Population characteristics and winter habitat selection by pine marten in southwest Montana
by Kenneth Wesley Coffin

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 Montana Department of Fish, Wildlife, and Parks and the U.S. Forest Service lacked site specific ecological data on which to base management decisions concerning pine marten in southwest Montana. This study, conducted during 1991 and 1992, was the last of 3 studies which began in 1989 to document population characteristics and habitat selection of pine marten in two areas of southwest Montana. Age and sex data from fur trappers catches was obtained to determine the effects of harvest on marten populations. Marten were radiocollared during the fall of 1991, and located using radio telemetry during the winter of 1991-1992. Marten locations were compared to random points to determine habitat selection. Habitat variables were divided into large, medium, and small scale categories. Small mammal trapping was conducted to determine the influence of small mammals in habitat selection of pine marten. Rest site structure was also noted. Juvenile marten outnumbered female marten 3:1 in harvested samples from Mosquito Gulch and Beaver/Tepee Creeks. Trappers regarded the 1991-1992 season as good, with catches being higher than the previous two years. Habitat use at the largest scale, involved all forested cover types but marten showed preference for mesic subalpine fir and lodgepole pine on the Big Hole study area. Sites with old growth characteristics were used less than expected on the Big Hole study area, but were sought out by marten on the Flats study area. On a medium scale, marten preferred areas with a higher basal area than that found at random points. At the smallest scale, marten locations were characterized by higher numbers of live trees and by a higher percent grass cover when compared to random points. Small mammal captures were not evenly distributed across habitats on the Big Hole or Flats study areas. Marten selected sites that were characterized by high densities of rodents. Marten utilized downed woody material in both areas for resting, but most rest episodes occurred in the tree canopy in red squirrel grass nests. Although pine marten in this study selected traits associated with mature forests they were found to be flexible with regard to habitat use on forested sites.

POPULATION CHARACTERISTICS AND WINTER HABITAT SELECTION BY PINE MARTEN IN SOUTHWEST MONTANA

by

KENNETH WESLEY COFFIN

A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Fish and Wildlife Management

MONTANA STATE UNIVERSITY
Bozeman, Montana

May 1994

APPROVAL

of a thesis submitted by

Kenneth Wesley Coffin

This thesis has been read by each member of the thesis comittee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

24 May 94
Date

Lynn R. Folz
Co-Chairperson, Graduate Committee

May 24, 1994
Date

Richard J. Douglass
Co-Chairperson, Graduate Committee

Approved for the Major Department

24 May 1994
Date

Robert S. Moore
Head, Major Department

Approved for the College of Graduate Studies

6/28/94
Date

R L Brown
Graduate Dean

STATEMENT OF PERMISSION TO USE

In presenting this thesis in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the Library shall make it available to borrowers under rules of the Library.

If I have indicated my intention to copyright this thesis by including a copyright notice page, copying is allowable only for scholarly purposes, consistent with "fair use" as prescribed in the U.S. Copyright Law. Requests for permission for extended quotation from or reproduction of this thesis in whole or in parts may be granted only by the copyright holder.

Signature Ken W. Eggers

Date MAY 24, 1994

ACKNOWLEDGMENTS

This project would not have been possible without the financial and technical assistance of the U.S. Forest Service, Montana Department of Fish, Wildlife, and Parks and Montana State University.

Jeff Jones and various staff members of the Wisdom Ranger District provided logistical support. Claude Coffin, Ron Nabor, J.T. Stangl, and Susan Lamont of the Hebgen Lake Ranger District also provided logistical support in addition to constructive discussion.

Kurt Alt and Mike Frisina took time to discuss project matters and provided equipment when needed. Howard Hash flew needed telemetry flights. Keith Aune, Phil Schladweiler and Kevin Frey were very helpful with scat analysis and providing harvest statistics. A special note of thanks goes to Al Harmata for providing telemetry equipment during all years of the study. Bill Semmens deserves thanks for his efforts trapping small mammals. Craig Fager and Quentin Kujala I thank for their early contributions to the project and their thoughts concerning pine marten ecology. Roland Whitman deserves thanks for his continued interest and support during all phases of this project.

I would like to thank Dr. Lynn Irby and Dr. Rick Douglass for their continued interest and technical advice. Also, I would like to thank Dr. Harold Picton and Dr. Thomas McMahon for their comments regarding thesis preparation.

Lastly, I wish to thank my parents, Claude and Karen Coffin, for their constant support and encouragement.

TABLE OF CONTENTS

Page

ACKNOWLEDGMENTS....................iv

TABLE OF CONTENTS....................v

LIST OF TABLES....................vii

LIST OF FIGURES xii

ABSTRACT....................xiii

INTRODUCTION....................1

STUDY AREAS....................3

- Upper Big Hole....................3
- West Yellowstone Flats....................5
- Mosquito Gulch....................6
- Beaver Creek....................7

METHODS....................9
- Livetrapping....................9
- Fur Trapping....................10
- Marten Locations....................11
- Home Range Determination....................11
- Population Monitoring....................12
- Habitat Evaluation....................12
  - Large Scale Habitat Features....................14
  - Medium Scale Habitat Features....................14
  - Small Scale Habitat Features....................14
- Rest Site Selection and Red Squirrel Midden Association....................15
- Small Mammal Trapping....................15
  - Spring/Fall.... 16
  - Summer....................17

RESULTS....................18
- Livetrapping....................18
- Furtrapping....................19
- Population Densities....................22
- Home Range and Movements....................23
  - Home Range....................23
  - Movements....................25

TABLE OF CONTENTS—Continued

Page

Habitat Evaluation....26
Large Scale Habitat Features....26
Habitat Series....26
Mesic versus Xeric Sites....26
Old Growth Use....27
Medium Scale Habitat Features....29
Trees/Hectare....29
Average Stand Diameter....29
Basal Area....29
Stand Density Index....29
Downed Woody Material....30
Small Scale Habitat Features....30
All Trees....30
Live Trees....32
Snags....35
Sound Downed Woody Material....35
Rotten Downed Woody Material....35
Combined Downed Woody Material....38
Ground Cover....38
Small Mammal Trapping....44
Spring/Fall....44
Summer....45
Rest Site Selection and Red Squirrel Midden Association....52

DISCUSSION....56
Harvest Dynamics....56
Population Monitoring....60
Home Range and Movements....60
Habitat Use....62
Large Scale Features....62
Medium Scale Features....64
Small Scale Features....65
Small Mammal Dynamics....67
Rest Site Selection....69

CONCLUSIONS....72

REFERENCES CITED....75

APPENDICES....80

LIST OF TABLES

Table Page

1. Livetrapping success for fall and winter on the Big Hole, Beaver Creek, Mosquito Gulch, and Flats study areas, 1991-1992....18

2. Sex and relative age structure of livetrapped marten by study area, 1991-1992....19

3. Fur harvest success and trapping effort for the Mosquito Gulch and Beaver Creek study areas, 1991-1992....20

4. Harvest of marked and unmarked marten for the Mosquito Gulch and Beaver Creek study areas, 1991-1992....21

5. Results from winter track transects (tracks/km) for the Big Hole, Beaver Creek, and Flats study areas....23

6. Home range estimates and mean consecutive day movements for radio-collared adult marten on the Big Hole and Flats study areas for winter, spring and all locations combined....24

7. Distances from point of live capture to harvest for 2 marten from the Flats study area and 2 marten from the Big Hole study area. All marten were classified as juvenile males at the time of live-capture....26

8. Habitat series and habitat type distribution for random (n=129) and all marten locations (n=84) for the Big Hole study area. (+) indicates use greater than expected and (-) indicates use less than expected based on 90% Bonferoni confidence intervals....27

LIST OF TABLES—Continued

Table Page

9. Percentage of random, individual marten, and total marten locations designated as mesic or xeric for the Big Hole study area based on soil moisture rating (Warren 1990). (+) indicates use greater than expected and (-) indicates use less than expected based on 90% Bonferoni confidence intervals................27

10. Percentage of random, individual marten, and total marten locations that met old growth minimum criteria on the Big Hole study area. (-) indicates use less than expected based on 90% Bonferoni confidence intervals....................................28

11. Percentage of random, individual marten, and total marten locations that met old growth minimum criteria on the Flats study area. Minimum age criteria was decreased to 100 from 150 years for lodgepole pine. (+) indicates use greater than expected based on 90% Bonferoni confidence intervals.............................28

12. Means for stand density index (SDI), trees/hectare, average stand diameter (ASD) in cm, and basal area (m^2/hectare), for random, individual marten, and total marten locations from the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.....................31

13. Mean downed woody material (metric tons/hectare) for random, individual marten, and total marten locations from the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level......................................32

14. Mean dbh (cm) and mean number of trees, $\geq$ 12.7 cm, for random, individual marten, and combined marten locations where live trees, snags, or both were found for the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level...................................33

LIST OF TABLES—Continued

Table Page

15. Mean dbh (cm) and mean number of live trees, $\geq$ 12.7 cm, for random, individual marten, and combined marten locations where only live trees were found for the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level....................34

16. Mean dbh (cm) and mean number of snags $\geq$ 12.7 cm, for random, individual marten, and combined marten locations where only snags were found for the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level....................36

17. Mean diameter (cm) and mean number of intercepts of sound downed woody material (DWM) $\geq$ 7.6 cm for random, individual marten, and combined marten locations where sound DWM occurred, for the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level....................37

18. Mean diameter (cm) and mean number of intercepts of rotten downed woody material (DWM) $\geq$ 7.6 cm for random, individual marten, and combined marten locations where rotten DWM occurred, for the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level....................39

19. Mean diameter (cm) and mean number of intercepts of combined sound and rotten downed woody material (DWM) $\geq$ 7.6 cm for random, individual marten, and combined marten locations where sound and/or rotten DWM was found for the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level....................40

LIST OF TABLES—Continued

Table Page

20. Mean percent coverage by cover type and frequency of locations in a particular cover type for the Big Hole study area. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level....41

21. Mean percent coverage by cover type and frequency of locations in a particular cover type for the Flats study area. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level....43

22. Observed and expected captures/100 trap nights for total rodents, total deer mice (DM) and total red-backed voles (RBV) for spring/fall (F=fall, S=spring, F/S=fall/spring) small mammal trapping on the Big Hole study area....46

23. Observed and expected captures/100 trap nights for total rodents, total deer mice (DM) and total red-backed voles (RBV) for spring/fall (F=fall, S=spring, F/S=fall/spring) small mammal trapping on the Flats study area....47

24. Minimum number alive, survival, and recriutment from 100 m x 100 m trapping grids for deer mice and red-backed voles on the Big Hole and Flats study areas during July, August and September of 1991 and 1992....48

25. Observed and expected captures for total rodents, total deer mice and red-backed voles for summer small mammal trapping on the Big Hole study area during 1991 and 1992....50

26. Observed and expected captures for total rodents, total deer mice and red-backed voles for summer small mammal trapping on the Flats study area during 1991 and 1992....51

LIST OF TABLES—Continued

Table Page

27. Total deer mouse and red-backed vole biomass (grams) lost from 100 m x 100 m trapping grids in 1991 and 1992 on the Big Hole and Flats study areas................52

28. Percentage of total resting episodes that occurred at a rest site more than one time, for 2 marten from the Big Hole study area and 3 marten from the Flats study area..53

29. Forested habitat types (Pfister et al. 1977) by series, code, scientific, and common name..................82

30. Summary of USFS old growth criteria. (Reprinted from Kujala 1993)................................84

31. Total numbers and species of rodents captured, and captures per 100 trap nights (TN) from small mammal trapping on the Big Hole study area during the fall of 1991 and spring of 1992........................85

32. Total numbers and species of rodents captured, and captures per 100 trap nights (TN) from small mammal trapping on the Flats study area during the fall of 1991 and spring of 1992........................86

33. Total numbers and species of rodents captured, and captures per 100 trap nights (TN) from small mammal trapping grids on the Big Hole and Flats study areas during July, August, and September of 1991 and 1992..87

34. Understory vegetation and relative structural characteristics of spring/fall small mammal trapping areas on the Big Hole study area..................88

35. Understory vegetation and relative structural characteristics of spring/fall small mammal trapping areas on the Flats study area....................88

36. Habitat characteristics of 100 m x 100 m small mammal trapping grids on the Big Hole and Flats study areas...89

LIST OF FIGURES

Figure Page

1. Map of the Big Hole study area, west of Wisdom Montana......4
2. Map of the Flats, Mosquito Gulch, and Beaver Creek study areas..8
3. Sex and age distribution of harvested marten from the Mosquito Gulch study area.........................22
4. Total deer mice and red-backed vole captures from 100 m x 100 m trapping grids from 1991 and 1992.......51
5. Percentage of rest episodes occurring in tree and ground rest sites by month on the Big Hole study area...54
6. Percentage of rest episodes occurring in tree and ground rest sites by month on the Flats study area.........54
7. Percentage of total resting episodes occurring in ground and tree rest sites for the Big Hole (n=64) and Flats (n=110) study areas, and percentage of total rest sites with a squirrel midden present.........55
8. Sex and age distribution of harvested marten from the Beaver Creek study area and Tepee Creek drainage..91
9. Age distribution for harvested marten from all of Montana for the 1988-1989 through the 1991-1992 harvests..92
10. Age distribution for harvested marten from Region 3 for the 1987-1988 through 1992-1993 harvests..93
11. Sex ratios for harvested marten from Region 3.............94
12. Percent of total volume of winter 1991-1992 food items found in stomachs of harvested marten from all of Montana...94

ABSTRACT

The Montana Department of Fish, Wildlife, and Parks and the U.S. Forest Service lacked site specific ecological data on which to base management decisions concerning pine marten in southwest Montana. This study, conducted during 1991 and 1992, was the last of 3 studies which began in 1989 to document population characteristics and habitat selection of pine marten in two areas of southwest Montana. Age and sex data from fur trappers catches was obtained to determine the effects of harvest on marten populations. Marten were radiocollared during the fall of 1991, and located using radio telemetry during the winter of 1991-1992. Marten locations were compared to random points to determine habitat selection. Habitat variables were divided into large, medium, and small scale categories. Small mammal trapping was conducted to determine the influence of small mammals in habitat selection of pine marten. Rest site structure was also noted. Juvenile marten outnumbered female marten 3:1 in harvested samples from Mosquito Gulch and Beaver/Tepee Creeks. Trappers regarded the 1991-1992 season as good, with catches being higher than the previous two years. Habitat use at the largest scale, involved all forested cover types but marten showed preference for mesic subalpine fir and lodgepole pine on the Big Hole study area. Sites with old growth characteristics were used less than expected on the Big Hole study area, but were sought out by marten on the Flats study area. On a medium scale, marten preferred areas with a higher basal area than that found at random points. At the smallest scale, marten locations were characterized by higher numbers of live trees and by a higher percent grass cover when compared to random points. Small mammal captures were not evenly distributed across habitats on the Big Hole or Flats study areas. Marten selected sites that were characterized by high densities of rodents. Marten utilized downed woody material in both areas for resting, but most rest episodes occurred in the tree canopy in red squirrel grass nests. Although pine marten in this study selected traits associated with mature forests they were found to be flexible with regard to habitat use on forested sites.

INTRODUCTION

Information regarding the biology and management of the pine marten (*Martes americana*) throughout its range is abundant, with many studies being completed within the last ten years (Archibald and Jessup 1984, Buskirk 1984, Buskirk and McDonald 1984, Wynne and Sherburne 1984, Bateman 1986, Raine 1987, Spencer 1987, Strickland and Douglas 1987, Thompson and Colgan 1987, Buskirk et al. 1988, Buskirk and McDonald 1989, Buskirk and Harlow 1989, Warren 1989, Fager 1991, Martin and Barrrett 1991, Corn and Raphael 1992, Kujala 1993). But until recently, little was known about the habits and habitat characteristics of the pine marten in southwest Montana. For decades, the only information collected on marten in southwest Montana had been pelt-tagging data from trappers (Fager 1991). Recent studies by Fager (1991) and Kujala (1993) have described habitat selection and harvest dynamics of the marten in this portion of their range.

The United States Forest Service (USFS) is responsible for managing most of the pine marten habitat in southwest Montana. The National Forest Management Act of 1976 mandated each National Forest to select and monitor indicator species. Both the Beaverhead and Gallatin National Forests have selected the pine marten as one of several management indicator species. Ecological uses of vertebrate indicators include using them to assess population trends and habitat quality, then extrapolating this information to other species (Landres et al. 1988). To effectively evaluate the use of the marten as an indicator species in southwest Montana, more information regarding pine marten habitat relationships was needed.

Management of marten populations falls under the jurisdiction of the Montana Department of Fish, Wildlife, and Parks (MDFWP). The primary concern of this agency was the uncertainty of the effects of unlimited harvests of marten over a 2-month season in MDFWP Region 3 (southwest Montana) coupled with habitat alterations mainly in the form of logging.

The USFS and the MDFWP funded a 3-year study to answer questions concerning population characteristics, harvest levels, habitat relationships, prey relationships, and to determine the relative population densities of local marten populations in southwest Montana. These objectives were also included in studies by Fager (1991) and Kujala (1993). Specifically, the objectives of my study, the last in series of 3, were to: 1) determine the effects of harvest activities on local pine marten populations; 2) determine local population densities; 3) determine home range size and movements; 4) determine the influence of large, medium, and small scale features on the habitat selection of pine marten; 5) determine how the abundance and availability of prey influences habitat selection.

STUDY AREAS

Four study areas in southwest Montana were selected for this project. The upper Big Hole study area was located on the Wisdom Ranger district of the Beaverhead National Forest. The West Yellowstone Flats, Mosquito Gulch, and Beaver Creek study areas were located on the Hebgen Lake Ranger district of the Gallatin National Forest. These areas were chosen based on historic pine marten harvests and their proximity to large untrapped areas. Study area selection was also based on representative habitat types.

Upper Big Hole

The upper Big Hole study area (Fig 1) was located 15 km west of Wisdom and immediately northwest of the Big Hole National Battlefield. The study area included 153 square kilometers (km^2) of the Anaconda range in the Beaverhead National Forest. Major drainages include Placer, South Fork of Tie, Tie, Johnson, Shultz and Bender Creeks. The area was bounded by Highway 43 to the south, the Continental Divide to the north and west, and the sagebrush grassland of the upper Big Hole valley to the east (Fager 1991).

Elevation varied between 1,950 and 2,500 meters (m). Annual average precipitation at the town of Wisdom averages 30 centimeters (cm). Average temperature at Wisdom averages 1.7 C (NOAA 1990).

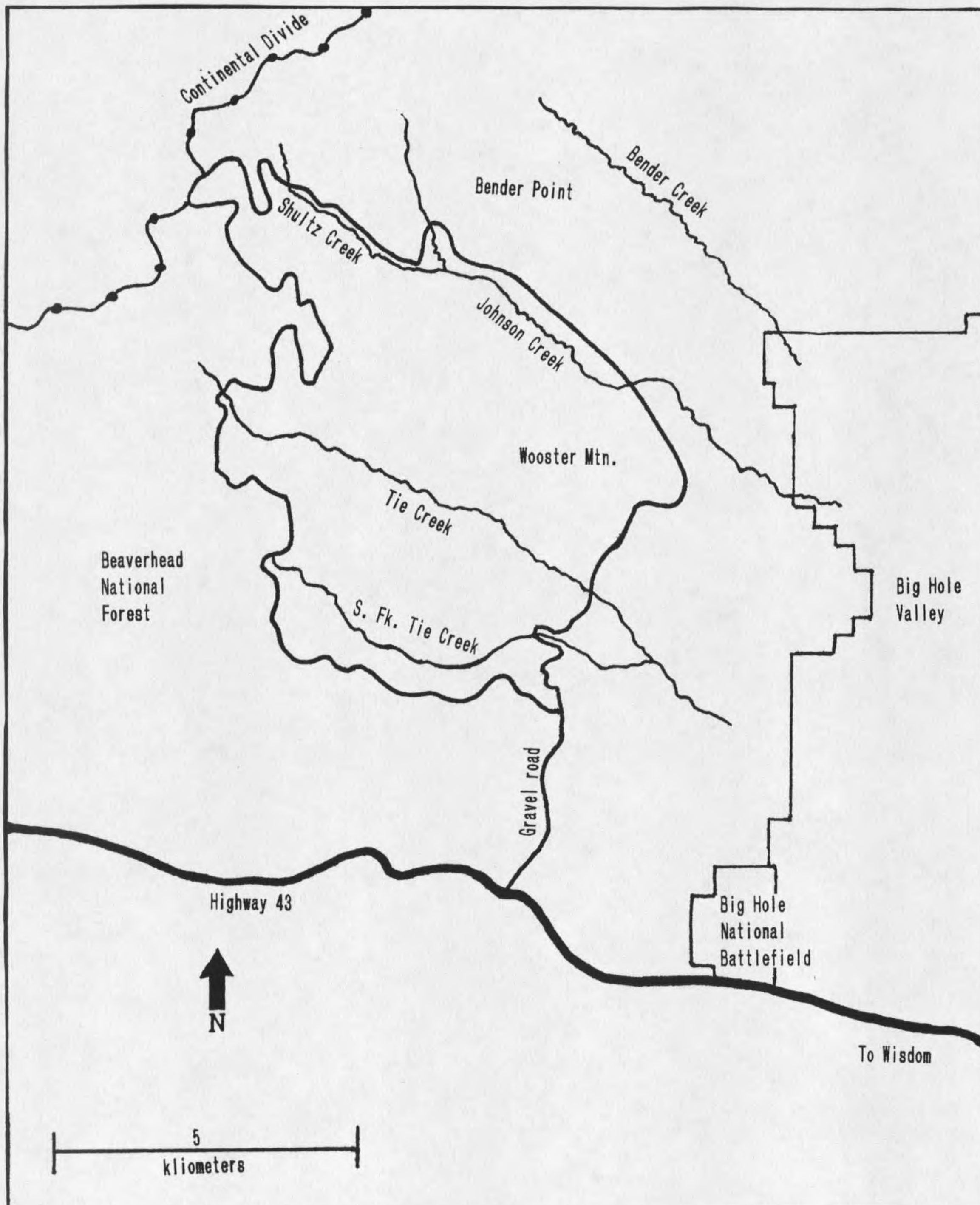

Figure 1. Map of the Big Hole study area, west of Wisdom Montana.

Spruce (*Picea spp.)* and subalpine fir (*Abies lasiocarpa)* habitat types were characteristic of drainage bottoms and higher elevation sites. Drier and lower elevation sites supported lodgepole pine (*Pinus contorta)* and Douglas-fir (*Pseudotsuga menziesii*) habitat types.

Major land uses in the area include logging, livestock grazing and recreation, mainly in the form of hunting and camping during the summer and fall and snowmobiling during the winter. Timber has been harvested on parts of the area since the late 1950's. Clearcut logging and associated road building were widespread in the last 2 decades, and consequently, motorized access to a majority of the study area was good (Fager 1991).

West Yellowstone Flats

The West Yellowstone Flats study area (Figure 2) was located in extreme southern Montana near the town of West Yellowstone on the Gallatin National Forest. Limited areas of Yellowstone National Park were included. The study area was bounded by Duck Creek on the north, Hebgen Lake and the South Fork of the Madison river to the west, Highway 20 to the south and Yellowstone National Park to the east. The Flats study area was situated in a high elevation basin at 2000 m with little topographic relief.

Average temperature for West Yellowstone is 1.6 C. (NOAA 1990). Precipitation in this area occurs primarily as snow and averages 56.7 cm (NOAA 1990).

A lodgepole pine-antelope bitterbrush association (*Purshia tridentata*) was the dominant vegetation in this area. Natural openings and clearcuts supported vegetation cover dominated by grass species. Willow (*Salix spp.*) communities were scattered throughout the area.

Primary land uses were recreation, logging, and firewood cutting. Recreational activities include hunting, fishing and camping during the summer and fall months. Snowmobiling was the dominant winter recreational activity followed by cross country skiing. Large scale timber harvesting has taken place on the study area since the late 1950's. An extensive network of roads and a flat physiographic nature permitted almost unlimited motorized access on the study area. Fur trapping has been intermittent for the last 50 years (Whitman pers. comm.)

Mosquito Gulch

The Mosquito Gulch study area (Figure 2) was located south of the Flats study area. This area was bounded by the South Fork of the Madison river to the east, the Idaho border on the south, Two Top mountain to the west, and the Flats to the north.

The area had a diverse topography, ranging from relatively flat benches to drainages with high topographic relief. Elevation ranged from 2035 m to 2500 m. Average precipitation is approximately 112 cm, at the Madison Plateau SNOTEL site, mostly in the form of snow. Average temperatures were similar to those in West Yellowstone.

Timber harvesting began in the late 1950's. Harvest activities are ongoing today, although not at the high rate of the past 3 decades. Recreation is the only other land use of the area. Hunting and sight seeing were the primary recreational activities during the summer and fall months. Snowmobiling and cross country skiing were the primary winter recreational activities. An extensive network of groomed snowmobile trails was maintained throughout the winter and provided good access to the area. Fur trapping has taken place on the Mosquito Gulch study area for at least the last 50 years (Whitman pers. comm.)

Vegetation of the area was dominated by communities of subalpine fir, lodgepole pine, and Douglas-fir. Grass cover was most pronounced in clearcuts, and willow communities were common along streams.

Beaver Creek

Beaver Creek (Figure 2) was located northwest of Hebgen Reservoir and 14 km northwest of the Flats study site. This area included 32 km^2 and was bordered on the south by Highway 287, the Lee Metcalf Wilderness to the west, Potamogeton Park to the north, and Cabin Creek to the east. Mean precipitation and temperature, measured at Hebgen Dam, are 73.2 cm, and 2.2 C. Elevation ranged from 2,000 m to 2,800 m. The topography of this study area was much steeper than any of the other study areas.

Spruce (*Picea engelmannii*) and subalpine fir dominated the creek bottom and much of the steep valley sides. Douglas-fir was a common component on all landforms. Lodgepole pine occurred in successional stands of Douglas-fir and subalpine fir habitat types.

Recreation and logging were the primary land uses in this area. Big game hunting and hiking/camping were the dominant recreational activities. Logging was limited to areas on the east side of the drainage. Clearcuts were isolated and comprised approximately 6% of the area at the time of the study (Kujala 1993). Timber harvesting activities were not widespread on the area. The last harvest activities took place in the early 1970's. Beaver Creek has been trapped for fur for at least the last 50 years (Whitman pers. comm.)

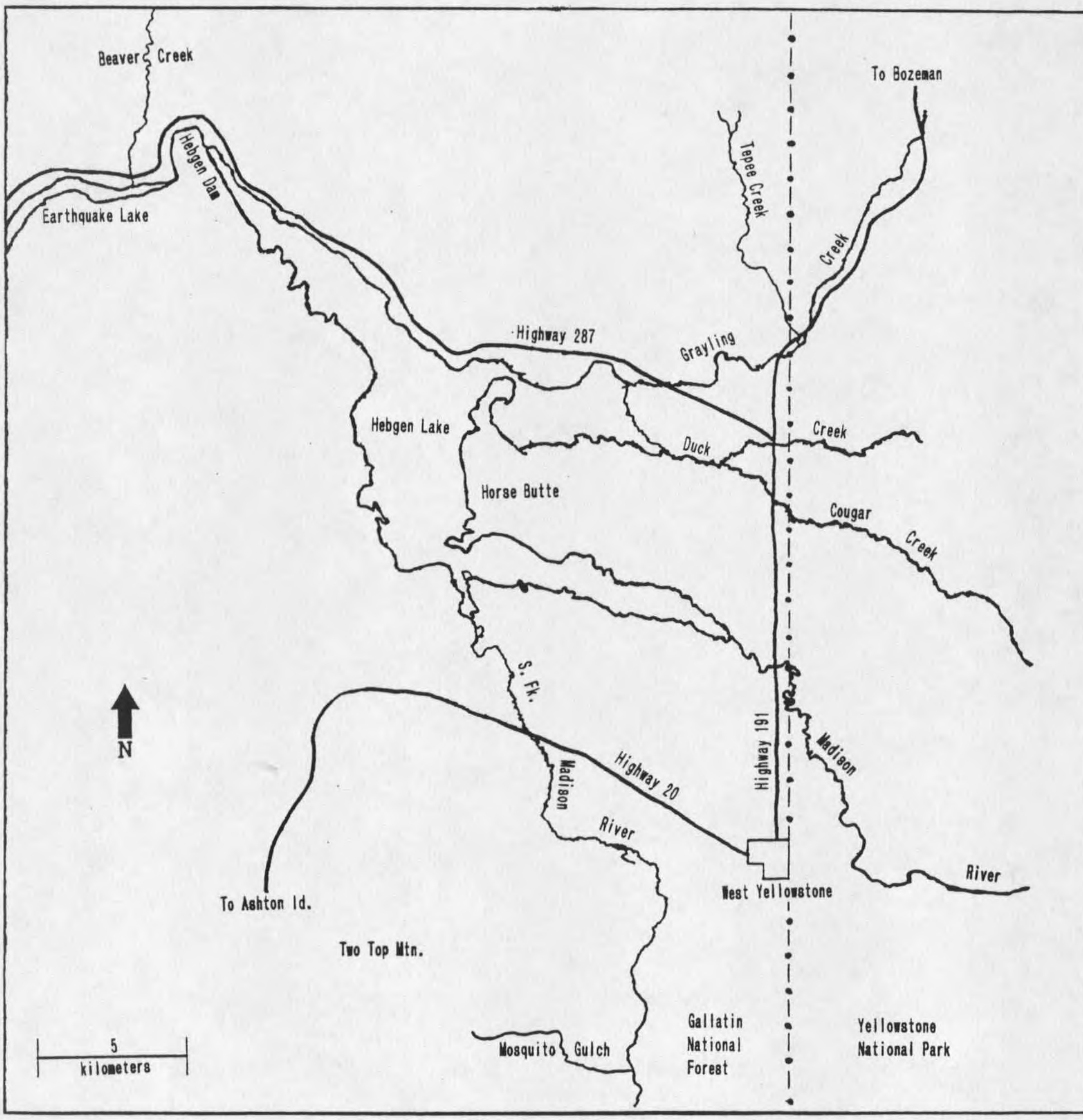

Figure 2. Map of the Flats, Mosquito Gulch, and Beaver Creek study areas.

METHODS

To meet the objectives of this study pine marten were livetrapped, fur trapping records were monitored, and track transects were established to determine effects of trapping and population densities. Radio telemetry was employed to determine home range size and movements and for habitat evaluation. Small mammal trapping was conducted to ascertain the availability of small mammal as prey.

Livetrapping

Pine marten were livetrapped on all study sites. Tomahawk, single door, live traps were placed in areas I identified as possible marten travel corridors (tree bands between clearcuts, mesic drainages) in fragmented habitats. On other sites, I simply saturated an area with traps where marten were known to occur. At the micro-site level, traps were placed in slash piles, under deadfall, or at the base of trees. A "cubby" set was constructed around each site using materials at the site as well as conifer limbs and snow in an effort to make the set more attractive to marten. This approach also provided thermal protection for trapped marten. All active traps were checked at least once every 24 hours via snowmobile, truck, or by foot. Traps were baited with deer (*Odocoileus hemionus*), elk (*Cervis elaphus)* or antelope (*Antilocapra americana)* hides and/or flesh. Also various species of Salmonids were used as bait. Sable oil was used to aid in attracting marten to sets.

Captured marten were anesthetized with 0.1 - 0.4 cc of ketamine hydrochloride (100mg/ml), depending on the size of the animal. Time from injection to release was generally under 30 minutes. Immobilized marten were placed back in the trap after processing and held until they displayed behavior similar to that observed before anesthesia.

Marten were classified as either juvenile or adult, as determined from sagittal crest development (Marshall 1951) and canine wear. Sex was also noted. Body weights and lengths were recorded for captured marten.

Ear tags were placed on unmarked marten. Marten caught the previous year who had retained ear tags or had removed them were not fitted with new tags. Radio transmitters, 148 mhz, (AVM Instrument Co., Livermore, CA or Telonics, Mesa, AZ) were placed on the majority of captured marten.

Furtrapping

Furtrapping was conducted only on the Mosquito Gulch and Beaver Creek study areas during 1991 and 1992. Trappers active in the study areas were asked to report numbers and sex of pine marten trapped as well as numbers of traps utilized and lengths of trap lines. I also inquired about historic population levels using harvests in past years as an index to relative status of the 1991-1992 harvest. Age of marten trapped on the Beaver Creek and Mosquito Gulch study areas was determined by cementum analysis (Aune and Schladweiler 1993).

Marten Locations

Pine marten locations were designated as resting or foraging. Locations were classified as resting when I determined that a radio signal was constant indicating that a marten was not moving before, or after a search effort. A fading radio signal indicated that a marten was moving. In this case a visual sighting, or marten track was marked as the foraging location. Marten were located by ground searches, triangulation, and by using fixed-wing aircraft. Most ground searches resulted in a visual sighting of the marten, a precise location of the rest site (within 1 m) or a fresh track. Triangulation was used when terrain or distance limited search efforts. The Horse Butte fire lookout tower was used often to locate marten on the Flats study area. All locations were recorded on 1:24,000 U.S. Geological Survey maps using Universal Transverse Mercator (UTM) coordinates. Ground locations were marked with flagging so the same locations could be relocated for further habitat measurements later in the summer.

Home Range Determination

Home ranges for marten were determined using the minimum convex polygon method (Mohr 1947) and the computer program TELDAY (Lonner and Burkhalter 1992). Locations gained via ground searches, triangulations, and fixed wing aircraft were used in home range calculations.

To index marten movement, daily straight line distances between locations were calculated from UTM coordinates of locations. Only locations from consecutive days were used to calculate this index.

Population Monitoring

Thirteen 1-kilometer (km) track transects were established (5 on the Upper Big Hole study area, 4 on the West Yellowstone Flats, and 4 on the Beaver Creek study area) in 1989-90 (Fager 1991) and monitored by methods described by Thompson et al. (1989). Each transect was examined 18-96 hours after a snowfall that was likely to have covered existing tracks. Replicated counts throughout the winter were used to assess the viability of this approach as a means of determining relative population densities of pine marten on the study areas.

Habitat Evaluation

Habitat variables were measured at all marten locations during the summer (May-August) of 1992. Measurement of habitat variables followed procedures developed by Fager (1991) for marten locations and random plots. This procedure was based on a modified timber stand exam procedure (U.S.D.A. 1985). Random plots measured by Fager (1991) were used for comparison against marten locations. Random points within clearcut boundaries were not included in habitat analysis. Since both Fager (1991) and Kujala (1993) showed that marten did not use clearcuts, I was only interested in comparing marten locations with forested random locations. Habitat analyses were only conducted on the Big Hole and Flats study areas. Marten were not collared in Beaver Creek, and only one collared marten survived the trapping season on the Mosquito Gulch site.

Combined marten and individual marten locations were compared to random points. Only those marten with 20 or more locations were compared individually to random locations. All three marten from the Big Hole study area had more than 20 locations each (m030=32, m040=26, m060=26). Five marten from the Flats study area were used for habitat analysis. Three of these marten had 20 or more locations (m140=37, m150=20, m578=43). Martens 080 and 110 had 8 and 12 locations, respectively, and were included in combined marten locations. I used aggregated resting and foraging locations to describe habitat use.

Tree species, diameter at breast height (dbh), and tree height were measured for each tree, $\geq$ 12.7 cm dbh, in a variable radius plot. A 20 basal area factor (BAF) angle gauge was used to identify specific trees included in the variable plot. Age was determined by coring the largest tree of every species on the plot (Kujala 1993). Canopy cover was obtained using a densiometer. Downed woody material was estimated with methods described by Brown (1974). One 8.2-m transect was run on an easterly bearing from plot center at all marten locations. Intercepts of woody material $\geq$ 7.6 cm in diameter were recorded to the nearest 2.5 cm diameter at the point of intercept and rated as sound or rotten.

Marten locations were classified to habitat type (Pfister et. al. 1977). Each marten location was also designated as mesic or xeric (Warren 1989). I used Forest Service old growth criteria (Appendix A Table 30), to classify each location as old growth or non-old growth.

To describe habitat use by pine marten from the landscape level to the micro site, I divided habitat evaluation into large, medium, and small scale habitat features. Habitat features at marten locations were compared to random points scattered across the study area.

Large scale habitat features

Habitat selection with respect to habitat series, old growth, and mesic versus xeric sites was determined through use-availability analysis using methods described by Marcum and Loftsgaarden (1980). I combined all marten locations for use-availability analysis. Habitat selection was determined for habitat series and mesic/xeric sites only on the Big Hole study area. These analyses could not be performed on the Flats study area because the lodgepole pine/bitterbrush habitat type made up >90% of available habitats and >90% of use by marten. Old growth use-availability was determined for both sites with the minimum age criteria for lodgepole pine habitats reduced from 150 to 100 years for the Flats study area only (See Appendix A Table 30).

Medium scale habitat features

Medium scale habitat features were described at the stand level. All marten and random locations were used to calculate mean trees/hectare, average stand diameter (ASD), stand density index (SDI), basal area (BA), mean downed woody material (DWM), and mean canopy cover. Trees/hectare, SDI, ASD, and BA were calculated according to procedures described by Daniel et. al. (1979). Downed woody material was expressed in metric tons/hectare. Medium scale habitat features were compared between marten locations and random points using t-tests.

Small scale habitat features

Only those marten and random locations where live trees, snags, or downed woody material were present, within 11.2 m of the actual marten location, were used to calculate small scale habitat features. For example, if a pine marten were resting in a live tree less than 12.7 cm in diameter and no trees with a dbh of 12.7 cm or greater were included in the variable radius plot, that location would not be included in the small scale habitat analysis of live trees. This approach allowed me to delete sites without the habitat variable in question which would have biased mean values for the size and number of trees and deadfall. Habitat variables examined include: mean dbh for all trees combined, live trees, snags, and diameter of deadfall material; mean numbers of live trees, snags, combined live trees and snags, and deadfall intercepts. Ground cover was also described at the micro-site level. Differences between marten and random locations were compared using t-tests. Chi-squares were used to detect differences between the frequency of random plots with a specific habitat variable and marten locations with that same variable.

<u>Rest Site Selection and Red Squirrel Midden Association</u>

Marten rest sites were noted as being on the ground or in a tree nest. The presence of a red squirrel (*Tamiasciurus hudsonicus)* midden within 11.3 m of the rest site was also noted. Rest site refers to the physical structure (eg., tree nest or deadfall) while rest episode refers to the activity.

<u>Small Mammal Trapping</u>

Small mammal trapping was conducted to determine the availability of small mammals as prey on the Big Hole and Flats study areas. Traps were set during the summer and fall of 1991 and the spring and summer of 1992. Sherman live traps were baited with peanut butter and rolled oats. Cotton was placed in each trap as insulation. Trapping sites were chosen to be representative of poor, fair, and good, pine marten habitat. Chi-square statistics were used to determine if small mammal captures were equally distributed among habitats.

Spring/Fall

Spring/fall trapping was done in order to determine relative abundance of small mammals and to gather information concerning over-winter survival across several different habitats. Traps were set in a single line of 50 or 2 parallel lines of 25, spaced 5 m apart. During each sampling period, sites were trapped for 3 consecutive nights and checked every morning. Animals were identified to species ear tagged or toe clipped, for future identification, and released.

Four sites were trapped on the Big Hole study area. Included were a dry lodgepole pine upland site, a spruce/fir riparian site, a spruce/fir/beargrass site and a recent clearcut with little regeneration over 50 cm (Appendix A Table 34). The dry lodgepole and the clearcut sites were trapped in both fall and spring while the creek bottom and spruce/fir sites were trapped only in the fall.

Seven sites were trapped on the Flats study area. All sites, with the exception of a moist Douglas-fir type, had a lodgepole pine cover type. Sites differed with respect to understory vegetation and structural makeup (Appendix A Table 35).

Summer

A more intensive trapping scheme was conducted during the summer months. Four grids were trapped on both the Big Hole and Flats study areas (Appendix A Table 36). Each grid was approximately 1 hectare in size (100 m x 100 m), and was sampled between July and September of 1991 and 1992. Ten parallel rows (10 traps per row) were set on each grid for 3 consecutive nights at bi-weekly intervals for a total of 3 trapping periods each year. Captured animals were ear tagged for future identification. To determine survival, recruitment, and rodent biomass lost over a 2-week period, an enumeration technique described by Chitty and Phipps (1966) was employed.

RESULTS

Livetrapping

Twenty-four marten were trapped in 4 study areas (Table 1). Livetrapping success in fall did not differ significantly among study areas (chi-square=1.8, df=3, P=0.62). Winter livetrapping success was not significantly different between the Big Hole and Flats study areas (chi-square=0.35, df=1, P=0.55). Livetrapping success in fall was not significantly different than winter in the Big Hole (chi-square=0.31, df=1, P=0.58), but success was higher in winter than fall on the Flats study area (chi-square=6.2, df=1, P=0.01).

Table 1. Livetrapping success for fall and winter on the Big Hole, Beaver Creek, Mosquito Gulch, and Flats study areas, 1991-1992.

		Fall*		Winter	
Study area	Tot. marten caught	Marten	Total trap nights	Marten	Total trap nights
Big Hole	10	8	473	2	76
Beaver Cr.**	3	3	286		
Mosquito Gulch	3	3	181		
Flats	8	5	581	3	66

*Fall trapping period September–December. Winter trapping period January–March.

**Beaver Creek and Mosquito Gulch areas were not trapped after December 1.

I did not detect significant differences in the sex ratio (Table 2) of live-captures among areas (chi-square=5.0, df=3, P=0.2). However, males outnumbered females on all study areas with the exception of Mosquito Gulch. Greatest deviation from a 50:50 ratio was on the Flats study area, 7M:1F.

Table 2. Sex and relative age structure of livetrapped marten by study area, 1991-1992.

	Study area			
Age/Sex	Big Hole	Beaver Cr.	Mosquito Gulch	Flats
Adult males	4	2	1	4
Adult Females	0	0	1	1
Juvenile males	4	1	0	3
Juvenile females	2	0	1	0
Total	10	3	3	8

Furtrapping

Only the Mosquito Gulch and Beaver Creek study areas were trapped during the 1991-1992 trapping season (Table 3). The 27 marten caught in the Mosquito Gulch area included marten that were marked on the Flats study area and were trapped on the Mosquito Gulch site. Only one trapper was active in the Mosquito Gulch area. He worked a trapline that ran approximately 48 km with approximately 2 traps/km.

Table 3. Fur harvest success and trapping effort for the Mosquito Gulch and Beaver Creek study areas, 1991-1992.

Study area	Total marten caught	Trap nights	Number of trappers	Trap nights/ marten
Mosquito Gulch	27	4280	1	156
Beaver Creek	27	3602	2	133

This individual has maintained about the same number of traps in the same locations since the 1985-1986 trapping season, with numbers of marten caught remaining the same or increasing each year. The 27 marten caught in the Mosquito Gulch area in 1991-1992 represents the highest catch in the 6 years this individual had trapped this area (Fountaine pers. comm.).

Two people trapped the Beaver Creek study area. One individual placed traps with a snowmobile along the roaded portion of the study area, with approximately 5 traps/km. Another trapper skied an 8 km loop starting at the end of the Beaver Creek road with approximately 4 traps/km. I combined the trap nights of these two trappers to determine trap nights/marten in the Beaver Creek study area.

Trapper success in Mosquito Gulch and Beaver Creek did not statistically differ (chi-square=0.4, df=1, P=0.5). Marked marten trapped on the Mosquito Gulch and Beaver Creek study areas made up 15% and 19% of the respective harvests (Table 4). All adult males that were marked previous to the trapping season were harvested in both areas.

Table 4. Harvest of marked and unmarked marten for the Mosquito Gulch and Beaver Creek study areas, 1991-1992.

Study area	Marten harvested	Marked marten	Marked marten in catch	Marked animals as percent of harvest
Mosquito Gulch	27	6 2AM,2JM* 1AF,1JF	4 2AM,1JM 1JF	15%
Beaver Creek	27	7** 4AM,1JM 2AF	5 4AM,1AF	19%

*AM=adult male, JM=juvenile male, AF=adult female, JF=juvenile female

**Includes 4 marten captured and collared in February 1991.

Cementum analysis revealed that 81% of the marten from the Mosquito Gulch harvest (Figure 3) were < 20 months old. Only 5 of 27 marten were between the age of 2 and 5. None of the harvested marten were older than 5 years. Not all the marten from the Beaver Creek area were submitted for aging. Those that were, were combined with marten trapped near the study area in Tepee Creek (Appendix B Figure 8). Age distribution of these marten was similar to those on the Mosquito Gulch site, with 76% of the Beaver/Tepee Creek catches consisting of marten < 20 months old. Juveniles accounted for 37% and 35% of the harvests on the Mosquito Gulch and Beaver/Teepee Creek study areas, respectively.

Sex ratios of marten on the Mosquito Gulch site were 56% males and 44% females, while on the Beaver/Teepee Creek site males made up 53% of the harvest and females 47%.

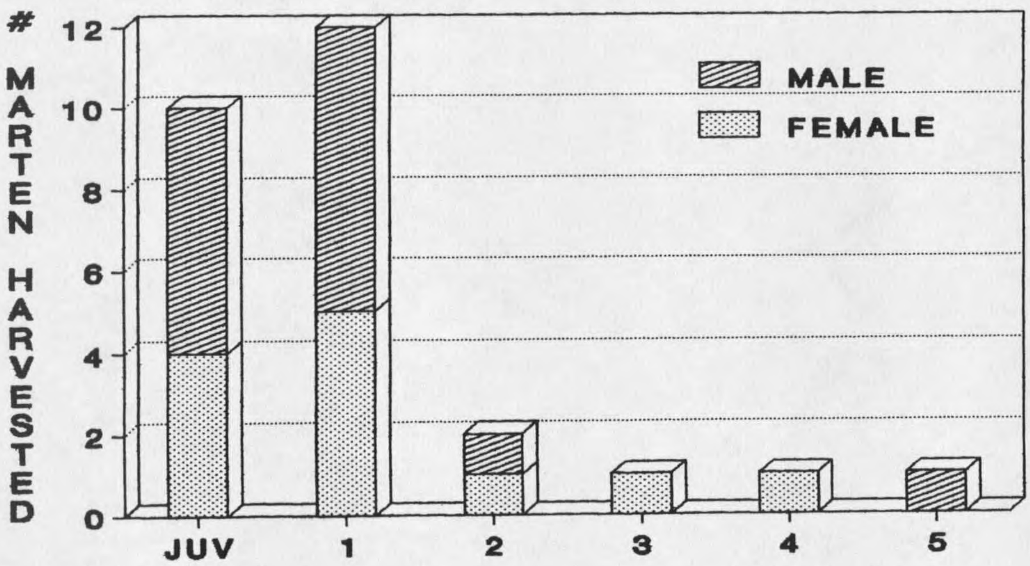

Figure 3. Sex and age distribution of harvested marten from the Mosquito Gulch study area.

<u>Population Densities</u>

Results from 1-km track transects in the Big Hole study area showed an overall mean of 0.38 tracks/km (Table 5). These transects were established in lodgepole pine, mesic subalpine fir, xeric subalpine fir, and a mix of lodgepole pine and mesic subalpine fir.

In the Beaver Creek study area, 3 of 4 transects were in mesic subalpine fir and 1 in a mesic Douglas-fir type. The Beaver Creek area exhibited the highest track density with 0.54 tracks/km (Table 5).

All transects on the Flats study area were located in a lodgepole pine/bitterbrush habitat type. Track densities on the Flats were the lowest at 0.23 tracks/km.

Table 5. Results from winter track transects (tracks/km) for the Big Hole, Beaver Creek, and Flats study areas.

	Study area		
	Big Hole	Beaver Creek	Flats
Number of transects	5	5	4
Kilometers of transect employed	17	8	10
Density (SD)	0.38 (0.38)	0.54 (0.37)	0.23 (0.41)

Home Range and Movements

Home Range

Radiocollared animals were used to calculate home ranges in the Big Hole and Flats study areas. Winter home ranges were estimated for 3 marten on the Big Hole study area and 5 marten on the Flats study area (Table 6). Spring home ranges for 3 marten and consecutive day movements for 6 marten were also calculated. Relocations used for home range calculations totaled 94 on the Big Hole study area and 132 on the Flats study area.

Winter home ranges of males were larger than females on both sites. Males on the Flats study area had larger home ranges than males on the Big Hole study area in both winter and spring. The home range for marten 080 is likely underestimated. This marten spent much of his time near the Yellowstone Park/Gallatin National Forest boundary. I was unable to locate this marten when he moved into more remote areas of the park. Only 1 female per site provided locations for home range estimates. Marten 110 had a home range 3 times larger than her counterpart in the Big Hole. Home ranges of neighboring marten on the Big Hole study area and Flats study area showed some degree of overlap. The home ranges of m060 and m040 overlapped approximately 40%, with almost all of the m060 polygon within the perimeter of the m040 polygon. Home range overlap between two males (m140 and m150) on the Flats study area was approximately 14%. In neither of the two cases of overlap were both marten found in the area of overlap at the same time.

Table 6. Home range estimates and mean consecutive day movements for radio-collared marten on the Big Hole and Flats study areas for winter, spring and all locations combined.

Marten	Study area	Area(km^2)			Consecutive day movements (km)
		Winter	Spring	All locs.	
030m*	Big Hole	7.2 (n=29)	1.6 (n=6)	12.7 (n=35)	1.9 (n=17)
040m	Big Hole	7.0 (n=29)		7.2 (n=33)	2.3 (n=12)
060f	Big Hole	2.8 (n=23)		3.0 (n=26)	1.5 (n=7)
080m	Flats	2.0 (n=12)		**	
110f	Flats	9.1 (n=13)		**	
140m	Flats	11.5 (n=24)	23.3 (n=13)	53.6 (n=38)	3.6 (n=13)
150m	Flats	16.6 (n=22)		**	1.4 (n=7)
578m	Flats	17.1 (n=25)	7.9 (n=18)	24.5 (n=47)	2.0 (n=16)

*m=male, f=female.
**Winter estimates and all locations are the same.

Movements

Average consecutive day movements were longer for marten on the Flats study area (mean=2.3, SD=1.1) than marten on the Big Hole study area (mean=1.9, SD=0.4).

Two marten on the Flats study area traveled long distances within their home ranges. Martens 140 and 150 routinely moved into Yellowstone Park and were often out of range for my equipment. Between April 14 and April 15, 1992, m140 moved at least 11 km to the east into Yellowstone Park. Movements of this nature required crossing large areas of forest burned by the 1988 North Fork fire. Only marten m150 was located within the perimeter of this burn during the study.

Movements of marten marked on 2 of the study areas and captured by fur trappers off the study areas suggest dispersal (Table 7). Both marten from the Flats crossed the Madison river. Marten 090 may have crossed when the river was frozen. However, between March 1991 and December 1991, the Madison river was not frozen, suggesting marten 240 swam the river. Marten 823 in the Big Hole area was trapped approximately 90 m from the forest edge in a sagebrush habitat type, 13 km from the point of live-capture, in a trap set for coyote (*Canis latrans*). Marten 017 also from the Big Hole study area was marked during the summer of 1990 (Fager pers. comm.). This marten made the longest movement at 34 km.

Table 7. Distances from point of livecapture to harvest for 2 marten from the Flats study area and 2 marten from the Big Hole study area. All marten were classified as juvenile males at time of live-capture.

Study area	Month/year of livecapture	Month/year of harvest	Distance moved (km)
Flats (m240)	3/91	12/91	17
Flats (m090)	11/91	12/91	12
Big Hole (m823)	10/91	1/92	13
Big Hole (m017)	6/90	1/92	34

Habitat Evaluation

Large Scale Habitat Features

Habitat Series. Marten on the Big Hole study area used all forested habitat series present on the site (Table 8). However, Chi-square analysis indicated that the distribution of marten locations within habitat series differed from that of random locations (X =27.7, df=4, P<0.01). Marten use of the mesic subalpine fir and lodgepole pine habitat types was greater than expected, while use of the xeric subalpine fir habitat types was less than expected. Douglas-fir and spruce types were used in proportion to their availability.

Mesic versus Xeric Sites. Combined marten locations on the Big Hole study area indicated that marten were found with higher frequency in mesic areas and less frequently in xeric areas (Table 9). Individually, only m040 showed any preference for mesic areas or avoidance of xeric areas. Martens 030 and 060 used mesic and xeric sites in proportion to their availability.

Table 8. Habitat series and habitat type distribution for random (n=129) and all marten locations (n=84) for the Big Hole study area. (+) indicates use greater than expected and (-) indicates use less than expected based on 90% Bonferoni confidence intervals.

Habitat series	Habitat* types	Percent random	Percent marten
Douglas fir	210,320 330	15.5	14.3
Spruce	440,450 460,480	2.3	1.2
Mesic sub-alpine fir	650,670 620, 720,740	12.4	+27.4
Xeric sub-alpine fir	660,690,790 730,750	55.8	-28.6
Lodgepole pine	930,940 950	14.0	+28.6

*Habitat types, and series, are summarized in Appendix A Table 29.

Table 9. Percentage of random, individual marten, and total marten locations designated as mesic or xeric for the Big Hole study area based on soil moisture rating (Warren 1990). (+) indicates use greater than expected and (-) indicates use less than expected based on by 90% Bonferoni confidence intervals.

	Random (n=129)	m030 (n=32)	m040 (n=26)	m060 (n=26)	All marten (n=80)
Mesic locations	14.7	21.4	+38.5	19.2	+27.4
Xeric locations	85.3	78.6	-61.5	80.8	-72.6

Old Growth Use. Forty-two percent of 128 random locations on the Big Hole study area were classified as old growth, as defined by the Forest Service (Table 10). Collectively, the 3 Big Hole marten used old growth sites less than expected. Individually, m060 was the only marten to avoid old growth, while martens 030 and 040 were found to use old growth sites in proportion to their availability.

Marten on the Flats study area used old growth more frequently than indicated by its availability. (Table 11). Two of 5 individual marten also were located more frequently than expected in old growth.

Table 10. Percentage of random, individual marten, and total marten locations that met old growth minimum criteria on the Big Hole study area. (−) indicates use less than expected based on 90% Bonferoni confidence intervals.

	Locations in old growth	Total locations
Random	42.2	128
m030	32.1	32
m040	26.9	26
m060	−19.2	26
All marten	−26.3	80

Table 11. Percentage of random, individual marten, and total marten locations that met old growth minimum criteria on the Flats study area. Minimum age criteria was decreased to 100 from 150 years for lodgepole pine. (+) indicates use greater than expected based on 90% Bonferoni confidence intervals.

	Locations in old growth	Total locations
Random	12.3	73
m080	37.5	8
m110	16.7	12
m140	13.5	37
m150	+45.0	20
m578	+34.9	43
All marten	+28.3	120

Medium Scale Habitat Features

Trees/Hectare. Mean number of trees/hectare for combined marten locations on the Big Hole study area did not differ significantly ($t=1.2$, $P=0.21$) from random points (Table 12). Only marten 060 used areas with significantly greater numbers of trees/hectare ($t=2.5$, $P=0.01$) than those found at random points. Marten locations on the Flats study area had a significantly higher number of trees/hectare than did random locations ($t=3.1$, $P<0.01$). Marten 140 ($t=2.5$, $P=0.01$) and marten 578 ($t=3.6$, $P<0.01$) occupied areas with significantly higher numbers of trees/hectare.

Average Stand Diameter. Average stand diameter (ASD) at marten locations on the Big Hole study area was significantly larger than at random locations ($t=3.1$, $P<0.01$) (Table 12). On the Flats study area, ASD for individual marten and combined marten did not differ from random points.

Basal Area. For the Big Hole study area, m040 ($t=2.8$, $P<0.01$) and combined marten ($t=2.5$, $P=0.01$) locations were characterized by a greater basal area than random locations (Table 12). Martens 140, 150, and 578 from the Flats study area also occupied areas with a greater basal area than found at random locations as did combined marten locations ($t=5.2$, $P<0.01$).

Stand Density Index. Martens 040, 060, and combined marten ($t=2.8$, $P<0.01$) had a significantly higher mean SDI than that calculated for random locations on the Big Hole study area (Table 12).

A similar pattern was noted in the Flats study area. Combined and 3 individual marten had significantly higher stand density indexes.

Downed Woody Material. Mean metric tons/hectare (t/ha) of downed woody material ranged from 47 to 70 for individual marten. These values were not significantly different from the mean of 71 t/ha at random locations for the Big Hole study area (Table 13). All marten on the Flats study area except m150 were found in areas with greater accumulations of downed woody material than that at random points (Combined marten $t=3.9$, $P<0.01$).

Small Scale Habitat Features

All Trees. Live trees and/or snags $\geq$ 12.7 cm dbh were present at all marten locations on the Big Hole study area and did not statistically differ from the frequency of random points with live trees and/or snags present (Table 14). Mean dbh for all trees at marten locations was not statistically different from random locations. Marten 040 ($t=2.8$, $P<0.01$) and all Big Hole marten combined ($t=2.5$, $P=0.01$) had a higher mean number of trees present than found at random locations.

Marten 140 was the only marten from the Flats study area (Table 14) that had a significantly higher number of locations with live trees and/or snags present compared to random locations (chi-square=4.3, df=1 $P=0.04$). Mean dbh for marten locations with trees was no different from random locations. Significantly more trees were found at locations for individual martens 140 ($t=2.4$, $P<0.01$), 150 ($t=2.3$, $P=.02$), 578 ($t=5.3$, $P<0.01$), and all marten combined ($t=5.0$, $P<0.01$) than at random sites.

Table 12. Means for stand density index (SDI), trees/hectare, average stand diameter (ASD) in cm, and basal area (m^2/hectare), for random, individual marten, and total marten locations from the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

	SDI	Trees/hectare	ASD	Basal area
Big Hole				
Random n=135	531 (298)	731 (507)	20.9 (7.9)	66.0 (39.6)
m030 n=28	565 (274)	742 (450)	<u>24.7</u> (7.8)	71.2 (30.3)
m040 n=26	<u>706</u> (335)	700 (311)	<u>26.1</u> (6.8)	<u>90.7</u> (49.4)
m060 n=26	<u>695</u> (305)	<u>1008</u> (503)	22.1 (7.9)	79.4 (35.1)
All marten n=79	<u>652</u> (308)	816 (446)	<u>24.3</u> (7.6)	<u>80.1</u> (39.1)
Flats				
Random n=74	289 (175)	452 (365)	19.2 (8.7)	32.9 (19.2)
m140 n=37	<u>476</u> (302)	<u>660</u> (503)	22.3 (6.2)	<u>58.4</u> (36.7)
m150 n=20	<u>393</u> (240)	557 (400)	20.3 (8.8)	<u>45.9</u> (28.2)
m578 n=43	<u>540</u> (249)	<u>725</u> (447)	21.0 (7.4)	<u>63.9</u> (28.3)
All marten n=120	<u>464</u> (277)	<u>648</u> (467)	20.4 (7.8)	<u>56.4</u> (35.3)

Table 13. Mean downed woody material (metric tons/hectare) for random, individual marten, and total marten locations from the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

	Big Hole				
	Random n=135	m030 n=32	m040 n=26	m060 n=26	All marten n=84
Metric tons per hectare	71 (65)	47 (58)	70 (68)	48 (35)	54 (54)
	Flats				
	Random n=74	m140 n=37	m150 n=20	m578 n=43	All marten n=120
Metric tons per hectare	13 (19)	26 (27)	25 (41)	24 (23)	30 (34)

Live Trees. All Big Hole marten locations had live trees present. This frequency was not significantly different from the 98% of random locations with live trees present (Table 15). No differences existed between live tree diameters at marten locations and live tree diameters at random locations. However, significantly higher numbers of live trees were found for martens 040 (t=2.4, P=0.02), 060 (t=2.4, P=0.02), and all marten combined (t=2.7, P<0.01) than at random sites.

Eighty-eight percent of all marten locations from the Flats study area had live trees present. This was significantly higher than percentages of random locations with live trees (chi-square=8.6, df=1 P=0.01). Locations for martens 140 (chi-square=4.4, df=1 P=0.04) and 578 (chi-square=12.1, df=1 P<0.01) also had a higher percentage of locations with live trees than did random locations. As in the Big

Hole, there was no difference between the dbh of live trees at marten locations and the dbh of live trees at random locations. Marten 140 was the only marten on the Flats study area to use areas where live trees were more abundant (t=2.6, P=0.01) than at random sites.

Table 14. Mean dbh (cm) and mean number of trees, $\geq$ 12.7 cm, for random, individual marten, and combined marten locations where live trees, snags, or both were found for the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

Study area	Total loc.	Percent loc. w/trees	Mean dbh for sites w/trees	Mean # trees for sites w/trees
Big Hole				
Random	129	98	25.9 (8.6)	5.9 (2.8)
m030	32	100	24.1 (9.4)	6.3 (2.5)
m040	26	100	24.4 (7.9)	<u>7.8</u> (4.1)
m060	26	100	24.4 (8.1)	6.9 (3.0)
All marten	84	100	24.6 (8.4)	<u>7.0</u> (3.2)
Flats				
Random	74	89	22.9 (6.4)	3.4 (1.6)
m140	37	100*	24.6 (5.1)	<u>4.7</u> (2.9)
m150	20	90	23.9 (6.1)	<u>4.4</u> (2.2)
m578	43	93	24.6 (5.3)	<u>6.2</u> (2.2)
All marten	120	93	24.1 (5.3)	<u>5.2</u> (2.6)

*Indicates significant difference between random and marten locations (Chi-square).

Table 15. Mean dbh (cm) and mean number of live trees, ≥ 12.7 cm, for random, individual marten, and combined marten locations where only live trees were found for the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

Study area	Total loc.	Percent locations with live trees	Mean dbh for live trees	Mean # live trees
Big Hole Random	129	98	26.4 (9.1)	5.2 (2.6)
m030	32	100	29.5 (12.2)	5.6 (2.3)
m040	26	100	29.7 (7.4)	6.5 (3.1)
m060	26	100	24.6 (8.1)	6.5 (2.8)
All marten	84	100	28.2 (9.9)	6.2 (2.7)
Flats Random	74	72	22.4 (7.6)	2.8 (1.4)
m140	37	89*	22.9 (5.6)	3.3 (2.1)
m150	20	80	23.1 (5.6)	3.8 (1.5)
m578	43	98*	22.9 (4.3)	3.3 (2.1)
All marten	120	88*	22.4 (5.1)	3.3 (2.0)

*Indicates significant difference between random and marten locations (Chi-square).

Snags. Marten 060 had a lower percentage of locations with snags present (chi-square=4.4, df=1 P=0.04) than did random locations on the Big Hole study area (Table 16). Snag diameters at marten locations did not differ from snag diameters at random points. Marten 040 was the only Big Hole marten that had a significantly higher quantity of snags (t=2.2, P=0.03). Of the 74 random locations from the Flats study area, 47% had snags present. Martens 140 (chi-square=4.1, df=1 P=0.04) and 578 (chi-square=24.7, df=1 P<0.01), and combined marten locations (chi-square=9.9, df=1 P<0.01), had a significantly higher proportion of locations with snags present than did random points. No significant deviation existed for mean dbh or mean number of snags between random and marten locations.

Sound Downed Woody Material. Analysis of sound downed woody material from the Big Hole study area revealed no differences between random and marten locations (Table 17). Combined marten locations from the Flats study area had a significantly higher number of locations with sound DWM present than did random locations (chi-square=4.9, df=1 P=0.03). Mean diameter of sound downed woody material was significantly greater for marten 578 (t=3.6, P<0.01) and combined marten locations (t=2.8, P<0.01) than for random locations. No differences were detected when the number of intercepts at marten locations was compared to that of random locations.

Rotten Downed Woody Material. Examination of rotten downed woody material from the Big Hole study area showed the only departure of this variable at marten locations from values at random locations was in the percentages of marten locations with rotten downed woody material present (Table 18). Marten 030 had a smaller proportion of locations with rotten DWM than random points (chi-square=15.0, df=1 P<0.01).

Table 16. Mean dbh (cm) and mean number of snags $\geq$ 12.7 cm for random, individual marten, and combined marten locations where only snags were found for the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

Study area	Total locations	Percent locations with snags	Mean dbh for snags	Mean# snags
Big Hole				
Random	129	47	24.9 (10.9)	1.6 (0.92)
m030	32	53	26.2 (6.9)	1.5 (1.0)
m040	26	65	27.2 (12.4)	<u>2.3</u> (1.6)
m060	26	27*	21.3 (7.4)	1.7 (1.3)
All marten	84	49	25.7 (9.7)	1.9 (1.3)
Flats				
Random	74	47	25.7 (9.4)	2.1 (1.2)
m140	37	68*	27.9 (6.4)	2.6 (2.4)
m150	20	30	30.7 (4.3)	3.0 (2.7)
m578	43	93*	27.4 (9.9)	3.0 (2.4)
All marten	120	70*	27.2 (8.4)	2.8 (2.4)

*Indicates significant differences between random and marten locations (Chi-square).

Table 17. Mean diameter (cm) and mean number of intercepts of sound downed woody material (DWM) $\geq$ 7.6 cm for random, individual marten, and combined marten locations where sound DWM occurred, for the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

Study area	Total loc.	Percent loc. w/sound DWM	Mean dia. of sound DWM	Mean #of sound intercepts
Big Hole				
Random	129	62	14.0 (5.3)	2.7 (2.1)
m030	32	16	12.4 (4.6)	3.4 (2.7)
m040	26	46	17.5 (8.6)	1.9 (0.29)
m060	26	35	12.7 (2.1)	1.7 (0.71)
All marten	84	31	14.7 (6.6)	2.1 (1.3)
Flats				
Random	74	45	10.9 (3.3)	2.5 (1.4)
m140	37	62	13.0 (4.3)	2.6 (1.6)
m150	20	50	13.0 (5.3)	2.7 (1.6)
m578	43	58	<u>14.7</u> (4.6)	2.1 (1.3)
All marten	120	61*	<u>13.5</u> (4.3)	2.7 (2.0)

*Indicates significant difference between random and marten locations (Chi-square).

Mean diameter of rotten downed woody material on the Flats study area was significantly larger at locations of marten 150 ($t=5.6$, $P<0.01$), and marten 578 ($t=2.8$, $P=0.01$) and combined marten ($t=3.0$, $P<0.01$) than at random locations.

<u>Combined Downed Woody Material.</u> Big Hole marten locations had a lower occurrence of DWM than did random locations (Table 19). Sixty-three percent of marten 030 locations had DWM present (chi-square=25.3, df=1 $P<0.01$), and 81% of marten 060 locations had DWM present (chi-square=5.8, df=1 $P=0.02$). All marten locations combined totaled 76% (chi-square=15.5, df=1 $P<0.01$). I did not detect significant differences for mean diameter or mean number of intercepts between marten and random locations.

The only significant difference between random and marten locations on the Flats study area for combined DWM analysis was the diameter of DWM. Locations for martens 140 ($t=2.1$, $P=0.04$), 150 ($t=2.7$, $P=0.01$), and 578 ($t=4.9$, $P<0.01$), as well as all marten locations combined ($t=3.8$, $P<0.01$) were characterized by larger diameter DWM.

<u>Ground Cover.</u> When ground cover variables were present (Table 20), marten locations had significantly less non-vegetated (rock, duff, bare ground) area than did random locations on the Big Hole study area (m030 $t=2.0$, $P=0.04$; m040 $t=3.1$, $P<0.01$, combined marten $t=3.5$, $P<0.01$). No differences existed between random and marten locations with respect to the frequency of non-vegetation features at marten locations. Percent coverage of slash (firewood and logging operations creating downed woody material) at marten locations was not different

from random points. Only marten 060 locations had a higher frequency of slash than random points (chi-square=10.6, df=1 P<0.01).

Table 18. Mean diameter (cm) and mean number of intercepts of rotten downed woody material (DWM) $\geq$ 7.6 cm for random, individual marten, and combined marten locations where rotten DWM occurred, for the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

Study area	Total loc.	Percent loc. w/rotten DWM	Mean diam of rotten DWM	Mean #of rotten intercepts
Big Hole				
Random	129	88	16.5 (6.6)	4.0 (2.3)
m030	32	59*	15.2 (5.3)	4.3 (2.6)
m040	26	81	16.5 (4.6)	4.8 (3.3)
m060	26	77	15.0 (2.5)	4.8 (2.7)
All marten	84	71*	15.5 (4.3)	4.7 (2.8)
Flats				
Random	74	35	13.2 (2.8)	1.6 (1.1)
m140	37	16	17.4 (7.9)	2.8 (1.3)
m150	20	25	<u>20.6</u> (1.4)	1.2 (0.45)
m578	43	30	<u>17.9</u> (5.3)	1.5 (0.52)
All marten	120	25	<u>18.5</u> (5.8)	2.1 (1.6)

*Indicates significant difference between random and marten locations (Chi-square).

Table 19. Mean diameter (cm) and mean number of intercepts of combined sound and rotten downed woody material (DWM) $\geq$ 7.6 cm for random, individual marten, and combined marten locations where sound and/or rotten DWM was found for the Big Hole and Flats study areas. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

Study area	Total loc.	Percent loc. w/DWM	Mean diam. of all DWM	Mean # of total intercepts
Big Hole				
Random	129	95	15.5 (5.1)	5.6 (3.2)
m030	32	63*	14.7 (5.3	5.0 (3.3)
m040	26	88	17.0 (6.6)	5.3 (3.6)
m060	26	81*	14.2 (2.0)	5.3 (2.6)
All marten	84	76*	15.5 (5.1)	5.2 (3.2)
Flats				
Random	74	84	11.7 (3.0)	2.7 (1.8)
m140	37	73	<u>13.5</u> (4.6)	3.0 (1.6)
m150	20	65	<u>14.7</u> (5.6)	2.5 (1.9)
m578	43	74	<u>16.0</u> (4.6)	2.3 (1.2)
All marten	120	75	<u>14.7</u> (5.1)	2.9 (2.0)

*Indicates significant difference between random and marten locations (Chi-square).

Table 20. Mean percent coverage by cover type and frequency of locations in a particular cover type for the Big Hole study area. Values in parentheses are standard deviations. Underlined values indicate significant differences from random points at the 0.05 error level.

Cover type		Random n=129	m030 n=32	m040 n=26	m060 n=26	All marten
Non Vegetative	Percent coverage	34 (19)	26 (19)	22 (14)	26 (20)	25 (18)
	Frequency	96	100	96	88	95
Slash	Percent coverage	11 (4)		25 (30)	16 (15)	18 (20)
	Frequency	6	3	15	27*	16
Natural Accumulation	Percent coverage	19 (11)	17 (10)	22 (13)	20 (12)	19 (12)
	Frequency	88	100*	92	92	94
Grass	Percent coverage	19 (16)	37 (18)	38 (19)	37 (14)	38 (17)
	Frequency	21	100*	96*	96*	98*
Grass Like	Percent coverage	22 (16)	23 (14)	18 (10)	17 (8)	18 (10)
	Frequency	62	25*	42	46	37*
Forb	Percent Coverage**					
	Frequency	33	0*	0*	4*	1*
Shrub	Percent Coverage	41 (23)	29 (19)	38 (23)	38 (21)	34 (21)
	Frequency	82	88	69	81	80

*Indicates a significant difference between marten and random locations (chi-square).

**Data were insufficient to perform statistical analysis.

Percent coverage and frequency of naturally accumulated downed woody material was no different from random observations. Grass coverage at marten locations was significantly higher than at random locations (m030 t=4.0 P<0.01; m040 t=3.8 P<0.01; m060 t=4.2 P<0.01; combined marten t=4.8 P<0.01) and varied little among martens (range=37-38%). Grass cover was more likely to be found at marten locations than at random points. Frequency of occurrence of non-grass monocots (*Carex spp., Xerophylum tenax)* was significantly higher for marten 030 (chi-square=14.2, df=1 P<0.01) and combined marten (chi-square=12.9, df=1 P<0.01) locations, than at random plots. But percent coverage was not statistically different from coverage at random points. Forbs were rare at marten locations, and at random points. Marten 030 locations had a significantly lower mean percent coverage of shrubs (t=2.4, P=0.02) than that at random points. Other marten did not show differences from random points with respect to percent coverage or frequency of shrubs.

Marten locations on the Flats had a lower percent coverage of the non-vegetated cover type (m140, t=4.9 P<0.01; m150, t=2.8 P<0.01; m578, t=5.0 P<0.01; all marten, t=6.8; P<0.01) than did random locations (Table 21). The non-vegetated cover type was also underepresented at marten locations (m140, chi-square=18.2 df=1 P<0.01; m150, chi-square=14.7 df=1 P<0.01; m578, chi-square=7.6 df=1 P=0.01; all marten, chi-square=15.0 P<0.01). Slash coverage was higher for marten 578 (t=5.2 P<0.01) and all marten combined (t=3.3, P=<0.01). However this result is based on 8 locations. Naturally accumulated downed woody material covered more area at all marten locations (m140, t=4.0 P<0.01; m150, t=3.0 P<0.01; m578, t=2.3 P=0.02; combined marten, t=4.0 P<0.01)

Table 21. Mean percent coverage by cover type and frequency of locations in a particular cover type for the Flats study area. Values in parentheses are standard deviations. Underlined values indicate significant differences from random random points at the 0.05 error level.

Cover type		Random n=74	m140 n=37	m150 n=20	m578 n=43	All marten n=120
Non Vegetated						
	Percent	45	20	25	22	23
	coverage	(25)	(13)	(22)	(18)	(17)
	Frequency	99	73*	75*	86*	79*
Slash						
	Percent	13			70	54
	coverage	(6)			(40)	(43)
	Frequency	16	3*	0	9	7*
Natural Accumulation						
	Percent	15	27	26	21	27
	coverage	(8)	(15)	(19)	(14)	(17)
	Frequency	9	81*	80*	88*	87*
Grass						
	Percent	23	33	34	31	32
	coverage	(13)	(14)	(21)	(13)	(14)
	Frequency	73	100*	85	100*	98*
Grass Like						
	Percent	14	40		13	17
	coverage	(6)	(17)		(6)	(15)
	Frequency	19	8	0*	7	12
Forb						
	Percent	20	10			9
	Coverage	(16)	(0)			(8)
	Frequency	68	8*	0*	0*	7*
Shrub						
	Percent	18	22	32	22	23
	coverage	(12)	(10)	(27)	(22)	(20)
	Frequency	58	59	90*	91*	73*

*Indicates significant difference between random and marten locations at the 0.05 error level (chi-squares).

and occurred more frequently at marten locations (m140, chi-square=12.5 df=1 P<0.01; m150, chi-square=7.3 df=1 P=0.01; m578, chi-square=20.7 df=1 P<0.01; all marten, chi-square=37.0 df=1 P<0.01) than at random points. As in the Big Hole, grass coverage was significantly higher at marten locations (m140, t=3.6 P<0.01; m150, t=2.7 P=0.01; m578, t=3.3 P=0.01; all marten, t=4.2 P<0.01) than at random points. Grass was also found with higher regularity at marten locations when compared to random locations (m140, chi-square=12.2 df=1 P<0.01; m578, chi-square=14.0 P<0.01; combined marten, chi-square=26.4 df=1 P<0.01). Marten 140 had a significantly higher coverage of grasslike plants (t=4.8, P<0.01) while marten 150 locations were void of grasslike vegetation (chi-square=4.4, df=1 P=0.04). Forbs occurred in 68% of random locations, but were essentially non-existent at marten locations (m140, chi-square=35.0 df=1 P<0.01; m150, chi-square=28.9 df=1 P<0.01; m578, chi-square=50.7 df=1 P<0.01; combined marten, chi-square=81.0 df=1 P<0.01). Shrub coverage at marten locations was only significantly higher for marten 150 (t=2.8, P=0.01), but shrubs occurred at higher than expected frequencies for martens 150 (chi-square=7.0, df=1 P=0.01), 578 (chi-square=13.8, df=1 P<0.01) and all marten combined (chi-square=4.8, df=1 P=0.03).

Small Mammal Trapping

Spring/Fall

All sites on the Big Hole study area were trapped during the fall trapping period . Deer mouse (*Peromyscus maniculatus*) captures ranged from 1.0 captures/100 trap nights to 4.7 captures/100 trap nights. Red-backed vole (*Clethrionomys gapperi*) captures ranged from 2.7 captures/100 trap nights to 9.3 captures/100 trap nights. (Appendix A Table 31). Captures were not statistically different among habitat types on the Big Hole study area (Table 22) except for red-backed vole captures during the fall. No red-backed voles were trapped during the fall or spring on the clearcut.

Deer mouse capture rates on the Flats study area ranged from 0.67 captures/100 trap nights during spring in the willow type to 8.3 captures/100 trap nights during fall in the Douglas-fir type (Appendix A Table 32). Red-backed vole capture rates ranged from 1.0 capture/100 trap nights in the Lodgepole 1 type to 17.7 captures/100 trap nights in the Douglas fir type during the fall. Rodent captures for the spring/fall trapping periods were not evenly distributed across habitats on the Flats study area (Table 23), during the fall for total rodents, deer mice, or red-backed voles. Red-backed vole captures were not evenly distributed for any period.

Summer

Each grid on the Big Hole study area was sampled during 1991 and 1992. Deer mice were present on all grids in the Big Hole study area. Deer mouse survival and recruitment was higher during 1992 than in 1991 (Table 24). Deer mouse survival was highest on the spruce grid while recruitment was highest on the lodgepole grid. Red-backed voles were present on all grids except the clearcut. For grids trapped in 1991 and 1992, red-backed vole survival and recruitment was highest in 1992.

Table 22. Observed and expected captures/100 trap nights for total rodents, total deer mice (DM) and total red-backed voles (RBV) for spring/fall (F=fall, S=spring, F/S=fall/spring) small mammal trapping on the Big Hole study area.

Grid cover type	Observed			Expected			Chi-square		
	F	S	F/S	F	S	F/S	F	S	F/S
Dry Lodgepole									
Total rodent	6.0	5.7	5.8	8.6	6.4	6.6	0.8	0.1	0.1
Total DM	2.0	4.7	3.3	1.9	3.4	2.4	0.01	0.5	0.4
Total RBV	2.7	0	1.3	4.0	0	0.7	0.4	0	0.5
Wet Spruce/Fir									
Total rodent	13.3			8.6			2.6		
Total DM	2.7			1.9			0.3		
Total RBV	9.3			4.0			7.0		
Dry Spruce/Fir									
Total rodent	7.3			8.6			0.2		
Total DM	2.0			1.9			0.01		
Total RBV	4.0			4.0			0		
Clearcut									
Total rodent	7.7	7.0	7.3	8.6	6.4	6.6	0.1	0.1	0.1
Total DM	1.0	2.0	1.5	1.9	3.4	2.4	0.4	0.6	0.3
Total RBV	0	0	0	4.0	0	0.7	4.0	0	0.7
Chi-square total									
Total rodent							3.7	0.2	0.2
Total DM							0.7	1.1	0.7
Total RBV							11.4*	0	1.2

*P=0.01

Survival rates were highest for the spruce grid in 1991 and 1992, while recruitment was highest for the subalpine fir grid in 1991 and the spruce grid in 1992.

On the Flats study area only the Lodgepole 3 and Douglas fir grids were trapped in 1991 and 1992. All grids on the Flats study area had deer mice present. As in the Big Hole, deer mouse survival and recruitment was higher in 1992 than 1991 for those grids trapped in both years. Survival and recruitment for deer mice was highest in the Douglas fir type. Red-backed voles were also present on all grids.

Table 23. Observed and expected captures/100 trap nights for total rodents, total deer mice (DM) and total red-backed voles (RBV) for spring/fall (F=fall, S=spring, F/S=fall spring) small mammal trapping on the Flats study area.

Grid cover type	Observed			Expected			Chi-square		
	F	S	F/S	F	S	F/S	F	S	F/S
Lodgepole 1									
Total rodents	3.0	8.7	6.0	9.4	7.9	11.0	4.4	0.1	2.3
Total DM	2.0	2.7	2.4	3.3	2.7	4.1	0.5	0	0.7
Total RBV	1.0	0	0.4	5.1	1.9	5.2	3.3	1.9	4.4
Lodgepole 2									
Total rodents	2.0			9.4			5.8		
Total DM	0			3.3			3.3		
Total RBV	0			5.1			5.1		
Lodgepole 3									
Total rodents	6.7	5.3	6.0	9.4	7.9	11.0	0.8	0.9	2.3
Total DM	3.0	4.0	3.3	3.3	2.7	4.1	0.3	0.6	0.2
Total RBV	1.7	0	1.1	5.1	1.9	5.2	2.3	1.9	3.2
Lodgepole 4									
Total rodents		8.7			7.9			0.1	
Total DM		3.3			2.7			0.1	
Total RBV		3.3			1.9			1.0	
Willow									
Total rodents		6.0			7.9			0.5	
Total DM		0.7			2.7			1.5	
Total RBV		0.7			1.9			0.8	
Clearcut									
Total rodents		8.0			7.9			0.001	
Total DM		2.0			2.7			0.2	
Total RBV		0			1.9			1.9	
Douglas Fir									
Total rodents	26.0	10.7	21.1	9.4	7.9	11.0	29.3	1.0	9.3
Total DM	8.3	3.3	6.7	3.3	2.7	4.1	7.6	0.1	1.6
Total RBV	17.7	7.3	14.2	5.1	1.9	5.2	31.1	15.3	15.6
Chi-square Total									
Total rodents							40.3*	2.6	13.9*
Total DM							11.7*	2.5	2.5
Total RBV							41.8*	22.8*	23.2*

*$P \leq 0.01$

Table 24. Minimum number alive, survival, and recruitment from 100 m x 100 m trapping grids for deer mice and red-backed voles on the Big Hole and Flats study areas during July, August and September of 1991 and 1992.

Study area and grid cover type	Deer mice						Red-backed voles					
	1991			1992			1991			1992		
	1	2	3*	1	2	3	1	2	3	1	2	3
Big Hole												
Clearcut												
MNA**	0	0	4	2	2	4						
SURV					0	0	No voles caught					
REC			1		1	1						
Spruce												
MNA	11	19	18	7	8	9	8	16	11	1	4	6
SURV		0.73	0.42		0.71	1		0.86	0.39		1	0.50
REC		0.58	0.56		0.38	0.11		0.56	0.54		3	0.66
Subalpine fir												
MNA	No deer mice			1	0	1	6	14	13	5	9	8
SURV	caught				0			0.30	0.38		0	0.56
REC					0	1		0.86	0.61		1	0.38
Lodgepole												
MNA	1	0	5	3	3	10	2	1	7	No voles		
SURV		0	0		0.33	0.33		0	0	caught		
REC		0	1		0.67	0.90		1	1			
Flats												
Lodgepole 1												
MNA	Not			2	1	1	Not			3	6	4
SURV	trapped				0	0	trapped				0.50	0.20
REC					1	1					0.83	0.75
Lodgepole 2												
MNA	Not			13	10	8	Not			4	2	1
SURV	trapped				0.54	0.70	trapped				0.33	0
REC					0.33	0.25					0.50	1
Lodgepole 3												
MNA	17	25	16	5	4	4	1	3	5	3	2	1
SURV		0.59	0.42		0.66	0.50		1	0.50		0	1
REC		0.60	0.38		0.50	0.50		0.66	0.80		1	0
Douglas fir												
MNA	11	16	14	11	6	19	22	26	33	13	16	28
SURV		0.91	0.38		0.45	1		0.41	0.72		0.65	0.57
REC		0.38	0.57		0.17	0.68		0.65	0.52		0.56	0.71

*Trapping period

For grids trapped in 1991 and 1992, survival and recruitment for red-backed voles was highest in 1991. For both trapping periods combined, the Lodgepole 3 grid had the highest survival rate, while recruitment was equal between the Lodgepole 3 and Douglas fir grids.

Rodent captures on the Big Hole study area ranged from 0.3 deer mice/100 trap nights on the subalpine fir grid to no captures of red-backed voles on the clearcut grid (Appendix A Table 33). On the Flats study area, rodent captures ranged from 1.3 deer mice/100 trap nights on the lodgepole 1 grid to 26.3 combined rodent captures/100 trap nights on the Douglas fir grid.

Summer small mammal trapping showed that captures were not evenly distributed among habitat types on the Big Hole study area (Table 25) except for total rodent captures in 1992. Rodent captures were consistently higher than expected on the spruce grid and consistently lower than expected on the clearcut and lodgepole pine grids. On the subalpine fir grid, deer mouse captures were lower than expected in both years, while red-backed vole captures were higher than expected in 1991 and 1992.

Only two grids were trapped on the Flats study area during 1991 and 1992, with the other two trapped only in 1992 (Table 26). Captures were not evenly distributed among habitats on the Flats. Lodgepole grids generally had lower than expected rodent captures, while the Douglas-fir grid had higher than expected captures.

Capture success for deer mice and red-backed voles (excluding the clearcut grid) was not significantly different on the Big Hole study area (Figure 4). Eighty-one deer mice were trapped in 1800 trap nights versus 85 red-backed voles. In 1200 trap nights significantly more deer mice were caught on the Flats (excluding the Douglas-fir grid), than red-backed voles (chi-square=13.9, df=1 P<0.01).

Table 25. Observed and expected captures for total rodents, total deer mice and total red-backed voles for summer small mammal trapping on the Big Hole study area during 1991 and 1992.

Grid cover type	Observed			Expected			Chi-square		
	91	92	91/92	91	92	91/92	91	92	91/92
Clearcut									
Total rodent	23	21	44	34.0	26.5	60.5	3.6	1.1	4.5
Total DM	3	6	9	11.0	11.5	22.5	5.8	2.6	8.1
Total RBV	0	0	0	15.5	5.8	21.3	15.5	5.8	21.3
Spruce									
Total rodent	63	36	99	34.0	26.5	60.5	24.7	3.4	24.5
Total DM	34	24	58	11.0	11.5	22.5	48.1	13.6	56.0
Total RBV	26	9	35	15.5	5.8	21.3	7.1	1.8	8.8
Subalpine fir									
Total rodent	32	32	64	34.0	26.5	60.5	0.1	1.1	0.2
Total DM	1	2	3	11.0	11.5	22.5	9.1	7.8	16.9
Total RBV	28	14	42	15.5	5.8	21.3	10.1	11.6	20.1
Lodgepole									
Total rodent	18	17	35	34.0	26.5	60.5	7.5	3.4	10.7
Total DM	6	14	20	11.0	11.5	22.5	2.3	0.5	0.3
Total RBV	8	0	8	15.5	5.8	21.3	3.6	5.8	8.3
Chi-square Totals*									
Total rodent							35.9*	9.0	39.9*
Total DM							65.3*	24.5*	81.3*
Total RBV							36.3*	25.0*	58.5*

*P<0.01

Deer mouse and red-backed vole biomass lost over a 2-week period varied among grids and years (Table 27). More than twice as much red-backed vole biomass was lost over a 2-year period than was deer mouse biomass on the Big Hole study area (excluding the clear cut grid), even though numbers of rodents were about equal. On the Flats study area the opposite was true. More than twice as much deer mouse biomass was lost compared to red-backed voles (excluding the Douglas-fir grid).

Table 26. Observed and expected captures for total rodents, total deer mice and total red-backed voles for summer small mammal trapping on the Flats study area during 1991 and 1992.

Grid cover type	Observed 91	Observed 92	Observed 91/92	Expected 91	Expected 92	Expected 91/92	Chi-square 91	Chi-square 92	Chi-square 91/92
Lodgepole 1									
Total rodent		34			43.0			1.9	
Total DM		4			13.8			7.0	
Total RBV		11			19.0			3.4	
Lodgepole 2									
Total rodent		39			43.0			0.4	
Total DM		17			13.8			0.7	
Total RBV		7			19.0			7.6	
Lodgepole 3									
Total rodent	61	20	81	70.0	43.0	119.5	1.2	12.3	12.4
Total DM	39	9	48	28.5	13.8	45.5	3.9	1.7	1.4
Total RBV	8	5	13	31.0	19.0	60.0	17.1	10.3	36.8
Douglas fir									
Total rodent	79	79	158	70.0	43.0	119.5	1.2	30.1	12.4
Total DM	18	25	43	28.5	13.8	45.5	3.9	9.1	0.1
Total RBV	54	53	107	31.0	19.0	60.0	7.4	60.8	36.8
Chi-square Totals									
Total rodent							2.4	44.7*	24.8*
Total DM							7.8*	18.5*	1.5
Total RBV							24.5*	82.1*	73.6*

$^{*}P \leq 0.01$

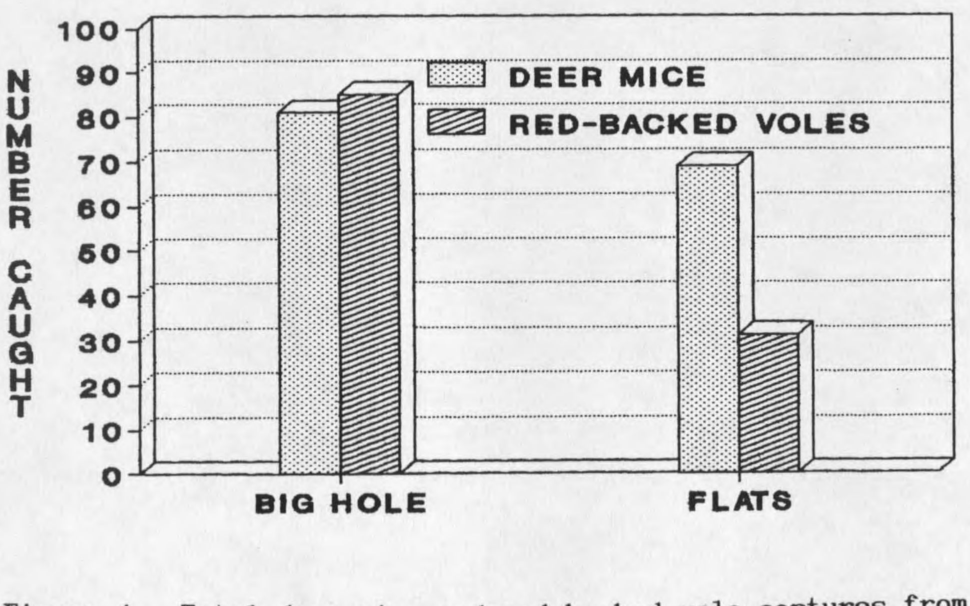

Figure 4. Total deer mice and red-backed vole captures from 100 m x 100 m trapping grids from 1991 and 1992.

Table 27. Total deer mouse and red-backed vole biomass (grams) lost from 100 m x 100 m trapping grids in 1991 and 1992 on the Big Hole and Flats study areas.

Study area and grid cover type	Deer mice 1991	Deer mice 1992	Deer mice Total	Red-backed voles 1991	Red-backed voles 1992	Red-backed voles Total
Big Hole						
Clearcut	0	42	42		No voles caught	
Spruce	48	40	88	13	36	49
Subalpine fir	No deer mice caught	0	0	101	125	226
Lodgepole pine	22	34	56	46	No voles caught	46
Flats						
Lodgepole 1	Not trapped	41	41	Not trapped	20	20
Lodgepole 2	Not trapped	104	104	Not trapped	44	44
Lodgepole 3	98	37	135	0	29	29
Douglas fir	17	80	97	256	88	344

Rest Site Selection and Red Squirrel Midden Association

Pine marten on both the Flats and Big Hole study areas used some rest sites more than once (Table 28). Resting episodes of 2 Big Hole marten occurred between 28% and 32% of the time at 3 different rest sites. Over half of the resting episodes for martens 140 and 578 were at 6 and 7 different sites, respectively. One male and one female marten from the Flats study area, as well as the remaining female on the Big Hole study area had no rest sites used more than once.

Table 28. Percentage of total resting episodes that occurred at a rest site more than one time, for 2 marten from the Big Hole study area and 3 marten from the Flats study area.

Marten	Number of rest sites used more than once	Total number of rest episodes	% of rest episodes that that occurred at a rest site more than 1 time
Big Hole			
m030	3	25	32
m040	3	25	28
Flats			
m140	6	36	56
m150	2	15	27
m578	7	37	57

One rest site on the Big Hole study area was used by martens 040 and 060 on 2 different occasions.

Resting episodes took place on the ground or in tree nests constructed by red squirrels (*Tamiasciurus hudsonicus*). Forty-three percent of the resting episodes in February on the Big Hole study area occurred on the ground (Figure 5). By April, all resting episodes were in trees. On the Flats study area, 93% of the resting episodes in January were on the ground. By May, all resting episodes were in trees (Figure 6). Of 64 total resting episodes on the Big Hole study area, 77% were in trees. Of 110 total resting episodes on the Flats study area 52% were in trees (Figure 7).

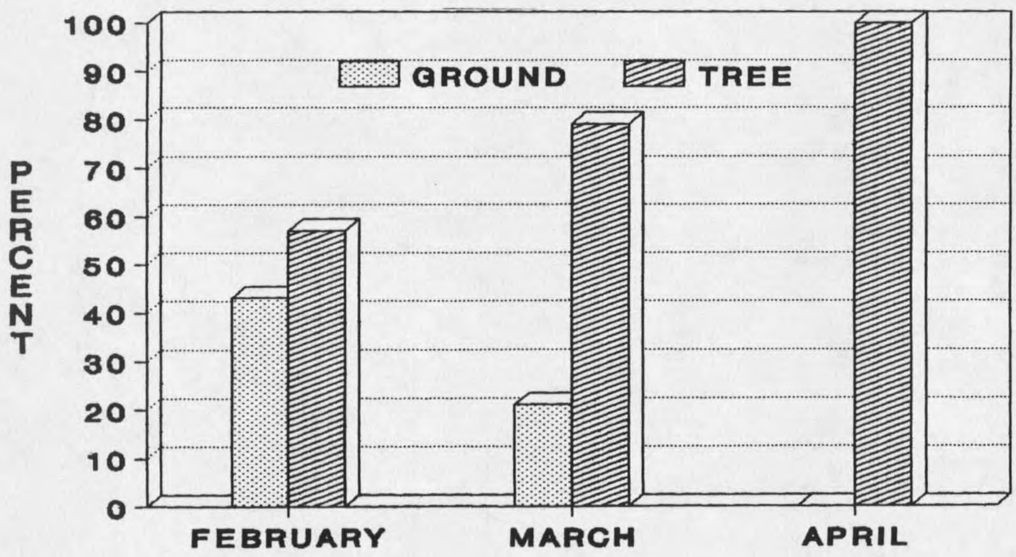

Figure 5. Percentage of rest episodes occurring in tree and ground rest sites by month on the Big Hole study area.

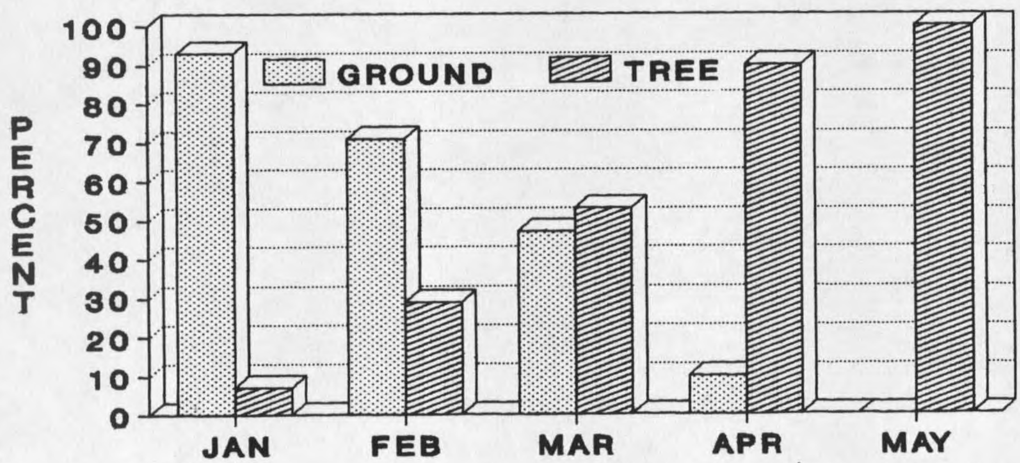

Figure 6. Percentage of rest episodes occurring in tree and ground rest sites by month on the Flats study area.

At each rest site I also recorded if a red squirrel midden was present within a radius of 11.3 m of the actual rest site (Figure 7). Forty-six and 64% of the total rest sites on the Big Hole and Flats study areas were associated with a squirrel midden.

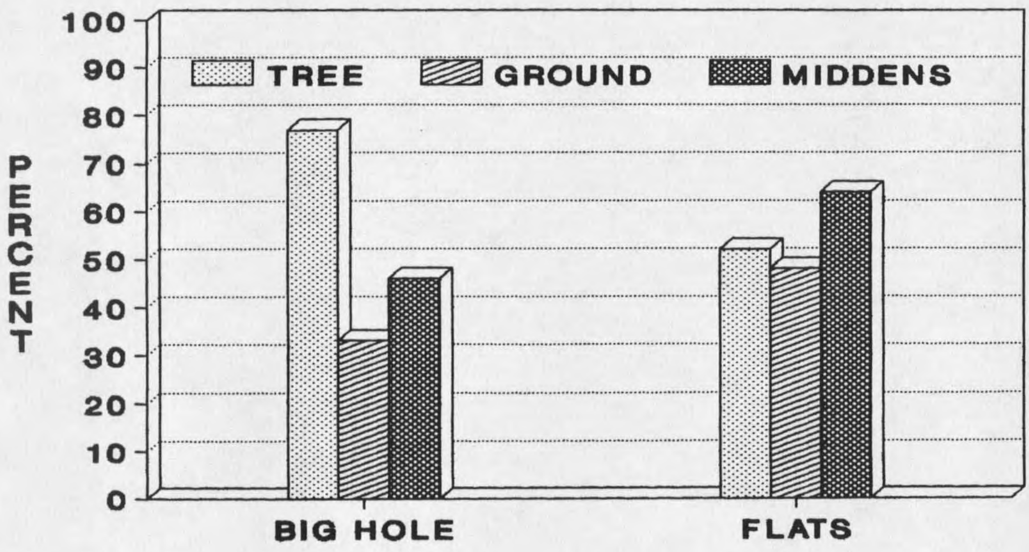

Figure 7. Percentage of total resting episodes occurring in ground and tree rest sites for the Big Hole (n=64) and Flats (n=110) study areas, and percentage of total rest sites with a squirrel midden present.

DISCUSSION

Harvest Dynamics

Two of the 4 study areas were intensively trapped by fur trappers for most of the 1991-1992 trapping season. Trappers in Beaver Creek trapped a smaller area, but trap density was 2-2.5 times greater than on the Mosquito Gulch site. The trapper in Mosquito Gulch spread his traps over a much larger area with about 2 traps/km. Differences in these approaches are likely due to the accessibility of these two areas. Beaver Creek is accessible by one road and a series of trails. Over 100 km of groomed snowmobile trails afford the opportunity to trap a large area on the Mosquito Gulch site.

Harvest of marten from the Beaver Creek area during the 1991-1992 season was the highest since monitoring began during the 1989-1990 trapping season (Fager 1991, Kujala 1993). This level is comparable to harvest levels prior to the 1989-1990 season (Fager 1991). Marked marten in the Beaver Creek area found in the harvest were in the lowest percentage since the 1989-1990 harvest. Marten harvests on the Mosquito Gulch site have steadily increased since the 1985-1986 season. The 1991-1992 harvest represented the highest catch (Fountaine pers. comm.). Quick (1956) believed that if kill levels are sustained over a period of years within a well defined area it can be assumed that the level of exploitation is not inimical to the population. However, this description of production potential is conservative and one cannot know how many more individuals could be taken without overexploiting the population (Quick 1956).

Juvenile marten appeared to be more vulnerable to trapping than adults in all study sites. Juveniles have not established a home range and tend to wander more than adults, making them more likely than adults to encounter traps. Lack of experience may also make them more susceptible than adults to traps (Strickland and Douglas 1987). Quick (1956) considered juveniles to be more abundant than any other age class and believed they could sustain the brunt of trapping pressure. Strickland et al. (1982) aged 1,300 marten caught by trappers from 1973 to 1978. Approximately 60% were less than 12 months of age, and most juvenile marten were harvested early in the season. They suggest the large percentage of young harvested early in the season can be used as a management method to select for young, nonbreeding animals.

Most of the harvest in both the Mosquito Gulch and Beaver/Tepee Creek areas consisted of marten less than 20 months old. Data from Strickland and Douglas (1987) as well as Archibald and Jessup (1984) showed that ovulation in marten less than 12 months old was extremely rare. Based on their data, I doubt that any of the juvenile age class had bred during the previous summer. Strickland and Douglas (1987) stated that in Ontario a ratio in the harvest of more than 3 juveniles to 1 adult female $\geq$ 2.5 years old represented an acceptable harvest. Juvenile marten from the Mosquito Gulch and Beaver/Tepee catches outnumbered female marten $\geq$ 2.5 years old, 3.3:1 and 3:1, respectively. Proportions of juveniles harvested statewide (Appendix B Figure 9) and in southwest Montana (Administrative Region 3, MDFWP) (Appendix B Figure 10) showed a marked decrease during the 1991-1992 trapping season. Juveniles in the harvest dropped from greater than 50% of the harvest to less than 40%. Captures of juveniles on the Mosquito Gulch and Beaver/Tepee areas were also less than 40%. Weckwerth and Hawley (1962) showed that the abundance and composition of the marten population was directly associated with the abundance of small mammals. My small mammal data do not support or refute the suggestion that a decline in small mammal numbers was the cause for the decreased catch of juveniles.

More males were livetrapped and trapped by furtrappers than females on all study areas. All adult males marked previous to the trapping season were caught by fur trappers in both areas. While sex ratios of marten at birth are about 1:1 (Yeager 1950), males are consistently found more frequently in catches (Yeager 1950, de Vos 1951, Quick 1956, Archibald and Jessup 1984). Yeager (1950) felt the wide foraging habits of the male increased its chances of finding sets. Two adult males collared on the Flats previous to the trapping season were trapped on the Mosquito Gulch site, adding credence to Yeagers' hypothesis. Fager (1991), however, felt that marten on the Flats avoided capture primarily because of their large home ranges. Depending on the distribution of traps over a large area, wide ranging marten may or may not be more vulnerable to trapping.

Sex ratios of marten trapped in the Mosquito Gulch and Beaver/Tepee Creek areas in 1992 were within ranges reported for marten harvested over all of southwest Montana (Administrative Region 3, MDFWP) from 1985 to 1992 (Appendix B Figure 11). Strickland and Douglas (1987) suggest that sex ratios can be used to evaluate harvest intensity and that a sex ratio which is nearly equal to or skewed towards females probably indicates overharvest. According to this criterion, harvests on both the Mosquito Gulch and Beaver/Tepee areas were appropriate. Because sex ratios in the population may vary with food abundance, sex ratios in the harvest were not regarded as good an indicator of harvest density as the ratio of juveniles to females (Strickland and Douglas 1987).

Each area where marten were harvested in this study was adjacent to an area where very little or no trapping occurred. Most marten that moved from these untrapped regions to those areas that were trapped probably consisted of young of the year (Quick 1956). Considering the number of juveniles in the Mosquito Gulch harvest and the yearly increase in numbers of marten caught from 1985 to 1992, dispersal from untrapped refuges may be important in augmenting the Mosquito Gulch population.

Sixty percent of the marten livetrapped on the Big Hole study area were classified as juveniles. However, the Big Hole study area was not trapped during the 1990-1991 or 1991-1992 trapping seasons leaving doubt as to whether or not these animals dispersed from other areas or are simply progeny of the resident population. Fager (1991) and Kujala (1993) also felt that surrounding untrapped areas may act as marten reservoirs. Refuges and untrapped areas have been identified as an important tool in managing the harvest of pine marten (de Vos 1951, Quick 1956, Archibald and Jessup 1984).

Population Monitoring

Relative population density calculated from 1-km track transects indicated marten densities were highest in Beaver Creek followed by the Big Hole and Flats study areas. Thompson et al. (1989) found that numbers of tracks were significantly correlated with live captures of marten. They felt that track abundance can be used as an index of populations. My livetrapping results suggested that highest marten densities occurred on the Big Hole followed by the Flats and Beaver Creek. I believe that the livetrapping estimates were more likely to be valid. Track counts were infrequent due to low snowfall and were based on sample units that were too small.

I agree with Kujala (1993) that a single marten is capable of leaving a large number of tracks on any 1 km piece of ground. Assuming every track represents an individual marten in areas that support low densities may severely overestimate a population. Trapping regulations dependent on track counts on short transects could allow for overharvests in these areas. In areas that support high densities of marten, short transect surveys may be more appropriate and not as critical.

Home Range and Movements

Home ranges varied between study areas. Generally, home ranges on the Flats were larger than those estimated for the Big Hole study area. Other investigators (Hawley and Newby 1957, Buskirk 1983, Wynne and Sherburne 1984) reported home ranges smaller than those I found. Raine

(1982) working in southeastern Manitoba recorded home ranges for juveniles that were similar to adults in the Big Hole. Home range sizes in western Newfoundland were most similar to the large home ranges I calculated for the Flats study area (Bateman 1986).

Buskirk and McDonald (1989) hypothesized that there was a strong relationship between home range size and site quality in terrestrial carnivores. More specifically, Soutiere (1979) attributed larger home ranges to high levels of clearcuting in Maine. Fager (1991) felt that the forest-grassland mosaic of the Flats area versus the more contiguous forests of the Big Hole study area resulted in larger home ranges on the Flats. Prey densities may also affect home range size (Thompson and Colgan 1987). Marten 040 was located 5 times foraging on a dead moose. This food source was the northern most point of his home range.

Marten 040 was followed for 2 consecutive years. His mean consecutive day movements during the winter of 1990-1991 (n=11) were 2.3 km (Kujala 1993) and 2.3 km during 1991-1992 (n=12). He also used essentially the same home area during both years.

Marten on both study areas, especially the Flats, were very mobile. Martens 140 and 150 routinely moved more than 7 km into Yellowstone Park in one night. I lost radio contact at ranges > 7 km, so the total area used by these two marten (as well as marten 080) was likely underestimated. Logging roads, groomed snowmobile trails, paved highways and small streams did not impede movements of marten on either study area. Hawley and Newby (1957) found that some home range boundaries were found to coincide with various vegetative or topographic features, including large meadows and burns. Most water ways within the study areas could be crossed on trees that had fallen across streams. Koehler and Hornocker (1977) stated that marten avoided meadows and burns in the winter. However, martens 140 and 150 could not have avoided crossing large areas of the 1988 North Fork fire based on radio signals that put them within the perimeter of the burn or in unburned islands.

Two marten from each area showed dispersal movements. I believe that the marten from the Big Hole were moving off the study area. I am less certain that the marten from the Flats were born there. They may have been dispersing from habitats south of the study area and only moving through the Flats. Numbers of radio locations for these marten while on the study areas ranged from 0-4 suggesting that they had not established themselves as residents. Marten 240 crossed the unfrozen Madison river between his last location in the spring of 1991 and his death in December 1991. Hawley and Newby (1957) documented a dispersal movement of 40 km that also required a large river crossing (North Fork of the Flathead) in northwest Montana. Raine (1982) reported a dispersal of 61 km in southeastern Manitoba. This was nearly twice as long as the maximum dispersal, 34 km, I observed.

Habitat Use

Large Scale Features

No single cover type was used exclusively by marten on the Big Hole study area. But mesic subalpine fir was used at greater than expected frequencies and marten avoided the xeric subalpine fir types.

While I found use of mesic sites to be greater than expected during my study, as did Fager (1991) and Kujala (1993), dry lodgepole pine was also important during the winter of 1991-1992. Both Fager (1991) and Kujala (1993) indicated avoidance of lodgepole pine by marten. Random plots measured by Fager (1991) revealed that lodgepole pine types ranked lowest with regards to canopy cover, trees per hectare, and downed woody material when compared to other types. Spencer et al. (1983) documented use of riparian lodgepole habitats in California, attributing this use to high densities of Microtus. Buskirk et al. (1989) indicated that juveniles rested mostly in lodgepole stands. They felt juveniles were displaced by adults from the more preferred spruce-fir stands and that juveniles were less experienced in selecting optimum resting areas. All collared marten on the Big Hole study area were adults and none of the lodgepole stands had a riparian association.

I found marten used old growth sites less than expected on the Big Hole study area. In contrast, Kujala (1993) found that marten selected areas of old growth. Marten in Kujala's study occupied the upper 1/2 of the study area where wetter stands of subalpine fir were more common. Marten in my study used the lower 1/2 where drier lodgepole pine and Douglas-fir stands were more common. This difference in old growth use between years could be because old growth attributes may be encountered more frequently in mesic subalpine fir habitats. Marten on the Flats appeared to seek out pockets, with older lodgepole pine. Marten habitat use was not restricted to old growth habitats.

No collared marten were located within the boundaries of clear cuts. Tracks were noted in areas that had regenerated for 20+ years. I saw no tracks in clearcuts up to 20 years old. These areas were lacking the structural features, such as downed woody material and large standing trees, that are necessary for marten to thrive. In addition to reducing winter habitat for at least 20 years, clearcuts and associated road building probably have a longer term affect by making marten more vulnerable to trapping. Using snowmobiles on roads created for logging operations makes larger areas accessible to trappers. In addition marten movements are restricted to uncut strips of timber. As the amounts of clearcuts increase in an area, movements of marten become more predictable, and they are easier to trap.

Medium Scale Features

Marten on both study areas selected areas of greater than average basal area. Basal area is influenced by the number of stems/hectare and the average stand diameter. On the Big Hole study area, marten used stands of trees with larger diameters, hence, greater basal area. On the Flats, average stand diameter was no different than that for random points. But unlike the Big Hole, marten on the Flats occupied areas with greater densities of trees/hectare which resulted in a significantly greater basal area than that found at random points. Soutiere (1979) believed harvesting methods that maintain a residual stand of 20-25m^2/ha basal area in pole and larger trees provided adequate habitat for marten in a spruce-fir-hardwood forest in Maine. I am uncertain what an acceptable minimum basal area would be in southwest Montana.

The mean stand density index calculated for marten locations was significantly larger than the mean at random points. The stand density index (SDI) is a relative measure of stand density that provides a relationship between stand basal area, trees per hectare, and average stand diameter (Reineke 1933). SDI's conveys more information about canopy closure, competition, and volume than basal area or trees/hectare. McCarter and Long (1986) indicate SDI is useful in examining the consequences of various management objectives or constraints. Daniel et al. (1979) and McTague and Patton (1989) feel that the stand density index may have the potential of measuring the stand density of uneven-aged forests more reliably than stand basal area alone.

Use of downed woody material by marten has been amply documented in the literature. It is important for resting (Spencer 1987, Buskirk et al. 1989, Fager 1991, Martin and Barrett 1991, Corn and Raphael 1992, Kujala 1993) and foraging, (Campbell 1979, Bateman 1986). Marten, however, did not seek out areas on the Big Hole study area that had higher than average amounts of downed woody material. Fager (1991) also noted this pattern and attributed this to the relatively even distribution of woody debris across the Big Hole landscape. On the Flats, downed woody material occured less frequently and was patchy in distribution. Those areas of the Flats where higher accumulations of downed woody material existed were sought out by marten.

Small Scale Features

On both the Big Hole and Flats study areas, micro-sites used by marten were characterized by a significantly higher number of trees than found at random sites. Live trees seemed to be of particular importance to marten on both areas. Live trees may have been important due to the high use of red squirrel grass nests on both areas. Most nests occurred in live trees. Snags occurred at marten locations in similar sizes and numbers to those at random sites. A higher proportion of marten locations on the Flats had snags present compared to random points. This was probably an artifact of marten selecting more mature portions of the lodgepole pine on the Flats.

If the decay class is important in the selection of downed woody material, as suggested by Corn and Raphael (1992), my gross classifications of "sound" or "rotten" were not refined enough to make such a distinction on the Flats study area. Marten in the area did appear to select for larger diameter "sound" and "rotten" downed woody material, but I think that marten were simply responding to larger diameter downed woody material rather than the designated decay classes.

However, marten on the Big Hole study area could be avoiding rotten downed woody material. Marten locations on the Big Hole had a significantly lower occurrence of downed woody material than at random sites. This could also be explained by the high use of red squirrel tree nests and the higher use of lodgepole pine habitats because lodgepole pine has been shown to have less downed woody material compared to all other types in the area (Fager 1991).

Micro-sites were also characterized by a higher coverage of grasses than random locations on both study areas. Bitterbrush occurred more frequently at marten locations on the Flats. Douglass (1989), following radio collared deer mice, found that the microhabitat at telemetry positions had greater values for bitterbrush and grass cover than in the representative sample. Marten may be keying in on microsites that are structurally adequate and support healthy densities of rodents.

Small Mammal Dynamics

Small mammal captures were not evenly distributed across either study area. Greatest total rodent capture success, species composition, and survival were in mesic areas that were moderate to high in structural complexity. Marten also selected similar habitats. The Lodgepole 2 and Willow spring/fall grids were mesic sites but were lacking in live trees and downed woody material. These sites had low captures of rodents, particularly deer mice and red backed voles.

Total rodent captures on clearcuts were similar to numbers of rodents trapped in other cover types. This was because of fairly high numbers of chipmunks and ground squirrels. Although the presence of ground squirrel (*Citellus columbianus*) remains in marten scats suggested to Koehler and Hornocker (1977) that marten used open habitats during the summer and fall, rodents such as golden mantled ground squirrels (*Spermophilus lateralis*) and yellow pine chipmunks that I trapped on clearcuts, hibernate during the winter and were unavailable to marten. Rodents that would be available to marten during the winter, such as deer mice and red backed voles, were captured in low numbers or absent. Although marten are thought to occasionally extract hibernating rodents (Buskirk and McDonald 1984), I believe that the lack of overhead cover on clearcuts kept marten from even attempting to exploit this food source. Hawley and Newby (1957) felt that openings served as psychological barriers.

When I excluded the clearcut on the Big Hole study area, no difference existed in numbers of red-backed voles and deer mice caught during the summers of 1991 and 1992. But twice as much red-backed vole biomass was lost over 2 years than deer mouse biomass. This relationship was not as evident on the Flats. Excluding the Douglas-fir grid, 3 times more deer mouse biomass disappeared than did red-backed vole biomass, but numbers of deer mice caught were 2 times greater than red-backed vole numbers. Predation risks are higher or lower for certain species depending on the habitats they are found in. Longland and Price (1991) found that habitat structure did affect the predation risk for two bipedal and two quadrupedal heteromyid rodent species.

Winter food habits of Montana pine marten (Aune and Schladweiler 1993) (Appendix B Figure 12), while varied, are centered around small mammals (*Microtus, Cleithrionomys, Peromyscus*). Voles (*Microtus, Cleithrionomys)* have been documented as important or preferred prey items (Lensink et al. 1955, Quick 1955, Murie 1961, Weckwerth and Hawley 1962, Douglass 1983, Buskirk 1984) of marten in many areas. Microtus spp. were encountered very rarely during spring/fall and summer small mammal trapping. Based on these data, and the fact that deer mice and red-backed voles were the two most abundant species of rodents trapped, it seems feasible that red-backed voles and deer mice would be the primary items in the winter diet of pine marten on both study areas.

Marten were found to frequent areas characterized by a higher structural complexity. The same areas also contained higher densities of small mammals, specifically red-backed voles and deer mice, than did other habitats.

Red squirrels were abundant and active on both study areas during the winter, however, I did not attempt to quantify their abundance. In preliminary scat analysis, I found red squirrel remains in 5 of 14 scats from the Flats. Reports of red squirrels in the diet of marten varies from little or no use (Murie 1961, Weckwerth and Hawley 1962, Bateman 1986) to being relatively important (Buskirk and McDonald 1984, Raine 1987).

Rest Site Selection

Talus slopes (2 locations), snags, downed woody material, and red squirrel tree nests were all used by marten as rest sites, with most resting episodes occurring in association with the latter two. Snags have been identified by some (Martin and Barrett 1983) as important to marten for resting. Some marten during my study did use snags as rest sites, but neither Fager (1991), Kujala (1993), nor myself found evidence of strong preference for areas with abundant snags. Snags probably are more important as sources of future downed woody material.

During my study, downed woody material was the second most commonly used resting structure. Subnivean resting sites on the Flats study area were affiliated with larger diameter downfall than that found at random sites. Marten may be keying on access sites provided by large downfall (Corn and Raphael 1992) or the large deadfall itself

(Kujala 1993). While it was only the second most used resting structure, its importance to the survival of pine marten during severe winters must not be overlooked. Marten possess extremely limited reserves of body fat (Buskirk and Harlow 1989); their fur is not exceptionally insulative (Scholander et al. 1950 cited in Buskirk 1988); and they have a relatively high surface area to mass ratio (Iverson 1972). Buskirk et al. (1988) measured the lower critical temperature of marten at 16 C. These morphological and physiological traits pose a serious thermoregulatory dilemma for marten during winter. Selection of subnivean resting sites associated with downed woody material during the coldest weather minimizes rates of energy loss by conserving body temperature (Buskirk et al. 1989). Some marten showed high fidelity to certain rest sites.

Red squirrel tree nests were the most frequently used resting structure during the winter of 1991-1992 on both the Big Hole and Flats study areas. Over half of the resting episodes on both study areas were in tree canopies. This extensive use of red squirrel tree nests during winter has not been reported elsewhere. Spencer (1987) noted some use of tree limbs and Buskirk (1984) recorded the use of three grass nests in Alaska.

The winter of 1991-1992 was relatively mild on both study areas with respect to temperature and snowfall. I believe the most likely explanation of this preference for tree nests was the above normal daytime temperatures characteristic of this winter. Daytime temperatures, as well as the insulative properties of the grass, must have been adequate for marten to maintain body temperature. On many days temperatures above the snow may have been warmer than those beneath the snow. If marten prefer tree nest sites over ground resting sites, and this use is dictated by the ambient temperature, then one would expect use to be greatest during the summer months. Wynne and Sherburne (1984) found that all resting sites used by males were in tree canopies during the summer in Maine.

Another possible explanation for use of tree nests would be predator evasion. Coyotes were common on both of my study areas, raising the possibility that tree nests were used to avoid predators. Tree nests would allow marten to avoid coyotes. This unexpected utilization of red squirrel nests and association of rest sites with squirrel middens raises interesting questions about rest site preferences and red squirrel-pine marten relationships, beyond a predator-prey relationship.

CONCLUSIONS

Pine marten harvests in the Mosquito Gulch and Beaver Creek areas during the 1991-1992 trapping season appeared to be at acceptable levels given the number of individuals actively trapping in each area and the effort exerted by each. Trapping intensity in the study areas is apparently dictated by the accessibility of an area. Fur prices, expenses associated with trapping and perceived marten populations also may play a role. Although trappers tend to regulate their harvests based on perceived population levels, the other factors are not tied to population levels so regulation of trapping is necessary.

There are several approaches to harvest management which could benefit marten populations. By promoting strategies that are biased to males and juveniles, the breeding stock of an area can be preserved. Continued monitoring of sex and age structures of harvested animals is essential to effective pine marten management. Effects of refuges and untrapped areas warrant further study in Montana, as it has potential to be a valuable management tool in areas with high trapping pressure.

When specific age and sex information is unavailable winter track counts are probably the most feasible method for monitoring trends in marten populations. Transects, however, should be longer than 1 km and possibly modified to account for multiple crossing of the transect by an individual.

Marten home range size and movements are likely tied to site quality and prey availability. Marten during my study were very mobile. Gravel roads, paved highways, groomed snowmobile trails, or small streams did not inhibit movements.

Most forested environments on the Big Hole and Flats study areas are suitable for pine marten survival. Each area has adequate amounts of overhead cover and/or downed woody material, which are the very basic structural elements that make areas of the forest acceptable to marten. What makes these areas attractive to marten most likely depends on the size, amount, and placement of structural elements across the landscape in addition to their association with prey items. While marten were found in the more "traditional" mesic habitats during my study, marten on the Big Hole study area made extensive use of less traditional cover types such as lodgepole pine. Presence of marten in southwest Montana is not contingent on abundant quantities of contiguous old growth forest, as marten are not restricted to old growth. Marten do seem to prefer traits associated with more mature timber stands such as larger diameter trees and downed woody material. Silvicultural measurements such as basal area, trees/hectare, and stand density indices may be helpful in assisting land managers to more easily visualize pine marten habitat requirements.

Marten exploited rest sites in the tree canopy, and in the more documented subnivean sites. This behavior may have been due to mild winter weather.

Prey availability must influence habitat selection in pine marten. Because the marten is in many ways maladapted to harsh winter climates, it must have access to a reasonably constant food supply to survive.

Cover types favored by marten tended to have more, or more vulnerable, red-backed voles and deer mice than less favored cover types. Habitat structure as well as species composition influenced prey availability.

Many forested environments suitable for marten in southwest Montana are isolated from sources of recolonization by extensive open valleys. Areas of contiguous habitat are being fragmented by human land uses. This fragmentation and isolation makes local populations vulnerable to overexploitation. However, this study has shown that marten can use disturbed habitats and have excellent immigration abilities. Nevertheless, a monitoring system for pine marten and its habitat in southwest Montana would be most valuable at the sub-regional level if it considered isolated populations and fragmented habitats.

REFERENCES CITED

References Cited

Archibald, W. R., and R. H. Jessup. 1984. Population dynamics of the pine marten *Martes americana*, in the Yukon Territory. Pages 81-97 *in* R. Olsen, R. Hastings, and F. Geddes, eds. Northern ecology and resource management. Univ. Alberta Press, Edmonton.

Aune, K. E., and P. Schladweiler. 1993. Wildlife laboratory annual report. December 1993. Montana Dept. of Fish, Wildl. and Parks. Helena, MT. 68pp.

Bateman, M. C. 1986. Winter habitat use, food habits, and home range size of the marten, *Martes americana*, in western Newfoundland. Can. Field-Na. 100:58-62.

Brown, J. K. 1974. Handbook for inventorying downed woody material. U.S.D.A. For. Serv. Gen. Tech. Rep. INT-16. Intermountain Forest and Range Experiment Station, Ogden UT. 34pp.

Buskirk, S. W. 1983. The ecology of marten in southcentral Alaska. Ph.D. Thesis, Univ. Alaska, Fairbanks. 131pp.

Buskirk, S. W. 1984. Seasonal use of resting sites by marten in south central Alaska. J. Wildl. Manage. 48:950-953.

Buskirk, S. W., and H. J. Harlow. 1989. Body-fat dynamics of the American marten, *Martes americana,* in winter. J. Mammal. 70:191-193.

Buskirk, S. W., H. J. Harlow, and S. C. Forrest. 1988. Temperature regulation in American marten. Nat'l. Geog. Res. 208-218.

Buskirk, S. W. and S. O. McDonald. 1984. Seasonal food habits of marten in south central Alaska. Can. J. Zool. 62:944-950.

Buskirk, S. W., and L. L. McDonald. 1989. Analysis of variability in home range size of the American marten. J. Wildl. Manage. 53:997-1004.

Buskirk, S. W., S. C. Forrest, M. G. Raphael, and H. J. Harlow. 1989. Winter resting site ecology of marten in the central rocky mountains. J. Wildl. Manage. 53:191-196.

Campbell, T. M. 1979. Short-term effects of timber harvests on pine marten. M.S. Thesis, Colorado State Univ., Fort Collins. 71pp.

Chitty, D. and E. Phipps. 1966. Seasonal changes in survival in mixed populations of two species of vole. J. Anim. Ecol. 35:313-331.

Corn, J. G., and M. G. Raphael. 1992. Habitat characteristics at marten subnivean access sites. J. Wildl. Manage. 56:442-448.

Daniel, T. W., J. A. Helms and F. S. Baker 1979. Principles of silviculture. Second ed. Mc Graw-Hill Book Co., New York, N.Y. 500pp.

deVos, A. 1951. Overflow and dispersal of marten and fisher from wildlife refuges. J. Wildl. Manage. 15:164-175.

Douglass, R. J., L. G. Fisher, and M. Mair. 1983. Habitat selection and food habits of marten, *Martes americana*, in the Northwest Territories. The Canadian Field Naturalist. 97:71-74.

Douglass, R. J. 1989. The use of radio-telemetry to evaluate microhabitat selection by deer mice. J. Mammal. 70:648-652.

Fager, C. 1991. Harvest dynamics and winter habitat use of the pine marten in southwest Montana. M.S. Thesis, Montana State Univ., Bozeman. 73pp.

Hawley, V. D. and F. E Newby. 1957. Marten home ranges and populations fluctuations. J. Mammal. 38:174-184.

Iverson, J. A. 1972. Basal energy metabolism of mustelids. J. Comp. Phys. 81:341-344.

Koehler, G. M., and M. G. Hornocker. 1977. Fire effects on marten habitat in the Selway-Bitteroot Wilderness. J. Wildl. Manage. 41:500-505.

Kujala, Q. 1993. Pine marten populations and Habitat Relationships in southwest Montana. M.S. Thesis, Montana State Univ., Bozeman. 58pp.

Landres, P. B., J. Verner, and J. W. Thomas. 1988. Ecological uses of vertebrate indicator species: A critique. Cons. Biol. 2:316-328.

Lensink, C. J., R. O. Skoog, and J. L. Buckley. 1955. Food habits of marten in interior Alaska and their significance. J. Wildl. Manage. 19:364-368.

Longland, W. S., and M. V. Price. 1991. Direct observations of owls and heteromyid rodents: can predation risk explain microhabitat use? Ecology. 72:2261.

Lonner, T. and T. Burkhalter. 1992. TELDAY. Montana Department of Fish, Wildlife and Parks and Computer Science Department, Montana State University. Bozeman.

Marcum, C. L. and D. O. Loftsgaarden. 1980. A non-mapping technique for studying habitat preference. J. Wildl. Manage. 44:963-968.

Marshall, W. H. 1951. An age determination method for pine marten. J. Wildl. Manage. 15:276-283.

Martin, S. K., and R. H. Barrett. 1991. Marten diet and prey availability at Sagehen Creek, California. Symposium on the Biology and Management of Martens and Fishers, Laramie, WY. (Abstract.)

Martin, S. K., and R. H. Barrett. 1983. The importance of snags to pine marten habitat in the northern Sierra Nevada. Snag Habitat Management Symposium. Northern Arizona Univ., Flagstaff. pp. 114-116.

McCarter, J. B., and J. N. Long. 1986. A lodgepole pine density management diagram. West. J. Appl. For. 1:6-10.

McTague, J. P., and D. R. Patton. 1989. Stand density index and its application in describing wildlife habitat. Wildl. Soc. Bull. 17:58-62.

Mohr, C. O. 1947. Table of equivalent populations of North American small mammals. Am. Midl. Na. 37:223-249.

Murie, A. 1961. Some food habits of marten. J. mammal. 42:516-521.

Pfister, R. D., B. L. Kovalchik, S. F. Arno, and R. C. Presby. 1977. Forest Habitat types of Montana. U.S. For. Ser. Gen. Tech. Rep. INT-34. 174pp.

Quick, H. F. 1955. Food habits of marten, *Martes americana*, in northern British Columbia. Can. Field-Na. 69:144-147.

Quick, H. F. 1956. Effects of exploitation on a marten population. J. Wildl. Manage. 20:267-274.

Raine, R. M. 1982. Ranges of juvenile fisher, *Martes pennanti*, and marten, *Martes americana*, in southeastern Manitoba. Can. Field-Na. 96:431-438.

Raine, R. M. 1987. Winter food habits and foraging behaviour of fishers, *Martes pennanti*, and martens, *Martes americana*, in southeastern Manitoba. Can. J. Zool. 65:745-747.

Reineke, L. H. 1933. Perfecting a stand density index for even-aged forests. J. Agric. Res. 46:627-638.

Soutiere, E. C. 1979. Effects of timber harvesting on marten in Maine. J. Wildl. Manage. 43:850-860.

Spencer, W. D. 1987. Seasonal rest-site preferences of pine martens in the Northern Sierra Nevada. J. Wildl. Manage. 51:616-621.

Spencer, W. D., R. H. Barrett, and W. J. Zielinski. 1983. Marten habitat preferences in the Northern Sierra Nevada. J. Wildl. Manage. 47:1181-1186.

Strickland, M. A. and C. W. Douglas. 1987. Marten. Pages 530-544 *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, eds. Wild Furbearer Management and Conservation in North America. Ministry of Natural Resources. Toronto, Ontario.

Strickland, M. A., C. W. Douglas, M. Novak, and N. P. Hunzinger. 1982. Marten. Pages 599-612 *in* J.A. Chapman and G.A. Feldhamer, eds. Wild mammals of North America. Johns Hopkins Univ. Press, Baltimore, Md.

Thompson, I. D. and P. W. Colgan. 1987. Numerical responses of martens to a food shortage in northcentral Ontario. J. Wildl. Manage. 51:824-835.

Thompson, I. D., I. J. Davidson, S. O'Donnel. and F. Brazeau. 1989. Use of track transects to measure the relative occurrence of some boreal mammals in uncut forest and regeneration stands. Can. J. Zool. 67:1816-1823.

U.S.D.A. 1985. Timber management data handbook. U.S. For. Ser. FSH 2409. Missoula, MT. 216pp.

U.S.D.C. 1990. Climatological Data Annual Summary. National Oceanic and Atmospheric Administration. Asheville, N.C. (93)13.

Warren, N. M. 1989. Old growth habitats and associated wildlife species in the northern Rocky Mountains. North. Region. Wildl. Habitat Relation. Program. U.S. For. Ser. Missoula, MT. 47pp.

Weckwerth, R. P. and V. D. Hawley. 1962. Marten food habits and population fluctuations in Montana. J. Wildl. Manage. 26:55-74.

Wynne, K. M. and J. A. Sherburne. 1984. Summer home range use by adult marten in northwestern Maine. Can. J. Zool. 62:941-943.

Yeager, L. E. 1950. Implications of some harvest and habitat factors on pine marten management. Trans. N. Am. Wildl. Conf. 15:319-334.

APPENDICES

APPENDIX A
TABLES

Table 29. Forested habitat types (Pfister et. al 1977) by series, code, scientific, and common name.

Habitat series and code	Scientific name	Common name
Douglas-fir series	*Psuedotsuga menziesii*	Douglas fir
210	*Agropyron spicatum*	Bluebunch wheatgrass
310	*Symphoricarpus albus*	Snowberry
320	*Calamagrostis rubescens*	Pinegrass
330	*Carex geyeri*	Elk sedge
Spruce series	*Picea engelmannii*	Engelmann spruce
410	*Equisetum arvense*	Common horsetail
440	*Galium triflorum*	Sweetscented bedstraw
450	*Vaccinium caespitosum*	Dwarf huckleberry
460	*Senecio streptanthifolius*	Cleft leaf groundsel
470	*Linnaea borealis*	Twin flower
480	*Smilacina stellata*	Starry Solomon's seal
Mesic subalpine fir series	*Abies lasiocarpa*	Subalpine fir
620	*Clintonia uniflora*	Queen cup beadlily
630	*Galium triflorium*	Sweetscented bedstraw
650	*Calamagrostis canadensis*	Bluejoint
670	*Menziesia ferrugina*	Menziesia
720	*Vaccinium globulare*	Blue huckleberry

Table 29. (Continued)

Habitat series and code	Scientific name	Common name
740	*Alnus sinuata*	Mountain alder
Xeric subalpine fir series	*Abies lasiocarpa*	Subalpine fir
660	*Linnaea borealis*	Twinflower
690	*Xerophyllum tenax*	Beargrass
730	*Vaccinium scoparium*	Grouse whortleberry
750	*Calamagrostis rubescens*	Pinegrass
790	*Carex geyrei*	Elk sedge
Lodgepole pine series	*Pinus contorta*	Lodgepole pine
910	*Purshia tridentata*	Bitterbrush
930	*Linnaea borealis*	Twinflower
940	*Vaccinium scoparium*	Grouse whortleberry
950	*Calamagrostis rubescens*	Pinegrass

Table 30. Summary of USFS old growth criteria (Reprinted from Kujala 1993).

Old growth type (cm)	SAF type	Habitat type groups	Large tree age	Trees per acre > minimum dbh
#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	Pondersosa 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

Table 31. Total numbers and species of rodents captured and captures per 100 trap nights (TN) from small mammal trapping on the Big Hole study area during the fall of 1991 and spring of 1992.

Grid cover type and Combined season rodents	Total number caught				Captures/100TN		
	DM*	RBV	YP	LC	DM	RBV	
Dry Lodgepole**							
Fall	6	8	4	0	2.0	2.7	6.0
Spring	14	0	2	1	4.7	0	5.7
Total	20	8	6	1	3.3	1.3	5.8
Wet Spruce/Fir							
Fall	4	14	2	0	2.7	9.3	13.3
Spring			No Data				
Total	4	14	2	0	2.7	9.3	13.3
Dry Spruce/Fir							
Fall	3	6	2	0	2.0	4.0	7.3
Spring			No Data				
Total	3	6	2	0	2.0	4.0	7.3
Clearcut**							
Fall	3	0	20	0	2.0	0	7.7
Spring	6	0	15	0	1.0	0	7.0
Total	9	0	35	0	1.5	0	7.3

*DM=Deer mouse (*Peromyscus maniculatus*), RBV=Red-backed vole (*Clethrionomys gapperi*), JM=Western jumping mouse (*Zapus princeps*), YP=Yellow pine chipmunk (*Eutamias amoenus*) LC=Least chipmunk (*Eutamias minimus*)

**Fall and spring data from based on data from large grid trapping during the summers of 1991 and 1992.

Table 32. Total numbers and species of rodents captured and captures per 100 trap nights (TN) from small mammal trapping on the Flats study area during the fall of 1991 and spring of 1992.

Grid cover type and season	Total number caught					Captures/100TN		
	DM*	RBV	JM	YP	LC	DM	RBV	Combined rodents
Lodgepole 1								
Fall	2	1	0	0	0	2.0	1.0	3.0
Spring	4	0	0	9	0	2.7	0	8.7
Total	6	1	0	9	0	2.4	0	6.0
Lodgepole 2								
Fall**	0	0	0	0	0	0	0	2.0
Spring				No Data				
Total								2.0
Lodgepole 3								
Fall	9	5	0	4	2	3.0	1.7	6.7
Spring	6	0	0	2	0	4.0	0	5.3
Total	15	5	0	6	2	3.3	1.1	6.0
Lodgepole 4								
Fall				No Data				
Spring	5	5	0	3	0	3.3	3.3	8.7
Total	5	5	0	3	0	3.3	3.3	8.7
Willow								
Fall				No Data				
Spring	1	1	0	4	3	0.67	0.67	6.0
Total	1	1	0	4	3	0.67	0.67	6.0
Clearcut								
Fall				No Data				
Spring	3	0	0	9	0	2.0	0	8.0
Total	3	0	0	9	0	2.0	0	8.0
Douglas Fir***								
Fall	25	53	0	1	0	8.3	17.7	26.0
Spring	5	11	0	0	0	3.3	7.3	10.7
Total	30	64	0	1	0	6.7	14.2	21.1

*DM=Deer mouse (*Peromyscus maniculatus*), RBV=Red-backed vole (*Clethrionomys gapperi*), JM=Western jumping mouse (*Zapus princeps*), YP=Yellow pine chipmunk (*Eutamias amoenus*) LC=Least chipmunk (*Eutamias minimus*)

**Two unidentified *Microtus* spp. were the only rodents trapped.

***Fall data based on data from large grid trapping during the summer of 1991.

Table 33. Total numbers and species of rodents captured and captures per 100 trap nights (TN) from small mammal trapping grids on the Big Hole and Flats study areas during July, August, and September of 1991 and 1992.

Study area, grid cover type, and year	Total number caught					Captures/100 TN		
	DM*	RBV	JM	YP	LC	DM	RBV	Combined rodents
Big Hole								
Clearcut								
1991	3	0	0	20	0	1.0	0	7.7
1992	6	0	0	15	0	2.0	0	7.0
Total	9	0	0	35	0	1.5	0	7.3
Spruce								
1991	34	26	1	2	0	11.3	8.7	21.0
1992	24	9	3	0	0	8.0	3.0	12.0
Total	58	35	4	2	0	9.7	5.8	16.5
Subalpine fir								
1991	1	28	0	3	0	0.3	9.3	10.7
1992	2	14	5	10	1	0.7	4.7	10.7
Total	3	42	5	13	1	0.5	7.0	10.7
Lodgepole								
1991	6	8	0	4	0	2.0	2.7	6.0
1992	14	0	0	2	1	4.7	0	5.7
Total	20	8	0	6	1	8.3	1.3	5.8
Flats								
Lodgepole 1								
1991			No Data					
1992	4	11	0	11	8	1.3	3.7	11.3
Total	4	11	0	11	8	1.3	3.7	11.3
Lodgepole 2								
1991			No Data					
1992	17	7	0	13	2	5.7	2.3	13.0
Total	17	7	0	13	2	5.7	2.3	13.0
Lodgepole 3								
1991	39	8	0	14	0	13.0	2.7	20.3
1992	9	5	0	4	2	3.0	1.7	6.7
Total	48	13	0	18	2	8.0	2.2	13.5
Douglas fir								
1991	18	54	0	7	0	6.0	18.0	26.3
1992	25	53	0	1	0	8.3	17.7	26.3
Total	43	107	0	8	0	7.2	17.8	26.3

*DM=Deer mouse (*Peromyscus maniculatus*), RBV=Red-backed vole (*Clethrionomys gapperi*), JM=Western jumping mouse (*Zapus princeps*), YP=Yellow pine chipmunk (*Eutamias amoenus*), LC=Least chipmunk (*Eutamias minimus*)

Table 34. Understory vegetation and relative structural characteristics of spring/fall small mammal trapping areas on the Big Hole study area.

Grid cover type	Dominant understory vegetation	Mesic or Xeric	Downed woody material	Trees per hectare
Dry Lodgepole	Grasses	Xeric	Med	High
Wet Spruce/ Fir	Forbs/Grasses	Mesic	High	Med
Dry Spruce/ Fir	Bear Grass	Xeric	Low	High
Clearcut	Grasses	Xeric	Med	None

Table 35. Understory vegetation and relative structural characteristics of spring/fall small mammal trapping areas on the Flats study area.

Grid cover type	Dominant understory vegetation	Mesic or Xeric	Downed woody material	Trees per hectare
Lodgepole 1	Bitterbrush	Xeric	Low	Med
Lodgepole 2	Sedge	Mesic	Low	Low
Lodgepole 3	Kinnikinick	Xeric	High	High
Lodgepole 4	Grasses	Xeric	Med	High
Willow	Sedge	Mesic	Low	Low
Clearcut	Sage/Grasses	Xeric	Med	None
Douglas Fir	Forbs/Grasses	Mesic	High	High

Table 36. Habitat characteristics of 100 m x 100 m small mammal trapping grids on the Big Hole and Flats study areas.

Study area and cover type	Trees/ hectare	Average stand diam (cm)	Basal area (m/ha)	SDI	Downed woody material (mt/ha)
Big Hole					
Clearcut	0	0	0	0	37.3
Spruce	444.0	46.2	2042.4	1161	112.1
Subalpine fir	1034.0	23.8	113.7	933	82.5
Lodgepole	393.7	17.2	22.5	513	49.3
Flats					
Lodgepole 1	84.8	26.4	11.9	91	14.2
Lodgepole 2	394.4	21.1	33.9	290	177.9
Lodgepole 3	2280.8	19.0	159.6	1427	18.6
Douglas fir	867.2	24.7	104.0	827	61.5

APPENDIX B
FIGURES

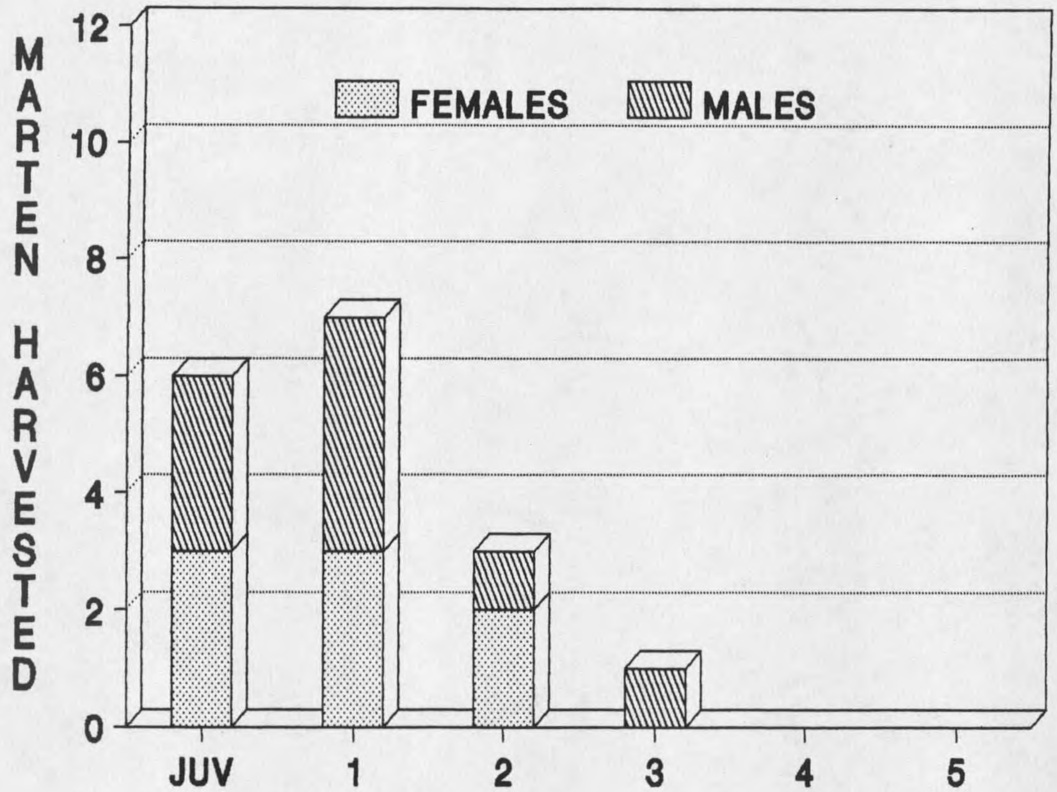

Figure 8. Sex and age distribution of harvested marten from the Beaver Creek study area and Tepee Creek drainage.

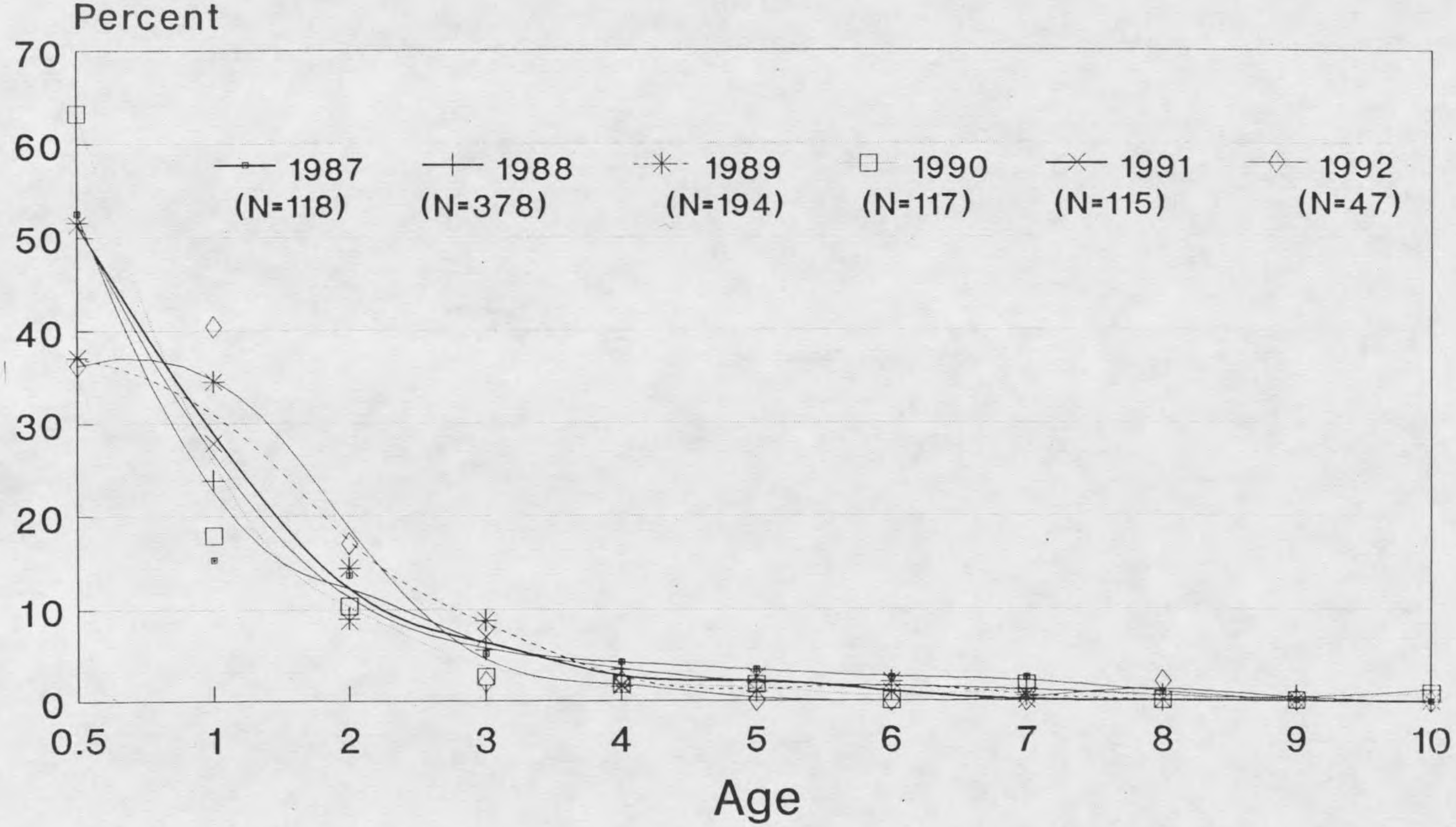

Figure 9. Age distribution for harvested marten from all of Montana for the 1988-1989 through the 1991-1992 harvests.

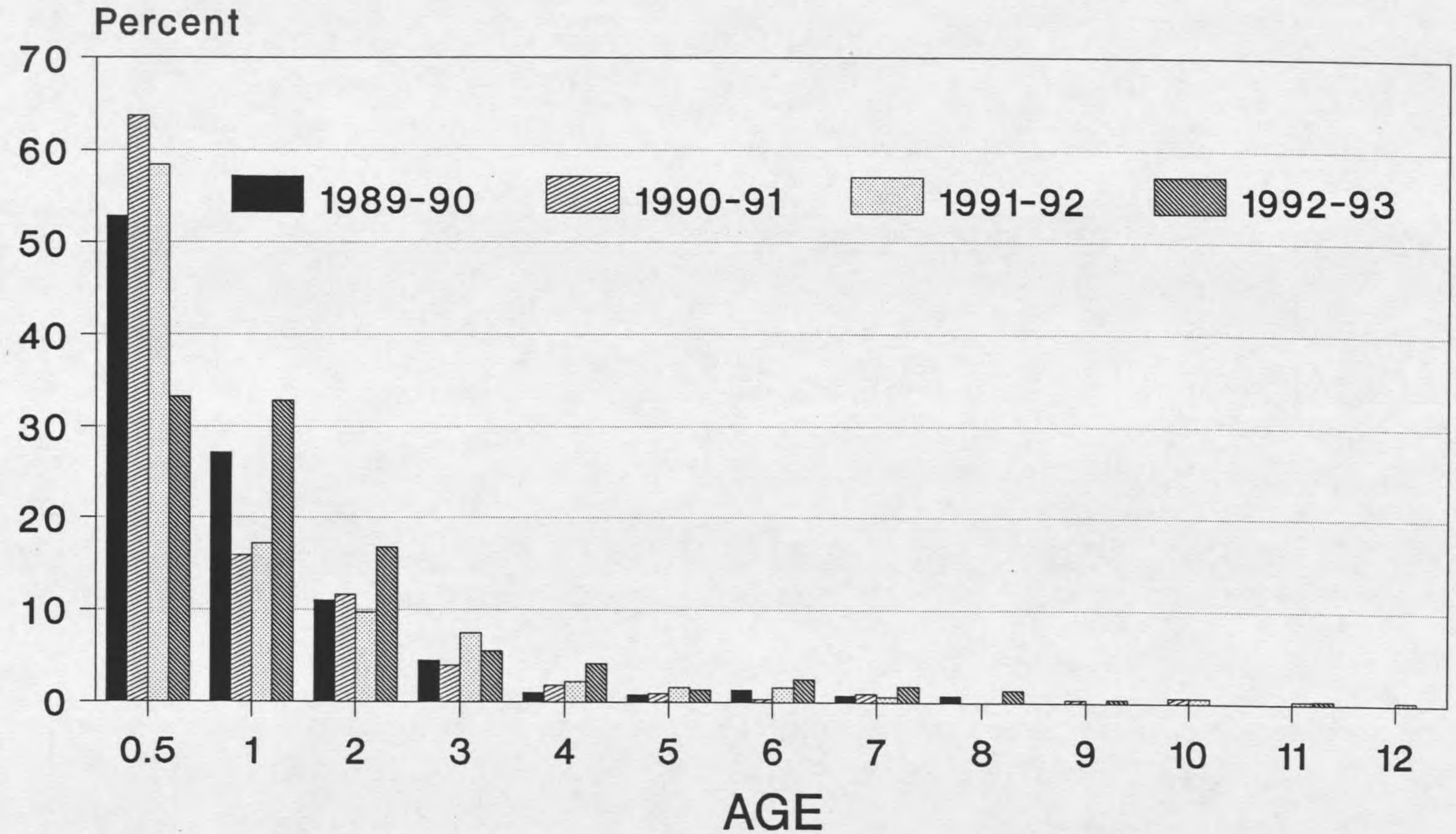

Figure 10. Age distribution for harvested marten from Region 3 for the 1987-1988 through 1992-1993 harvests.

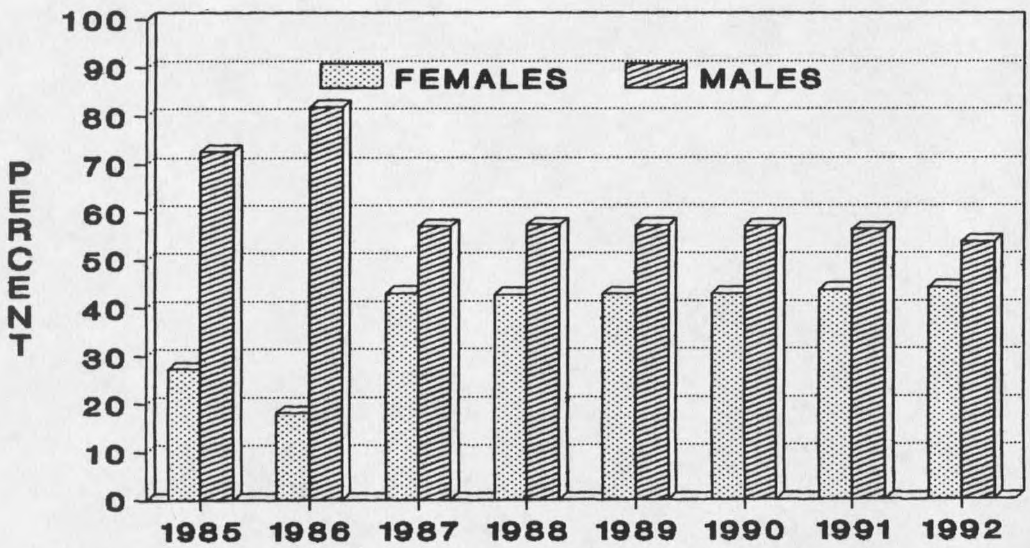

Figure 11. Sex ratios for harvested marten from Region 3.

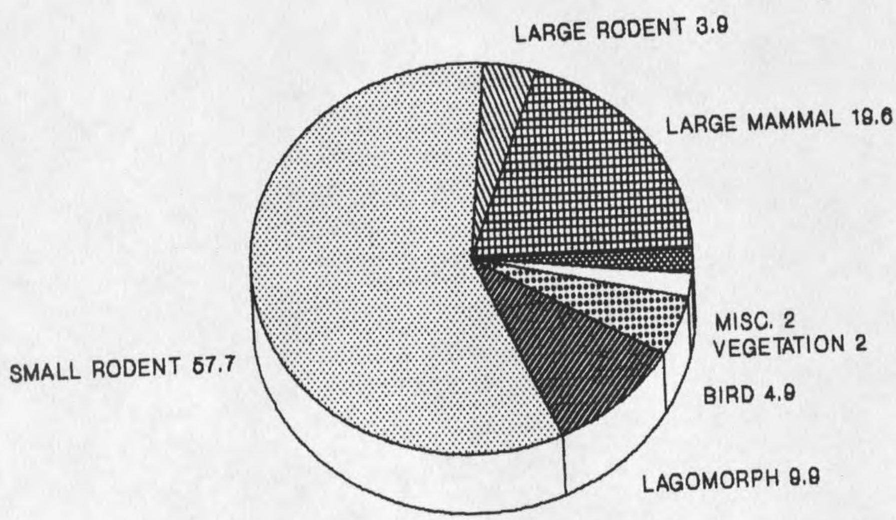

Figure 12. Percent of total volume of winter 1991-1992 food items found in stomachs of harvested marten from all of Montana.