).

Habitat Evaluation Using Radio Telemetry Locations

Radio-collared animals produced too few locations in areas sampled by random point sets on the Flats and in Beaver Creek for habitat characteristics use and availability analysis. I, therefore, limited habitat use evaluation to the Big Hole study area.

Live Tree Numbers and Sizes

When data for all Big Hole study area marten were combined, there were more subalpine fir (t=2.36, p<0.01) and spruce (t=4.56, p<0.01) on marten location plots and fewer lodgepole (t=2.97, p<0.01) than there were in random plots (Table 9). Subalpine fir (t=3.61, p<0.01) and Engelmann spruce (t=2.37, p<0.01) at marten locations were significantly larger than fir and spruce trees in random plots (Table 10).

Table 9. Mean (SD) numbers of live trees >12.7 cm DBH at random plots and all marten locations on the Big Hole study area.

	Aver. number of live subalpine fir >12.7 cm	Aver. number of live Engelmann spruce >12.7 cm	Aver. number of live lodgepole pine >12.7 cm	Aver. number of live Douglas-fir >12.7 cm
Big Hole random points (n=110)	0.9 (1.5)	1.0 (2.3)	2.7 (2.4)	0.4 (1.2)
Big Hole marten locations (n=113)	1.4 * (1.9)	2.7 * (3.5)	1.8 * (1.9)	0.5 (1.5)

* indicates a difference between marten locations and random points at the 0.03 level of significance.

Table 10. Mean (SD) diameters of live trees >12.7 cm DBH at random plots and all marten locations on the Big Hole study area.

	Aver. dia. of live subalpine fir >12.7 cm	Aver. dia. of live Engelmann spruce >12.7 cm	Aver. dia. of live lodgepole pine >12.7 cm	Aver. dia. of live Douglas-fir >12.7 cm
Big Hole random plots	23.0 (7.9) (n=97)	40.7 (13.0) (n=104)	22.5 (10.7) (n=299)	39.8 (22.9) (n=42)
Big Hole marten locations	27.8 * (11.6) (n=156)	46.2 * (19.2) (n=308)	23.2 (6.8) (n=206)	34.8 (14.5) (n=61)

* indicates a difference between marten locations and random plots at the 0.03 level of significance.

The 4 individual marten located frequently enough for individual analysis varied with respect to tree number and size. One adult male on the Big Hole study area, 636, used sites that had larger ($t=1.97$, $p<0.03$) and more subalpine fir ($t=3.00$, $p<0.01$), more spruce ($t=6.55$, $p<0.01$), and fewer lodgepole pine ($t=3.10$, $p<0.01$) than total random plots (Tables 11 and 12). Locations used by 261, an adult female, had larger ($t=2.07$, $p<0.03$) and more subalpine fir ($t=2.81$, $p<0.01$) and larger ($t=2.45$, $p<0.01$) and more spruce ($t=4.62$, $p<0.0005$) and fewer lodgepole pine ($t=2.58$, $p<0.01$) than total random plots. Marten 221, a juvenile male, did not use sites that differed significantly from total random sites with respect to sizes and numbers of different tree species. A second juvenile male, 613, used plots with larger subalpine fir ($t=3.68$, $p<0.01$) and spruce trees ($t=5.00$, $p<0.01$) and more Douglas-fir ($t=3.27$, $p<0.01$) than was found on random plots. This pattern was influenced by a site used at least 9 different times that had one large spruce 89.7 cm in diameter.

Table 11. Mean (SD) numbers of live trees >12.7 cm DBH at random plots and individual marten locations on the Big Hole study area.

	Aver. number of live subalpine fir >12.7 cm	Aver. number of live Engelmann spruce >12.7 cm	Aver. number of live lodgepole pine >12.7 cm	Aver. number of live Douglas-fir >12.7 cm
Random plots (n=110)	0.9 (1.5)	1.0 (2.2)	2.7 (2.4)	0.4 (1.3)
Adult male 636 (n=25)	2.0 * (2.1)	7.4 * (8.6)	1.1 * (1.7)	trace
Adult female 261 (n=24)	1.9 * (2.1)	3.6 * (3.7)	1.3 * (1.9)	trace
Juvenile male 221 (n=26)	0.5 (1.0)	1.6 (3.2)	3.0 (2.0)	0.7 (1.6)
Juvenile male 613 (n=33)	1.5 (2.1)	1.8 (2.4)	2.0 (1.8)	1.4 * (2.1)

* indicates a difference between marten locations and random plots at the 0.03 level of significance.

Table 12. Mean (SD) diameters of live trees >12.7 cm DBH at random plots and individual marten locations on the Big Hole study area.

	Aver. dia. of live sub-alpine fir >12.7 cm	Aver. dia. of live Engelmann spruce >12.7 cm	Aver. dia. of live lodgepole pine >12.7 cm	Aver. dia. of live Douglas-fir >12.7 cm
Random plots	23.0 (7.9) (n=97)	40.7 (13.0) (n=104)	22.5 (10.7) (n=299)	39.8 (22.9) (n=42)
Adult male 636	25.7 * (7.6) (n=49)	43.1 (14.6) (n=92)	25.2 (6.0) (n=28)	unknown
Adult female 261	26.4 * (10.9) (n=43)	45.6 * (14.6) (n=87)	25.6 (7.5) (n=32)	unknown
Juvenile male 221	23.2 (6.8) (n=13)	35.9 (15.3) (n=41)	20.9 (6.1) (n=77)	39.0 (15.1) (n=17)
Juvenile male 613	29.3 * (12.8) (n=50)	56.4 * (27.1) (n=60)	24.1 (7.0) (n=67)	34.3 (16.0) (n=45)

* indicates a difference between marten locations and random plots at the 0.03 level of significance.

Deadfall and Snag Numbers and Sizes

In comparisons of random plots and all marten locations, deadfall >23 cm in diameter (t=2.18, p<0.03), all snags >12.7 DBH (t=4.09, p<0.01), and snags >23 cm DBH (t=3.63, p<0.01) were more abundant at marten locations (Table 13). The average diameter of deadfall at marten locations was significantly greater than the diameter of deadfall at random plots (t=3.14, p<0.01).

Table 13. Mean (SD) numbers of snags and deadfall at random plots and all marten locations on the Big Hole study area.

	Aver. number of snags >23 cm	Aver. number of snags >12.7 cm	Aver. number of deadfall intercepts >7.6 cm	Aver. number of deadfall intercepts > 23 cm	Aver. dia. of deadfall intercepts >7.6 cm
Big Hole random plots	0.4 (0.8) (n=111)	3.1 (2.4) (n=110)	5.7 (3.5) (n=111)	0.9 (1.2) (n=111)	15.7 (5.1) (n=106)
Big Hole marten locations	1.0 * (1.6) (n=113)	4.8 * (3.9) (n=113)	4.9 (4.0) (n=113)	1.2 * (1.4) (n=113)	18.0 * (4.7) (n=83)

* indicates a difference between marten locations and random plots at the 0.03 level of significance.

Locations of individual marten varied in deadfall and snag numbers and sizes. The locations for marten 636 had more snags >12.7 cm DBH than Big Hole random plots ($t=5.04$, $p<0.01$) (Table 14). Marten 261 used sites where deadfall >23 cm in diameter ($t=2.76$, $p<0.01$) and snags >12.7 DBH ($t=4.56$, $p<0.01$), and snags >23 cm DBH ($t=7.04$, $p<0.01$) were more abundant than they were at random plots. Deadfall intercepts on marten 261's locations were larger than intercepts at random plots ($t=1.98$, $p<0.03$). Marten 221 used sites that did not appear to differ from random plots with respect to sizes and numbers of deadfall and snags. Sites used by 613 had fewer deadfall intercepts >7.6 cm in diameter ($t=5.47$, $p<0.01$) but more snags >12.7 DBH ($t=4.09$, $p<0.01$) and more snags >23 cm DBH ($t=2.45$, $p<0.01$) than random plots did. The average deadfall diameter at marten 613's locations was larger than that at random plots (t=4.02, p<0.01).

Table 14. Mean (SD) numbers of snags and deadfall at random plots and individual marten locations on the Big Hole study area.

	Aver. number of snags >23 cm	Aver. number of snags >12.7 cm	Aver. number of deadfall intercepts >23 cm	Aver. number of deadfall intercepts >7.6 cm	Aver. dia. of deadfall intercepts >7.6 cm
Random plots	0.4 (0.8) (n=111)	3.1 (2.4) (n=110)	0.9 (1.2) (n=111)	5.7 (3.4) (n=111)	15.7 (5.1) (n=106)
Adult male 636	0.8 (1.1) (n=25)	5.9 * (3.5) (n=25)	1.3 (1.3) (n=25)	6.5 (4.8) (n=25)	17.3 (4.3) (n=24)
Adult female 261	2.3 * (2.1) (n=24)	6.3 * (5.6) (n=24)	1.7 * (1.5) (n=24)	6.0 (3.8) (n=24)	18.1 * (6.1) (n=23)
Juvenile male 221	0.4 (0.5) (n=26)	2.4 (2.5) (n=26)	1.0 (1.3) (n=26)	4.7 (3.1) (n=26)	17.6 (3.5) (n=25)
Juvenile male 613	0.9 * (1.5) (n=33)	5.0 * (2.5) (n=33)	1.1 (1.4) (n=33)	2.3 * (2.2) (n=33)	12.0 * (5.2) (n=30)

* indicates a difference between marten locations and random plots at the 0.03 level of significance.

Habitat Type Use versus Availability

In comparisons of plot information from random points and all marten locations, all habitat types were used in proportion to availability except for the mesic subalpine fir type (Table 15). This type was used more than expected.

Table 15. Numbers of marten locations and random points in different habitat types on the Big Hole study area. Values outside 91% Bonferroni confidence intervals were considered selection for or against any specific type.

	Mesic subalpine fir	Xeric subalpine fir	Lodgepole pine	Spruce	Douglas-fir	Scree
Random points (n=116)	13	68	11	4	15	5
Total locations (n=155)	51(+)*	71	9	5	15	4
Adult male 636 (n=25)	14(+)	11	0(-)	0	0(-)	0
Adult female 261 (n=24)	14(+)	10	0(-)	0	0(-)	0
Juvenile male 221 (n=26)	5	14	5	0	1	1
Juvenile male 613 (n=33)	5	24	1	0	3	0

* (+) indicates apparent selection while (-) indicates apparent avoidance or nonuse.

When locations for individual marten were compared to all random points (Table 15), 2 of the marten selected mesic subalpine fir while avoiding lodgepole pine and Douglas-fir. The other 2 marten used all habitat types in proportion to their availability.

Mesic versus Xeric Sites

For Big Hole marten locations, the locations classified as mesic had more Engelmann spruce ($t=6.81$, $p<0.01$) and fewer lodgepole pine ($t=5.15$, $p<0.01$) (Table 16) as well as larger lodgepole pine ($t=2.00$, $p<0.03$) than locations in more xeric habitat types (Table 17). At Big Hole mesic random plots, there were more ($t=9.00$, $p<0.01$) and larger ($t=2.69$, $p<0.01$) Engelmann spruce and larger lodgepole pine ($t=2.62$, $p<0.01$) (Tables 18 and 19) than at random plots at dry sites.

Table 16. Mean (SD) numbers of live trees > 12.7 cm DBH at mesic and xeric marten locations on the Big Hole study area.

	Aver. number of live subalpine fir trees >12.7 cm	Aver. number of live Engelmann spruce trees >12.7 cm	Aver. number of live lodgepole pine trees >12.7 cm
Mesic marten locations (n=43)	1.6 (1.6)	5.1 (4.1)	0.7 (1.4)
Xeric marten locations (n=70)	1.3 (2.1)	1.3 * (1.9)	2.5 * (1.9)

* indicates a difference between mesic and xeric marten locations at the 0.03 level of significance.

Table 17. Mean (SD) diameters of live trees >12.7 cm DBH at mesic and xeric marten locations on the Big Hole study area.

	Aver. dia. of live subalpine fir >12.7 cm	Aver. dia. of live Engelmann spruce >12.7 cm	Aver. dia. of live lodgepole pine >12.7 cm
Mesic marten locations	26.8 (9.9) (n=68)	45.6 (15.8) (n=220)	25.4 (6.7) (n=32)
Xeric marten locations	26.9 (11.3) (n=93)	47.8 (24.8) (n=88)	22.8 * (6.8) (n=174)

* indicates a difference between mesic and xeric marten locations at the 0.03 level of significance.

Table 18. Mean (SD) numbers of live trees >12.7 cm DBH at mesic and xeric random plots on the Big Hole study area.

	Aver. number of live subalpine fir >12.7 cm	Aver. number of live Engelmann spruce >12.7 cm	Aver. number of live lodgepole pine >12.7 cm
Mesic random plots (n=18)	1.4 (1.8)	4.3 (3.9)	1.7 (2.6)
Xeric random plots (n=93)	0.8 (1.3)	0.3 * (0.8)	2.9 (2.4)

* indicates a difference between mesic and xeric random plots at the 0.03 level of significance.

Table 19. Mean (SD) diameters of live trees >12.7 cm DBH at mesic and xeric random plots on the Big Hole study area.

	Aver. dia. of live subalpine fir >12.7 cm	Aver. dia. of live Engelmann spruce >12.7 cm	Aver. dia. of live lodgepole pine >12.7 cm
Mesic random plots	21.3 (6.2) (n=26)	42.7 (12.9) (n=77)	24.4 (6.8) (n=31
Xeric random plots	23.4 (8.4) (n=70)	35.1 * (11.8) (n=27)	21.7 * (5.2) (n=269)

* indicates a difference between mesic and xeric random plots at the 0.03 level of significance.

Deadfall/snag data indicated that the only difference between mesic and xeric Big Hole marten locations was the greater number of 12.7+ cm snags at mesic sites ($t=3.87$, $p<0.01$) (Table 20). Mesic Big Hole random plots differed from their xeric counterparts in that average deadfall size was greater at mesic sites ($t=2.38$, $p<0.01$) (Table 21).

Table 20. Mean (SD) numbers of snags and deadfall at mesic and xeric marten locations on the Big Hole study area.

	Aver. number of snags >23 cm	Aver. number of snags >12.7 cm	Aver. number of deadfall intercepts >7.6 cm	Aver. number of deadfall intercepts >23 cm	Aver. dia. of deadfall intercepts >7.6 cm
Mesic marten locations	1.3 (1.8) (n=43)	6.5 (4.4) (n=43)	5.3 (4.4) (n=43)	1.2 (1.3) (n=43)	18.2 (5.7) (n=41)
Xeric marten locations	0.8 (1.3) (n=70)	3.8 * (3.1) (n=70)	4.7 (3.8) (n=70)	1.3 (1.4) (n=70)	18.3 (4.2) (n=67)

* indicates a difference between mesic and xeric marten locations at the 0.03 level of significance.

Table 21. Mean (SD) numbers of snags and deadfall at mesic and xeric random plots on the Big Hole study area.

	Aver. number of snags >23 cm	Aver. number of snags >12.7 cm	Aver. number of deadfall intercepts >7.6 cm	Aver. number of deadfall intercepts >23 cm	Aver. dia. of deadfall intercepts >7.6 cm
Mesic random plots (n=18)	0.4 (0.6)	3.3 (1.9)	5.3 (3.2)	1.4 (1.5)	18.3 (8.1)
Xeric random plots (n=93)	0.4 (0.9)	3.0 (2.4)	5.7 (3.5)	0.8 (1.1)	15.2 * (4.2)

* indicates a difference between mesic and xeric random plots at the 0.03 level of significance.

Old Growth Use versus Availability

Seventy-one percent of all marten locations on the Big Hole study area were at sites classified as old growth using USFS criteria (Table 28, Appendix). When Big Hole random plots were compared to all Big Hole marten locations, marten were located in old growth situations more frequently than expected (Table 22). Two of 4 individual marten selected old growth conditions (Table 22).

Table 22. Number of locations that met old growth minimum criteria on the Big Hole study area. Selection was determined using 91% Bonferroni confidence intervals.

	Old growth	Total locations
Randoms points	52	109
Marten locations	69 *	97
Adult male 636	21 *	25
Adult female 261	21 *	24
Juvenile male 221	9	26
Juvenile male 613	18	32

* indicates apparent selection.

Habitat Evaluation Using Long (3-8 km) Track Transects

Lily Lake Transect (4 km)

Long transects produced results similar to those obtained via radio telemetry. The track location plots on the Lily Lake long transect had more total live trees >12.7 cm DBH (t=4.01, p<0.01), larger trees (t=2.43, p<0.01), more snags >12.7 cm DBH (t=4.39, p<0.01), and bigger deadfall (t=2.67, p<0.01) than the nontrack locations (Table 23). On the Lily Lake trail, xeric subalpine fir was preferred while Douglas-fir cover types appeared to be avoided (Table 23).

Table 23. Mean (SD) numbers of trees, snags, and deadfall and habitat type use and availability on the Lily Lake long (4 km) track transect.

Variable	Nontrack (n=31)	Track (n=9)
Aver. number of trees per plot >12.7 cm	5.9 (4.2)	12.6 * (5.2)
Aver. dia. of biggest tree on plot (cm)	52.6 (20.7)	73.8 * (30.1)
Aver. number of snags per plot >12.7 cm	1.4 (2.3)	5.1 * (2.1)
Aver. number of deadfall intercepts per plot >7.6 cm	1.9 (2.1)	3.8 (3.7)
Aver. dia. of biggest deadfall intercept per plot (cm)	24.4 (8.4)	33.4 * (10.6)
Meadow	1	0
Mesic subalpine fir	2	3
Xeric subalpine fir	7	6 +
Douglas fir	21	0 −

* indicates a difference between track and nontrack locations at the 0.03 level of significance while (+) indicates selection and (−) indicates avoidance.

Tepee Creek Transect (8 km)

The plots at track locations on the Tepee Creek transect had larger trees ($t=3.11$, $p<0.01$) and more deadfall intercepts >7.6 cm in diameter ($t=2.33$, $p<0.03$) than the nontrack plots (Table 24). Mesic subalpine fir was selected on the Tepee Creek transect while lodgepole pine was avoided (Table 24).

Table 24. Mean (SD) numbers of trees, snags, and deadfall and habitat use and availability on the Tepee Creek long (8 km) track transect.

Variable	Nontrack (n=26)	Track (n=55)
Aver. number of trees per plot >12.7 cm	5.4 (3.3)	6.2 (3.3)
Aver. dia. of biggest tree on plot (cm)	11.9 (5.0)	15.7 * (5.2)
Aver. number of snags per plot >12.7 cm	9.4 (10.7)	9.7 (7.8)
Aver. number of deadfall intercepts per plot >7.6 cm	1.7 (1.9)	2.8 * (1.9)
Aver. dia. of biggest deadfall intercept per plot (cm)	19.7 (7.0)	21.9 (6.7)
Mesic subalpine fir	4	22 +
Xeric subalpine fir	11	31
Lodgepole pine	8	1 -
Douglas-fir	3	1

* indicates a difference between track and nontrack locations at the 0.03 level of significance while (+) indicates selection and (-) indicates avoidance.

Specimen Creek Transect (4 km)

The only difference between track and nontrack plots on the Specimen Creek long transect was more snags >12.7 cm DBH on the track plots (t=2.47, p<0.01) (Table 25). On the Specimen Creek transect, xeric subalpine fir was selected while meadows were avoided (Table 25).

Table 25. Mean (SD) numbers of trees, snags, and deadfall and habitat use and availability on the Specimen Creek long (4 km) track transect.

Variable	Nontrack (n=26)	Track (n=16)
Aver. number of trees per plot >12.7 cm	4.9 (3.3)	6.3 (2.6)
Aver. dia. of biggest tree on plot (cm)	42.2 (10.2)	42.8 (6.7)
Aver. number of snags per plot >12.7 cm	4.0 (3.6)	6.7 * (3.2)
Aver. number of deadfall intercepts per plot >7.6 cm	2.7 (4.0)	4.4 (3.6)
Aver. dia. of biggest deadfall intercept per plot (cm)	19.9 (5.2)	19.9 (6.4)
Mesic subalpine fir	4	2
Xeric subalpine fir	9	14 +
Spruce	1	0
Douglas-fir	1	0
Willow	2	0
Meadow	9	0 -

* indicates a difference between track and nontrack locations at the 0.03 level of significance while (+) indicates selection and (-) indicates avoidance.

Cougar Creek Transect (3 km)

Plots at track locations on the Cougar Creek long transect had larger trees (t=3.08, p<0.01) and more deadfall intercepts >7.6 cm in diameter (t=2.49, p<0.01) than the nontrack locations (Table 26). This transect ran through a homogeneous lodgepole pine/bitterbrush cover type.

Table 26. Mean (SD) numbers of trees, snags, and deadfall on the Cougar Creek long (3 km) track transect.

	Aver. number of trees per plot >12.7 cm	Aver. dia. of biggest tree on plot (cm)	Aver. number of snags per plot >12.7 cm	Aver. number of deadfall intercepts per plot >7.6 cm	Aver. dia. of biggest deadfall intercept on plot (cm)
Non-track n=19	3.3 (2.8)	25.3 (6.7)	no data	0.7 (1.1)	15.2 (8.5)
Track n=21	4.7 (2.9)	32.1 * (7.2)	no data	1.9 * (1.9)	20.1 (5.4)

* indicates a difference between track and nontrack locations at the 0.03 level of significance.

Population Monitoring Using Short (1 km) Track Transects

Statistical analysis of short (1 km) track transect results (Table 27) revealed only 1 difference between transects within study areas. Transect 2 differed from transect 4 on the Beaver Creek study area ($t=2.27$, $p<0.05$). Statistical analysis of short track transect results between study areas suggested only 1 statistical difference. The Big Hole and Beaver Creek transects produced different results ($t=3.32$, $p<0.01$) (Table 27).

Table 27. Results of short (1 km) track transects on the three study areas.

Transect ID	Aver. (SD) number of tracks/12 hr period following snowfall	Number of trials
Big Hole Transect 1	0.5 (0.8)	14
Big Hole Transect 2	0.3 (0.5)	12
Big Hole Transect 3	0.3 (0.5)	11
Big Hole Transect 4	0.1 (0.3)	11
Big Hole Transect 5	0.1 (0.1)	10
Flats Transect 1	0.3 (0.5)	4
Flats Transect 2	0.5 (0.7)	4
Flats Transect 3	0.7 (1.3)	4
Flats Transect 4	0.5 (1.0)	4
Beaver Creek Transect 1	0.3 (0.6)	3
Beaver Creek Transect 2	0.2 (0.3)	3
Beaver Creek Transect 3	1.3 (0.9)	2
Beaver Creek Transect 4	2.2 (1.5)	3
Big Hole Total	0.3 (0.5)	58
Flats Total	0.5 (0.9)	16
Beaver Creek Total	1.0 (1.2)	11

DISCUSSION

Impacts of Fur-trapping

Fur-trappers killed more marten than I live-trapped in the Flats and Beaver Creek study sites. Although this could be due to several factors such as different baits and lures and possibly greater efficiency of harvest/removal traps (as opposed to live-capture traps), I believe experience, higher trap densities, marten removals due to harvest efforts, and perhaps timing were the most influential factors. I trapped predominately in the fall while fur-trappers were active in December and January.

Hawley and Newby (1957) noted that trapping success was best during the winter when food was least available for martens. They also noted that marten were more likely to move into vacant areas than areas occupied by marten. Zielinski et al. (1983) and Lensink et al. (1955) felt that movement increased as food for martens decreased (winter). Removal trapping may create openings that encourage immigration which provides more marten for trapping (Quick 1956). The combination of winter conditions and harvest removals may explain the high winter live-trapping success on the trapped Flats and Beaver Creek as opposed to the higher fall success on the untrapped Big Hole study area (Table 2).

Of the 2 sites I studied that were trapped (Beaver Creek and the Flats), marked marten made up the lowest percentage of the total harvest in the area that had the least security and the poorest habitat, the Flats (Table 3). Although survival and resident marten density were low in the Flats, populations were supplemented by immigration from neighboring Yellowstone National Park. The high Peterson index estimate (compared to live-capture and fur-trapping results) is invalid due to the incorrect assumption of no egress or ingress.

Much of the discussion on maintaining marten populations has been based on the idea of maintaining core areas that are not trapped and consequently act as source areas for outlying population sinks (de Vos 1951, Quick 1956). Marten are capable of moving long distances through suitable habitat, but refuges are more effective if they are close to sinks (de Vos 1951). Judging from the distances traveled by collared marten and home range sizes, trappers with traps up to 5 km from a source area may encounter marten that spend at least part of their time in the reservoir area. Quick (1956) felt that the minimum average diameter of a foraging range for marten was 1 km. In clearcut forests, this distance may increase (Soutiere 1979).

Home Ranges

The home ranges of 1990-91 were generally consistent with 1989-90 home ranges (Fager 1991). The extremes Fager and I found, 3.25 (1990-91 field data) and 19.1 km^2 (1989-90 field data-Table 4) were within extremes reported in the literature (Raine 1982, Buskirk and McDonald 1989).

Three of 4 Big Hole marten (1AM, 1JM, and 1 AF) had ranges of approximately 9 km^2. One juvenile male had a home range of 3.25 km^2. This male's home range was the only one that did not include any clearcuts within its boundaries. The other home ranges touched and/or surrounded 1 or more clearcuts. Soutiere (1979) commented that home range increased in clearcut forests. If a minimum amount of foraging area is needed with any given prey density, removal of blocks of foraging area via clearcuts may result in larger total home range size.

Small Mammal Live-trapping

Red-backed voles favored the mesic sites favored by marten in areas I trapped (Tables 5 and 8). Red-backed vole capture success rates were highest in Beaver Creek (Table 7) where marten live-capture success rates (Table 2) were also high. Koehler and Hornocker (1977) reported that microtines made up 79% of the prey of marten and that this prey base was most abundant in mesic situations. Murie (1961) also reported high vole use. Dulkiet (1929 cited in Lensink et al. 1955) felt that home range size was influenced by food as did Thompson and Colgan (1987). Corn and Raphael (1992) believed marten selected areas based on prey availability.

Habitat Use

Pine martens may select specific sites based on plant species or species groups, prey availability, habitat structural conditions, or all three (Douglass et al 1983). Marten in my study preferred mesic sites with large downfall and well developed canopy cover (associated with large live trees and no clearcuts).

Clearcuts were not used by marten on my study areas. Soutiere (1979) and Steventon (1979) both reported low use of clearcuts. Steventon and Major (1982) reported little use of regenerating clearcuts. Yeager (1950) reported some use of clearcuts by marten during the summer.

All of the preferred habitat classifications had relatively high vegetative productivity and my limited small mammal trapping efforts indicated they had relatively high small mammal numbers. Corn and Raphael (1992) felt that marten were capable of determining the presence or absence of prey with casual investigations of openings in the snow. Marten presumably could also key in on physical or vegetative features that either were associated with high prey density or high prey vulnerability.

There are several possible candidates for visual cues. If, as some other studies suggest (Steventon and Major 1982, Buskirk et al. 1989b.), subnivean forage sites and dens are important for both forage and rest activities, then entrances to those subnivean sites may be such a visual cue. Large pieces of deadfall may act as access points (Buskirk et al 1989b, Corn and Raphael 1992). Since all marten locations (mesic and xeric) had similar sizes and amounts of deadfall (Table 20) while random plots did not (Table 21), martens may be keying in on the bigger deadfall (Table 13) or at least the access points the big deadfall may represent. Preference for wetter sites (Table 15) is an artifact of this selection.

Another visual cue could be snags. The importance of snags (an associated trait of old growth though not necessarily tied to age) to marten, other than as a source for deadfall, is questionable. Neither Fager (1991) nor I saw evidence of strong preference for areas with abundant snags in southwest Montana. Spencer (1987) reported that snags were used more than availability suggested in the northern Sierra Nevadas. Martin and Barret (1983) reported 23% of their marten rest sites were in snags. Ground locations (under snow), red squirrel (<u>Tamiascurus hudsonicus</u>) nests, and broomed needle casts in live trees were important rest sites during my field season. Wynne and Sherbourne (1984) found considerable use of witches' brooms while Buskirk (1983) reported red squirrel grass nest use.

Population Monitoring

The short track transects were established to determine if track counts reflected marten density (Thompson et al. 1989). Live-trapping results and trapper harvest suggested that Beaver Creek had the highest density followed in order by the Big Hole and the Flats (Tables 2 and 3). Short transect results suggested that Beaver Creek had the highest density with no difference between the Big Hole and the Flats (Table 35). A single marten is quite capable of utilizing any 1-km piece of ground. Transects this short may, in effect, merely be sampling for the presence or absence of a single marten along that 1-km distance. If that single marten crosses and recrosses the transect line, the procedure of assuming every track is a different marten is incorrect.

Many of the high transect counts were from transects running parallel to creek bottoms. If marten are attracted to mesic situations (Table 15), then those transects placed in mesic situations will have more tracks of marten (possibly the same marten). It may be best to stay away from creek bottoms (or cross at right angles) to eliminate multiple counts of the same animal and to increase transect length to better differentiate between low track intercept counts. If 1-km transects are used, they should be checked for the presence or absence of marten rather than the number of track crossings.

Peterson index estimates of marten populations using live-capture and harvest results may or may not be accurate. In sink situations with rapid turnovers of individual marten due to harvest removal and/or egress and ingress, the estimates obtained using this method may be too high. In situations of good quality habitat and large numbers of resident marten, the Peterson index method may be an accurate procedure.

CONCLUSIONS

Population Characteristics

Live and fur-trapping indicated sex and age ratios within ranges reported for healthy marten populations. Home range sizes also were consistent with normal marten populations

Evaluation of Fur Harvest

Trapping in 1990-91 certainly removed individuals from my 3 study areas, but some marten remained in each area after harvest efforts. Fur-trapping does appear to have the ability to locally influence pine marten populations. In areas with low accessibility and/or those near untrapped reservoirs, ingress should quickly fill losses due to trapping. In years or areas of low marten numbers and high fur demand (price), those areas with considerable trapper access potential and low reservoir recruitment potential could definitely experience excessive harvest.

Trappers want to maintain a way of life that is very much under scrutiny by some parts of the non-trapping public. They should expect to monitor themselves, their effort, and their catch. Accurate age data may be difficult to ascertain from trappers, but accurate sex data and the location of harvest sites can only help the MDFWP in continued monitoring and maintenance of marten trapping.

Description of Habitat Use Patterns

In my study areas, the pine marten was often associated with, but was not an absolute indicator of, old growth. Old growth situations were often preferred habitat, but the presence of marten may not necessarily indicate old growth or undisturbed sites. The marten appears to be moderately flexible with respect to habitat demands and habits.

Martens in southwest Montana consistently avoided clearcuts up to 30-40 years old. Fall-winter habitat in southwest Montana can best be catagorized as mature sites (large trees and large deadfall) with a tendency towards the more mesic sites associated with spruce/fir communities. Lodgepole pine and Douglas-fir should not be considered nonmarten habitat. The lodgepole dominated Flats were successfully used by some marten. Lodgepole appears to be merely suitable as opposed to preferred. Whether or not old growth monocultures (i.e. when regrowth on clearcuts produces large diameter trees) will provide adequate habitat in southwest Montana remains to be seen. My study areas did not have any clearcuts with regrowth much past the post/pole size.

Prey Base Relationships

Limited trapping indicated rodent population density was not directly correlated with marten habitat. Species of rodents vary in susceptibility to marten. Red-backed vole density appears to be a better indicator than total rodent density.

Population Monitoring

Marten population levels in my study areas were evidently influenced by timber management, fur-trapping, accessibility of areas to trappers, and small mammal composition and abundance. With so many variables and with our inability to regulate many of those variables, monitoring at the microsite level may not be the best approach. If monitoring is needed, it should include systems such as long track transects to monitor the presence or absence of the species at the drainage or landscape level rather than looking for marten in specific "marten sites".

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APPENDIX

Table 28. Summary of USFS old growth criteria.

Old growth type	SAF type	Habitat type groups	Large tree age	Trees per acre > minimun DBH (cm)
#1	Douglas-fir	A	200	4>43.2
#2	Douglas-fir	B,C,D,E,F,H	200	5>48.3
#3	Douglas-fir	G	180	10>43.2
#4	Ponderosa pine	A,B,C,K	180	4>43.2
#5	Limber pine	A,B	120	6>22.9
#6	Lodgepole pine	A,B,C,D,E,F,G,H,I	150	12>25.4
#7	Engelmann spruce	C	160	12>43.2
#8	Subalpine fir, Engelmann spruce	D,E	160	7>43.2
#9	Subalpine fir, Engelmann spruce	F,G,H,I	160	10>33.0
#10	Subalpine fir, Engelmann Spruce	J	135	8>33.0
#11	Whitebark pine	D,E,F,G,H,I	150	11>33.0
#12	Whitebark pine	J	135	7>33.0