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A relationship between the marten population and the abundance of small mammals in Glacier National Park

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THE RELATIONSHIP BETWEEN THE MARTEN POPULATION AND THE ABUNDANCE OF SMALL MAMMALS IN GLACIER NATIONAL PARK

by

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INTRODUCTION

This food habits study of the marten (Martes americana) is the second phase of a long term ecological study being conducted in Glacier National Park by graduate students of the Montana Cooperative Wildlife Research Unit, Montana State University, Missoula, Montana.

The study was initiated by Fletcher E. Newby in 1952, working in cooperation with Dr. Philip L. Wright. The study area was selected in August of that year and a number of marten were trapped and marked during the summer and fall.

Vernon D. Hawley was assigned to the study in June, 1953 and completed his work in June, 1955 (Hawley, 1955). Marten live-trapping was the major objective of his study. He found that marten occupied permanent home ranges and that these areas varied in size according to sex. The average home range size for six male marten was 0.86 square miles, while the average home range for four females was 0.23 square miles. He also conducted a vegetative survey of the study area and correlated marten captures with different habitat types.

In the fall of 1954 the number of marten on the study area decreased due to the loss of juvenile marten. This was coincident with a decline in small mammal populations. Because of the decrease in available marten food it was felt that a major part of the present study should be concentrated on marten food habits in conjunction with a more intensive study of the small mammal population. This was done because all indications pointed to food as the limiting factor which determined the carrying capacity of the study area for marten.

The objectives of the present study:

1. To determine the seasonal food habits of marten through analysis of scats.
2. To determine the amount and type of food available to marten through census of small mammals.
3. To determine marten population density, distribution and composition through live-trapping.
4. To learn more of the life history and breeding characteristics of marten on the study area.

This phase of the study was conducted over a period of two years (1955-1957). The periods of field investigation were; June 17 to September 20, 1955; December 26, 1955 to January 16, 1956; January 22 to February 11, 1956; June 8 to June 15, 1956; August 14 to October 20, 1956.

Reports dealing with marten food habits have been published by Dulkeit (1929), Marshall (1946), Cowan and Makay (1950), Jurgenson (1951), Remington (1952), Lensink, Skoog and Buckley (1955) and Quick (1955). Unpublished master's theses referring to marten food habits were written by Newby (1951) and Remington (1951).

DESCRIPTION OF THE STUDY AREA

Geography

The permanent study area is located in Glacier National Park in the drainage of the North Fork of the Flathead River approximately 16 miles north of West Glacier, Montana. The study area contains 5.43 square miles of land west of the Continental Divide. It is bounded on the east by Anaconda Creek, on the south by the North Fork Truck Trail, on the west by the Adair Ridge Fire Trail and on the north by a watercourse approximately one mile north of the Anaconda Creek Cut-Off Trail. Its exact locations are: s½S13, s½S14, S23, S24, S25, S26, n½S36 of T34N R20W; w½S19 and nw¼S30 of T34N R19W, Flathead County. (Fig. 1).

Topography

The topography consists mainly of ridges which are extensions of the Livingstone Range to the northeast near the Continental Divide. Past glaciation has greatly modified the area. Elevations range from 3500 feet on the south and east boundary to 4500 feet on the north. This change is not abrupt, but increases through a series of steps up a long ridge running approximately from north to south. The area is drained by Anaconda Creek on the east and Logging Creek on the west. Both streams drain into the North Fork of the Flathead River south of the study area.

Climate

Prevailing westerly winds carry moisture laden air inland from the Pacific Ocean. This contributes a higher rate of precipitation on the study area than is average for the rest of Montana. Topography

evidently affects the local climate as snow depths vary greatly on different sections of the study area. Table I summarizes temperature and precipitation data recorded at the Polebridge Ranger Station 15 miles north of the study area on the North Fork Truck Trail.

Vegetation

A large fire burned much of the study area in 1910, but the size classes of trees indicate other previous burns creating many seral stages of lodgepole (Pinus contorta) and western larch (Larix occidentalis). The climax is spruce-fir (Picea-Abies). Microclimates due to different exposures are in evidence and a few stands of large ponderosa pine (Pinus ponderosa) are interspersed throughout the southwest portion of the area. This interspersion and juxtaposition of the various types create a study area with an infinite number of edges. The principal vegetation types and classes are shown in Figure 2 (Hawley, 1955).

Size classes of the timber types are: seedling class (0-0.9 inches d.b.h.) as Class I, reproduction class (1-3.9 inches d.b.h.) as Class II, small tree class (4.0-11.9 inches d.b.h.) as Class III, and mature trees (12.0 inches d.b.h. and over) as Class IV (Hawley, 1955).

Figure 1

STUDY AREA AND ADJACENT TRAILS

Figure 1

STUDY AREA AND ADJACENT TRAILS

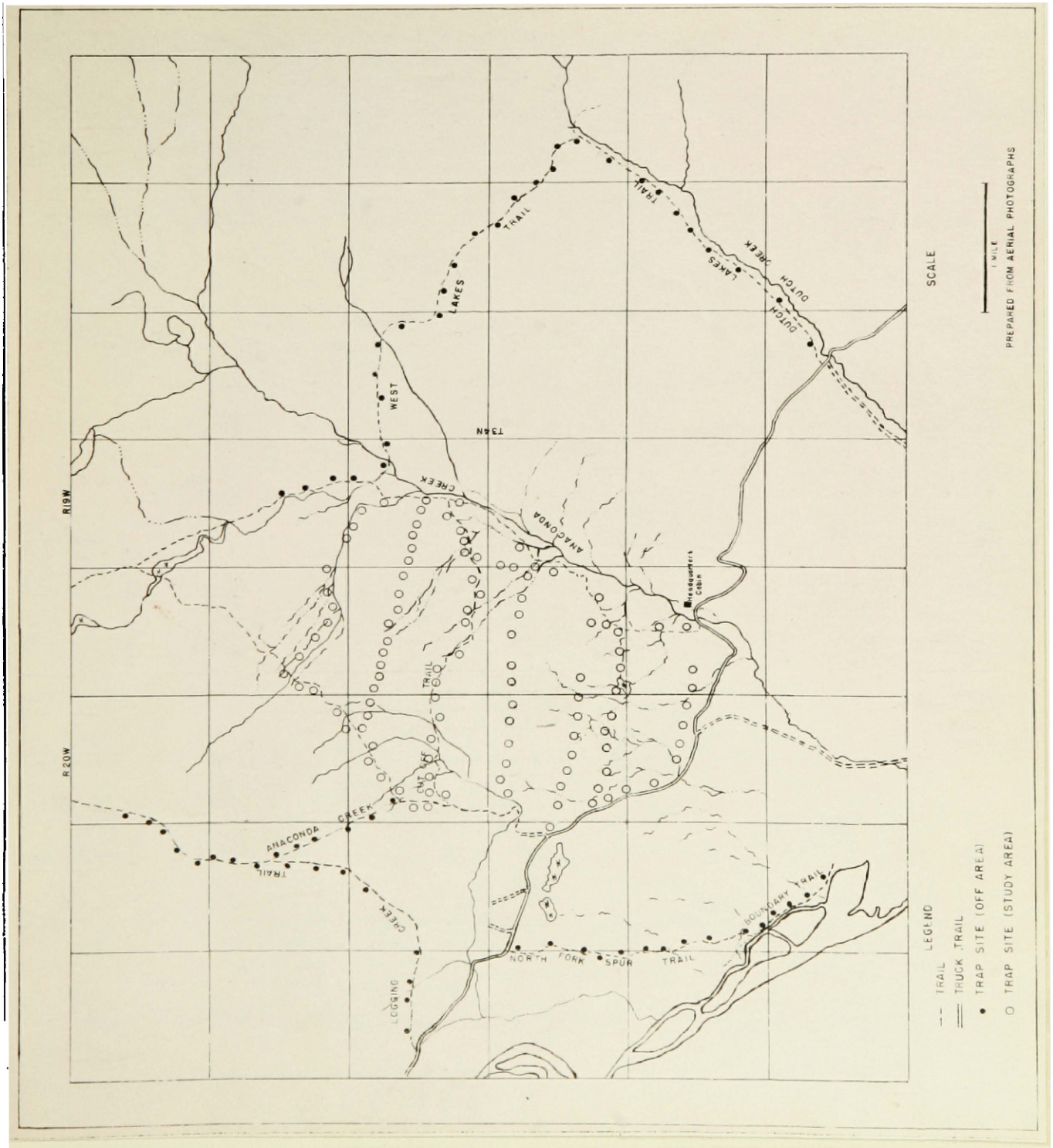


Table I

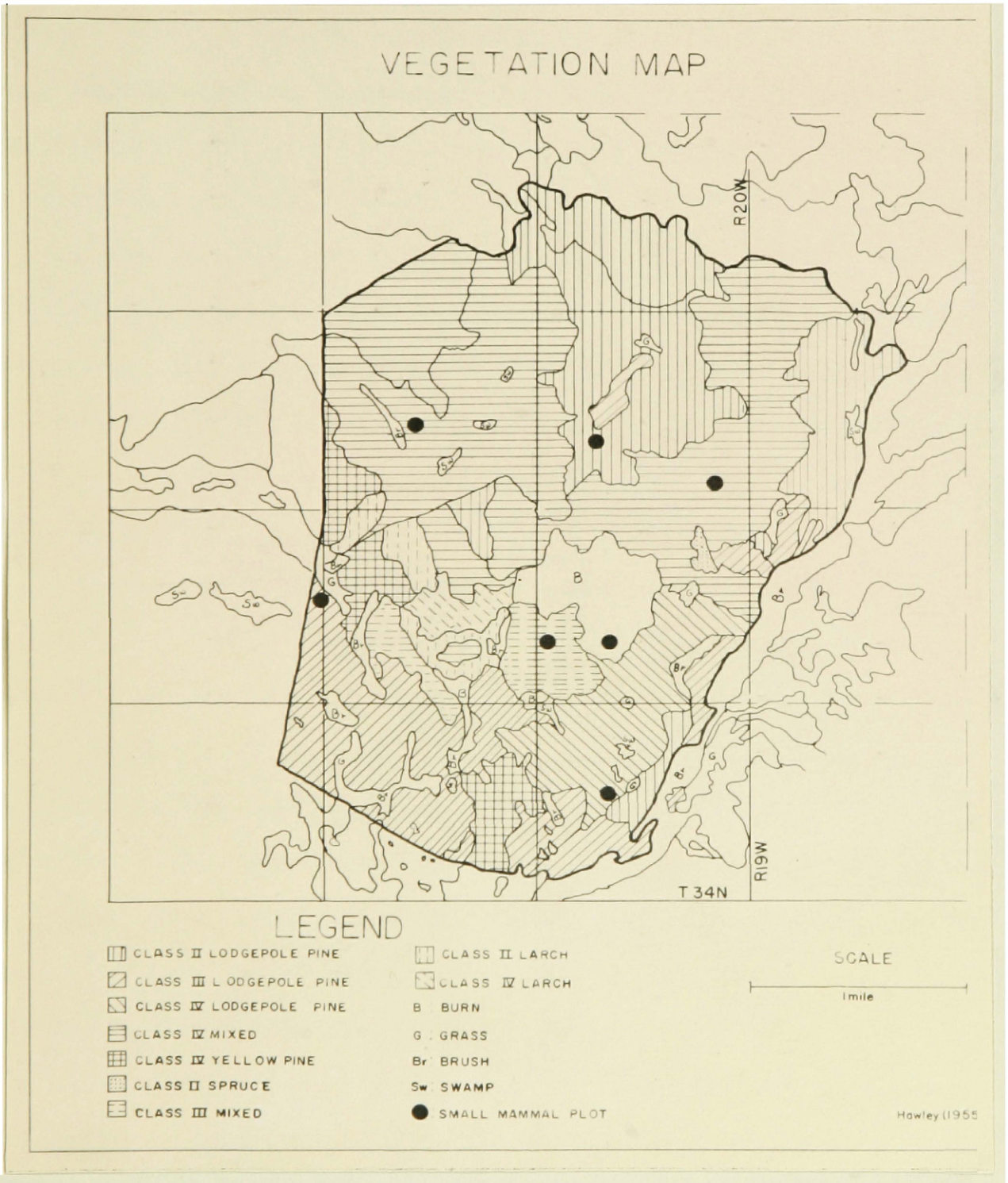
TEMPERATURE AND PRECIPITATION DATA

	* Precipitation (inches)		* Av. Temperature (°F)			
			1955		1956	
Month	1955	1956	Max.	Min.	Max.	Min.
January	0.51	1.88	30.3	9.1	28.0	10.1
February	1.60	1.73	29.8	4.6	28.4	6.3
March	1.56	2.05	34.0	4.0	38.7	6.7
April	0.54	1.76	46.4	19.9	45.8	21.7
May	1.08	1.41	58.6	24.8	64.6	22.8
June	1.34	2.23	72.5	33.0	60.3	38.3
July	1.93	1.90	75.7	-	73.6	39.5
August	0.01	1.04	79.6	-	80.7	34.6
September	1.48	1.10	66.5	-	72.0	32.0
October	2.59	1.24	52.2	32.9	52.7	25.6
November	3.18	0.48	28.7	8.0	35.6	16.3
December	4.43	4.64	25.3	5.2	29.9	10.2
Annual	20.25	21.46				
Maximum Temperature			93		96	
Minimum Temperature				-34		-40

* Weather data from Polebridge Ranger Station, Polebridge, Montana

Figure 2

VEGETATION MAP AND SMALL MAMMAL STUDY PLOTS



MARTEN LIVE-TRAPPING

Purpose

In order to relate food habits with the ecology of the marten it was necessary to determine the status of the population. The population density, composition, distribution and movements were all checked through live-trapping. The study area was live-trapped four times during the course of the field investigations. In addition, portions of six trails in the immediate vicinity were trapped during the summer of 1955. Trapping dates were: July 25 through August 11, 1955; September 15 through September 17, 1955; August 13 through September 3, 1955 (off the study area): January 3 through January 15, 1956; January 22 through February 11, 1956; August 20 through September 14, 1956; October 3 through October 19, 1956.

Trap Lines and Trap Sites

Seven trap lines including 112 marked trap sites had previously been established by Hawley (1955). Many of these sites were permanent, either chiseled into rotten stumps or ends of fallen logs. Less permanent sites were located along logs or stumps. Deep snow necessitated the establishment of temporary sets during the winter. These were erected on the snow, using bark for a platform and placed as near the permanent site as possible. All trapping on the study area was confined to these lines and to park trails in order to conform to the pattern set by the previous investigators.

Five days was the maximum length of time any trap line was continuously in operation. Individual traps were, on occasion, closed

after two successive captures of the same marten. Closing single traps or a portion of the line was sometimes necessary if disturbance by a bear became too troublesome.

Traps were checked as early in the morning as possible so marten would not remain in the traps for too long a period. The traps were checked twice daily during the winter when only one line was in operation. A trap check form for recording trapping field notes was carried each day (Fig. 3). This form made it possible to record rapidly all data concerning the condition of each trap, number of traps set and their location.

Traps, Bait and Scent

Live-traps of two types were used; 6x6x19 inch single door and 6x6x24 inch double door (modified to set single door only). These traps are manufactured by the National Live Trap Company, Tomahawk, Wisconsin. Both are collapsible to permit ease of handling. The modified 6x6x24 inch double door traps proved to be the most efficient for capturing large male marten. The larger males could evidently trip the trigger of the 19 inch traps and then retreat, holding the door open with their backs. The 24 inch traps were less rigid and consequently required more care in setting. If they were not rigidly braced the door would often catch on the sides of the trap when tripped. Future live-trapping would be more efficient if at least one-half of the traps were single door 6x6x24 inch models. This would enable the investigator to set a long trap at every other trap site.

Traps were carefully covered with bark to protect captured marten from the elements and to exclude all light. Sets exhibiting a "light-

Figure 3
TRAP CHECK FORM

TRAPPING FIELD NOTES

Date:_____195__Location:_____

Weather:_____

TmLvHdqs_____TmRetHdqs_____DistTrv_____

TRAP CHECK

No	O	S	F	A	U	R	TS	NO	O	S	F	A	U	R	TS
1								26							
2								27							
3								28							
4								29							
5								30							
6								31							
7								32							
8								33							
9								34							
10								35							
11								36							
12								37							
13								38							
14								39							
15								40							
16								41							
17								42							
18								43							
19								44							
20								45							
21								46							
22								47							
23								48							
24								49							
25								50							

Remarks

O: Trap open
S: Trap snapped
F: Trap failure
A: Animal which snapped trap or was captured
U: Unknown cause of failure or snapped trap
R: Trap reset
TS: Trap site number

leak" were usually disturbed or snapped from the rear. Canvas covers were used in the winter to insure the utmost protection for trapped marten.

Kippered herring was used exclusively as bait. Approximately one-third can (1 oz.) was placed to the rear of the pan (trigger) and covered with bark or sticks in an effort to make it less accessible. Large marten could steal uncovered bait without springing the trap. The bait proved to be very satisfactory; it did not decompose appreciably after five days, although a few days' dampness sometimes produced a slight mold.

A scent made from rotted fish with the addition of a few drops of catnip oil was used. This was placed near the entrance of the trap and also on a tree or limb above the set to insure maximum dispersal of the odor.

Handling and Marking

Captured marten were transferred from the trap to a holding cone for examination. This cone was constructed of 16 inch metal rods held in place by bead chains welded to the rods at approximately three inch intervals. The cone is a modification of one described by Emlen (1944). A canvas tube designed to fit over the door of the trap was fastened to the large end of the cone (Plate I). A trap which contained a marten was removed from the site and the canvas portion of the cone was fitted over the entrance. The door was raised with a wire hook. The marten was then free to enter the cone, but sometimes force was required in the case of a stubborn animal. After the marten had entered the cone the canvas was tied off at the base of the metal rods and the animal

securely held for examination and weighing. This cone worked very well except when a portion of the bead chain broke. If this occurred small female marten could escape unless tightly held.

Unmarked animals were tagged near the base of each ear with strap-type fingerling tags manufactured by the Salt Lake Stamp Company, Salt Lake City, Utah. They were inserted with pliers whose jaws were taped in a manner that prevented the tags from applying too much pressure on the ear.

When animals are recaught within a few days after tagging, the ear usually has become swollen around the tag, and in several cases slight infections were evident. During the two years of this study 18 tags were known to have been lost, but in no instance was it evident that a marten had lost both tags. Losses probably resulted from infection and sloughing of tissue, or through bending and tearing (Hawley, 1955). A greater amount of the retagging was necessary in the summer, but the period when the marten actually lost the tag is not known.

Newby and Hawley (1954) felt that fingerling tags were more successful than the button type tags or battery-operated tattoo, but that continued experimentation was necessary to develop a better marking method. Miller, Ritcey and Edwards (1955) have terminated marten and mink live-trapping until a better type of tag becomes available. Tag losses never became serious during this study, and it is my opinion that if the interval between trapping periods is six months or less, there will be few or no cases of marten losing both tags. Two marten on the study area at the end of the last trapping period had retained both original tags for four years and three have retained

both original tags for three years.

Data concerning the capture of each marten were recorded on a separate form (Fig. 4). These data were later transferred to Unisort Analysis Cards manufactured by the Charles Hadley Company, Los Angles, California. This insured duplication of all capture data and provided a more permanent record from which data could easily be sorted at a later date.

Sexing and Aging

An experienced investigator could immediately differentiate the marten's sex by size, males being considerable larger than the females. Marten were sexed by visual observation of the vulva in the case of females and by palpitation of the baculum in males.

The criteria used in aging live marten in the field were developed by Dr. Philip L. Wright, Professor of Zoology, Montana State University and Fletcher E. Newby, Fur Resources Biologist, Montana Fish and Game Department. These criteria were derived from known age skulls and bacula. Males were aged by palpitation of the sagittal crest and baculum, and females were aged by palpitation of the sagittal crest and examination of their mammae. Males could easily be divided into two age classes, juvenile and adult, after some experience had been acquired. Females were more difficult to age because the sagittal crests were never as fully developed as in males and required a more careful examination to determine if a crest was actually present or if ridges which were felt might have been temporal crests in a near middorsal position which had not yet fused.

Aging was accomplished by the following characteristics:

Figure 4

MARTEN CAPTURE FORM

MARTEN CAPTURE NOTES

Date:_____,195__ Time Cpt. Ntd._____

Location:_____

Weather:_____

Tag Nos. L___, R___; Sex___; Wt._____

Sagittal Crest:_____

Baculum:_____

Mammae:_____

Age:_____

Description:_____

_____

Breeding Condition:_____

_____

Behavior in Trap:_____

_____

Behavior on Release:_____

_____

REMARKS & SKETCHES Use other side if necessary

1. Juvenile males; no sagittal crest, small, pliable thin baculum without enlarged basal portion. 2. Adult males; sagittal crest present, larger thick baculum with enlarged basal portion at points of attachment of corpora cavernosa. 3. Juvenile females; no sagittal crest, inconspicuous light-colored mammae. 4. Adult females; sagittal crest present and larger, dark-colored mammae indicating that the animals were parous. Females exhibiting a crest and small inconspicuous mammae were tentatively classed as yearlings (Hawley, 1955). A more complete explanation of aging criteria based on morphological changes is presented by Hawley (1955). Size of mammae and evidence of lactation were recorded for all females captured, and the size of the testes and condition of the vulva were recorded during the breeding season (Enders and Leekley, 1941).

Results of Live-Trapping

Marten live-trapping was confined to the study area except for the summer of 1955, when portions of several trails in the immediate vicinity of the study area were trapped. This trapping was done in an effort to tag as many juvenile marten as possible. Trails trapped were Dutch Lakes Trail, West Lakes Trail, Logging Creek Trail, Anaconda Creek Cut-Off Trail, North Fork Spur Trail, and the Boundary Trail (Fig. 1). Hawley (1955) found that juvenile marten dispersed up to 25 miles, whereas established adult marten tended to remain within the limits of their home ranges. Only four juvenile males were tagged outside the study area during this trapping and none were recaptured on the study area so no evidence of a fall dispersal was noted for the period.

Eighty-five days were spent trapping, during the three quarters

spent on the study area. Data from 1940 trap units (a trap unit is one trap set for 24 hours) were obtained and 206 captures of 45 different marten were made. The trapping success was 10.6 per cent and 9.4 trap units were required to capture one marten. Hawley (1955) captured one marten for every eight trap units. These figures are considerably higher than the results obtained from other live-trapping studies to date (de vos 1952; de Vos and Guenther 1952; Miller, Ritcey and Edwards, 1955).

Of the 45 marten captured, 28 were males and 17 females. Seventy-three per cent of the marten were captured more than once. A total of 50 captures were made of 17 females, or 2.9 captures per female; twenty-eight males were captured 156 times, or 5.6 captures per male.

Four other species were captured in the live-traps while trapping. These included: 47 red squirrels (Tamiasciurus hudsonicus), one flying squirrel (Glaucomys sabrinus) and one toad (Bufo spp.). Many of the red squirrels captured were taken in sets near seed caches.

A total of 102 sets were either partially disturbed or torn out. Evidence such as feces, claw marks and tooth marks found in the vicinity, indicated bear were responsible for 50 disturbances. Marten molested 10 traps, and 42 sets were torn out by unknown animals. One instance was recorded of a bear carrying a trap 150 feet from the site. Bear did not molest traps containing marten or attempt to harm the marten in any way.

In many instances traps were snapped, but did not contain marten. This occurred 286 times; signs indicated that marten sprung 56, while in 230 cases the cause was not discovered. During the winter, especially

after fresh snow, tracks indicated that marten were the cause of most of the snapped traps. This probably occurred during the other trapping periods, but the evidence was not observable.

Trapping Outside the Study Area

Portions of six trails adjacent to the study area were live-trapped from August 14 to September 3, 1955. It was found that the marten living off the study area were easier to trap. Reasons for this difference in trapping success may have been that traps were not placed at regular intervals along trails, but only at locations where marten sign was observed or where the habitat looked promising. Marten were not "trap-wise", and there were fewer snapped traps.

During this period, 307 trap units were set resulting in 40 captures of 21 marten (14 males, 7 females) for a trapping success of 13 per cent. This success was higher than that realized on the study area at any season except the winter of 1956 when the trapping success was 13.6 per cent.

Trapping on the Study Area

The study area was trapped four times during this investigation; summer 1955, winter 1956, summer 1956 and fall 1956. A total of 1633 trap units resulted in 166 captures of 27 marten (16 males, 11 females). The average trapping success was 10.1 per cent or an average of 9.8 trap units necessary to capture one marten. The number of trap units needed to capture one marten varied from 7.6 (winter 1956) to a high of 16.8 (summer 1955). Winter conditions were such that only one of the more distant trap lines could be operated daily, thus cutting down the number of trap units in operation during a given period. Traps were

usually checked twice a day while trapping the more distant trap lines and in two instances marten were captured on the return check. Hawley (1955) recorded a much higher frequency of captures on the second daily check. This differential may have been due to a higher population density and greater snow depths during the winter of 1954 which made prey species less vulnerable to predation by marten. The highest number of captures made in one day of trapping was recorded on January 7, 1956 when six captures were made of five marten with 13 trap units. Table II summarizes marten live-trapping data.

Age Composition

The age structure of the marten residing on the study area as of October, 1956 is not indicative of an expanding population. Of the 14 marten thought to be resident, none were juveniles. Type of residence was based on the time interval between first and last capture (Hawley, 1955). The three classes are: Transients, a marten not captured longer than one week; temporary residents, marten captured longer than one week, but less than three months; and residents, marten captured over a period of three months or longer. Table III shows the residential status of marten on the study area.

The minimum ages of the 14 resident marten range from one and one-half to five and one-half years, of which 50 per cent are at least four and one-half years old. Table IV shows the minimum ages as of October 19, 1956. Several of these marten may be older than the ages shown in the table because they were adults when first captured.

Table II

SUMMARY OF MARTEN LIVE-TRAPPING DATA

	1955		1956		
	Summer Off Area	Summer	Winter	Summer	Fall
Trap Units	307	421	425	487	300
No. Marten Captures	40	25	58	51	32
Per Cent Success	13.0	5.9	13.6	10.5	10.7
No. Trap Units/Marten	7.6	16.8	7.6	8.6	9.3
No. Marten	21	10	21	13	13
Captures/Marten	1.9	2.5	2.7	3.9	2.5
No. Males	14	7	11	8	9
No. Captures of Males	31	20	39	38	23
No. Captures/Male	2.1	2.9	3.5	4.6	3.5
No. Females	7	3	10	5	4
No. Captures of Females	9	5	19	13	9
No. Captures/Female	1.3	1.7	1.9	2.6	2.2
Males/100 Females	200	233	110	160	225

Table III

RESIDENTIAL STATUS OF MARTEN ON STUDY AREA

	1955 Summer			1956 Winter			1956 Summer			1956 Fall			Total All Classes		
	M	F	Tot	M	F	Tot	M	F	Tot	M	F	Tot	M	F	Tot
No. Transients	1	1	2	2	3	5	1	-	1	-	-	-	4	4	8
Non-Juveniles	1	-	1	2	1	3	-	-	-	-	-	-			
Juveniles	-	1	1	-	2	2	1	-	1	-	-	-			
No. Residents	8	3	11	9	7	16	10	7	17	9	5	14	12	7	19
Non-Juveniles	8	2	10	9	5	14	9	7	16	9	5	14			
Juveniles	-	1	1	-	2	2	1	-	1*	-	-	-			
Total	9	4	13	9	7	16	11	7	18	9	5	14	16	11	27
Non-Juveniles	8	2	10	9	5	14	9	7	16	9	5	14			
Juveniles	1	2	3	-	2	2	2	-	2	-	-	-			

* Juvenile male that died in trap was not classed as transient or resident, but is listed under residents.

Transients - Captured over a period less than one week.
Residents - Captured over a period of three months or longer.

Table IV

MINIMUM AGES OF MARTEN AT CLOSE OF TRAPPING

	yrs.	yrs.	yrs.	yrs.	yrs.
Minimum Age	1½	2½	3½	4½	5½
Male	0	1	2	3	3
Female	1	1	1	1	1

The population has remained fairly stable during the two years this study was in progress. Hawley (1955) stated that approximately 14 marten remained on the area when his field work was completed in the fall of 1954. This population fluctuated from 13 to 21 marten during 1955-1956. Densities thus ranged from 2.4 marten per square mile to 3.9 marten per square mile. The highest density occurred during the winter quarter of 1956, but five of the marten captured in this period were never taken again and evidently were transients.

Population fluctuations can be influenced by mortality, natality, emigration and immigration. The most noticeable influx was observed during the winter when five transient marten were captured. Table V summarizes information concerning the last captures of marten during each trapping period. Three marten were lost from the population during the summer of 1956. Two were due to trap deaths and one was taken for examination in an effort to determine the minimum breeding age.

Breeding Age

Very little is known about the breeding age of marten in the wild. Hawley (1955) noted that male marten showed enlargement of the testes when 15 months of age and that one yearling female exhibited the type

Table V

NUMBER OF MARTEN LAST CAPTURED IN EACH TRAPPING PERIOD

	Summer 1955	Winter 1956	Summer 1956 [1]	Fall 1956
Non-Juveniles	2	4	2	*
Males	2	3	-	-
Females	-	1	2	-
Juveniles	1	2	1	-
Males	-	-	1	-
Females	1	2	-	-
Total	3	6	3	-

* All summer residents were captured during the fall trapping period except one adult female. This animal had been difficult to capture and probably was missed.

[1] One adult female and one juvenile male died in traps during this period and one yearling female was taken for examination.

of vulva shown by adult females in estrus.

During this investigation one known age yearling female was captured on August 31, 1956. An autopsy was performed at Montana State University and the ovaries serially sectioned. This animal was not pregnant nor was she approaching estrus. Since she was taken after the breeding season she should be regarded as sexually immature. Another known age female, tagged as a juvenile in August, 1953 by Hawley, was captured in January, 1956 as a two year old. Examination of the mammae showed no indication of her having nursed young. This female was recaptured in September, 1956 and the mammae were dark and large, indicating that she had nursed young the previous spring and was evidently three years of age when she had her first litter.

The adult female which died in the trap on September 13, 1956 had three blastocysts in her reproductive tract.

This evidence is not conclusive because of the limited number of known age females examined. It is possible that the population of the study area is maximal which tends to raise the minimum breeding age.

Effective reproduction was apparently at a very low level in 1955 and 1956. During this investigation only four juvenile marten were tagged on the area during the summer months; two females in 1955 and two males in 1956. Several other areas were trapped by Vernon Hawley and me during August 1955 and very few juveniles were caught in comparison to the numbers captured by Hawley in 1953 and 1954.

Home Range and Movements

Extensive home range data were acquired during this investigation but will not be discussed as Hawley (1955) described home ranges in

detail. No apparent differences were noted when the home range sizes derived from the two studies were compared. There seems to be a tendency for some adult animals to change home ranges. Two such instances were noted during this investigation. An adult male was tagged for the first time on the Dutch Creek Trail outside the study area in August, 1955, and was captured on the study area in the winter of 1956. An unmarked adult female was also first captured during the winter of 1956. Both were captured on the area the next summer. The female died in a trap on September 13, 1956 and the male was still known to be resident when fall trapping was terminated in October, 1956. The female occupied a range on the southern portion of the study area in marginal habitat. The male was captured in several traps during the winter and was known to have travelled considerably before taking up residence on the eastern boundary of the area.

Live-trapping was useful in checking the movements of marten. Hourly, daily and seasonal movements were recorded within the animal's home range. Seasonal movements were also noted through live-trapping the trails adjacent to the study area and through reports of trappers.

The longest hourly movement was recorded during the winter trapping period, when an adult male was captured twice along the same trap line. The distance between captures was approximately one mile and the time interval was one hour and forty minutes. A light snow which had fallen the night before made tracking easy. This marten visited several traps along the line before he was recaptured. The longest movement in a 24 hour period was one and three-quarters miles. The longest seasonal movement noted within the park was approximately five miles. This

marten, an adult male, was first captured on the Dutch Lakes Trail in August of 1955. He appeared on the study area in January of 1956 and subsequently established a home range. The longest movement recorded was that of a juvenile male marked on the Adair Ridge Watercourse in August, 1956, who was later taken by a trapper outside the park boundary in the vicinity of Half Moon Lake, approximately 17 miles south of the study area. In order to reach this area it was necessary for the marten to cross the Middle Fork of the Flathead River, and possibly several smaller streams, and the Apgar Mountains. This approaches the 25 mile movement recorded by Hawley (1955) for another juvenile male. This type of movement or emigration substantiates the theory (Hawley, 1955) that juvenile marten will often travel many miles from their birthplace in order to become permanently established in an adequate home range. Dice (1952) states that when animals compete for food, or space, intraspecific strife results. The younger animals usually suffer the heaviest mortality, or are forced into unsuitable habitats.

Marten Behavior

The general behavior of trapped marten was thoroughly described by Hawley (1955) so only one unusual incident will be described in this paper. When trapping the North Fork Spur Trail during the summer of 1955, an adult male was captured. While I was reading the ear tag numbers a coyote, apparently attracted by the cries of the marten, approached the trap site running. The coyote came within four feet and turned away when I shouted. Upon his release, this marten immediately climbed high into a nearby tree and jumped into two other

trees before returning to the ground. I am of the opinion that the marten scented the coyote and climbed the tree for protection, because upon his release after the next capture he did not react in the same manner. Only two other marten climbed trees upon release and one of these I chased.

Trap Mortality

Two marten, an adult female and a juvenile male, died in traps on September 13, 1956. The female had been captured five times in eight days. During this period her weight dropped from 600 grams to 450 grams. She was very quiet and appeared to be sick when captured the third time. She was recaptured the next day and although quiet, had apparently recovered somewhat. The next day she was found dead in a different trap. The juvenile male was captured six times over a 15 day period and lost 300 grams. His weight at the initial capture was 900 grams and six days later dropped to 850 grams. He was captured four more times and his weight at death was 600 grams. Neither of these marten were captured consecutively in the same trap site.

Autopsies were performed and no evidence of disease was noted in either animal, although four nematodes were found in the stomach of the adult female. The male had a skin puncture under the left foreleg but no evidence of internal damage or infection was found. Both marten were very thin and appeared to be suffering from malnutrition as a result of excessive captures.

Small Mammals

The food habits studies of Cowan and Makay (1950), Jurgenson (1951), Lensink, Skoog and Buckley (1955), Marshall (1946), Newby (1951), Quick (1955) and Remington (1951) emphasize the importance of small mammals, especially the microtine rodents, in the diet of the marten. Hawley (1955) sampled the small mammal populations on the study area by snap trapping in two different forest types. He found that the mouse population declined sharply in 1954 and that this was correlated with a decrease in marten.

During this study more intensive efforts were made to examine the small mammal population than were made for other wildlife species, in an effort to determine their importance to the ecology of the marten living on the study area.

Study Method

Two study plots had been previously established by Hawley. Five new small mammal plots were established in different forest types, thus giving a total of seven plots. They represent a major portion of the vegetative types present on the area. These areas were chosen with Hawley's assistance, and laid out in 1955. Lines were laid out using a forester's compass and a 100 foot steel tape. These plots were the type described by Calhoun (1948). His method consists of two parallel lines, 475 feet long and 200 feet apart, with a yellow tipped wooden stake driven into the ground to mark each trapping station. The 20 stations were spaced at 25 foot intervals and three traps were set

within a two and one-half foot radius at each station, giving 60 traps per line. The traps used were Victor and McGill four-way snap traps and were baited with a mixture of peanut butter and rolled oats. All trap lines in operation were checked daily and the specimens collected for examination. This method entails both summer and fall trapping to denote a change in density and each line is operated for three consecutive days.

Description of Small Mammal Plots

The geographic location of the seven small mammal plots can be checked on the vegetation map (Fig. 2) of the study area. Plots I and II were trapped by Hawley in 1953 and 1954, and the five remaining plots were established in June 1955 (See Plates I and II).

Plot I is located in a Class IV lodgepole pine (Pinus contorta) type. There is a slight gradient from east to west, and the lower ends of the lines are in a small swamp. Some aspen (Populus tremuloides) occur in this area. The upper ends of the lines are in the vicinity of Class II lodgepole reproduction. The forest floor is relatively clear; few logs or debris are on the ground and little reproduction is present.

Plot II is located in a Class IV mixed type. The most abundant dominant species is Engelmann spruce (Picea engelmannii). Other dominants are: larch (Larix occidentalis), Douglas fir (Pseudotsuga menziesii), lodgepole pine (Pinus contorta), and alpine fir (Abies lasiocarpa). Portions of these lines have a dense spruce understory and many fallen logs are present on the forest floor. The terrain is fairly level although one stream flows past the southeast end of the

lines.

Plot III is located in a dense stand of Class II lodgepole pine reproduction. Ground cover is sparse, but patches of reproduction are prostrate because of the weight of snow in winter, and these form dense entanglements. Trees are growing so close together in some sections that travel is difficult.

Plot IV is a Class IV mixed type. Douglas fir, lodgepole pine, larch, alpine fir and Engelmann spruce, in order of descending abundance are the dominant species. The heaviest reproduction is in Engelmann spruce. This area is located on a slope facing east. A ground cover of shrubs, forbs and grass is fairly dense. Fallen logs are common, especially on the lower end of line number two.

Plot V is in a Class III mixed type. Lodgepole pine is the dominant species; Engelmann spruce and larch are also present. Engelmann spruce provides the greatest amount of reproduction. Ground cover is moderate and many logs are on the ground.

Plot VI is located in Class III lodgepole and ponderosa pine (Pinus ponderosa). Some larch and aspen are present and the reproduction is of lodgepole pine and larch. Ground cover is relatively sparse except for the northern boundary of the plot which is moist and supports more vegetation. Very little debris and logs are present.

Plot VII is located in an area that had been previously burned and very few trees are present although scattered lodgepole pine, aspen, spruce and Douglas fir are in evidence. The line is located on a southeast slope and the ground cover is fairly heavy. Snowberry (Symphoricarpos spp.) and serviceberry (Amelanchier alnifolia) are the

Facing -30-

Plate I

Figure a. Marten Live-Trap and Cone

Figure b. Small Mammal Plot I

Figure c. Small Mammal Plot II

Figure d. Small Mammal Plot III

Figure a.

Figure b.

Figure c.

Figure d.

Facing -31-

Plate II

Figure e. Small Mammal Plot IV

Figure f. Small Mammal Plot V

Figure g. Small Mammal Plot VI

Figure h. Small Mammal Plot VII

Figure e.

Figure f.

Figure g.

Figure h.

most abundant shrubs. Many logs are on the ground as a result of a forest fire.

Line transects were taken on every plot in order to sample the ground vegetation. Ten-foot transects were taken in four different locations on the plot in an effort to get a representative sample. A rope was stretched between two stakes and all vegetation touching the rope was recorded by species in inches. The amount of bare ground, moss and logs was also recorded. Table VI summarizes the plants found on each plot by frequency of occurrence.

Data Recorded From Small Mammal Captures

The small mammal trap lines were checked daily as early as possible and each animal captured was tagged with a cardboard marking disc which contained the following information: The number of the plot, line, and station where captures were made. The specimens were examined later at field headquarters. Data recorded were: Species, sex, age, breeding condition, size of testes, size and number of embryos, total length, tail length, length of right hind foot, and weight. Study skins and skeletal material were prepared to be used later for comparative purposes when analyzing scats.

Results of Small Mammal Trapping

Data from Plots I and II are available for a four-year period, as they were first trapped by Hawley in 1953 (Table VII). Plot I was first trapped in the summer of 1953, and upon examining the data, three outstanding contrasts are apparent. 1. Microtus pennsylvanicus and Microtus longicaudus were relatively abundant in 1953, and again in the summer of 1954, but only appeared once during the two years of this

Table VI

PERCENTAGE OF GROUND VEGETATION ON SMALL MAMMAL PLOTS ACCORDING TO LINE TRANSECTS

Species	Plot Number 1	2	3	4	5	6	7
Moss	26.8	13.7	10.9	7.9	34.6	34.5	2.4
Lycopodium complanatum		0.6					
Lycopodium spp.		1.6					
Pinus contorta			0.8				
Picea spp.				0.2			
Gramineae	24.1	32.4	26.1	29.7	20.2	22.9	27.5
Cyperaceae	0.1					1.9	3.8
Clintonia uniflora				1.1			
Disporum oregonum					0.2		
Goodyera oblongifolia				0.4			
Populus tremuloides							0.6
Salix spp.	0.6					2.7	
Ranunculus uncinatus		0.2					
Thalictrum spp.	0.2		0.5				
Berberis repens		0.8		0.8	3.6	1.2	2.0
Mitella breweri		0.8					
Amelanchier alnifolia	0.1		0.2	2.1	1.1	0.3	3.7
Fragaria spp.	3.8	5.5	3.8	2.9		6.1	15.8
Rosa spp.	2.9	1.1	0.1	0.2		0.1	0.4
Rubus parviflorus		2.7		0.1	0.8		
Spiraea spp.					0.2		
Lathyrus spp.			0.2				
Trifolium spp.							2.3
Vicia americana	0.2	0.4		1.2		0.4	2.0
Pachistima myrsinites					0.6		
Viola spp.		3.1		2.0	0.4	0.4	
Heracleum lanatum	1.7						
Cornus canadensis		7.1					
Cornus stolonifera	0.4						
Chimaphila umbellata				4.6			
Arctostaphylos uvi-ursa	4.9					8.1	
Vaccinium spp.	4.0	0.4	3.7	1.5		5.8	
Mentha arvense	0.2						
Prunella vulgaris		0.2					0.1
Galium spp.	0.5	0.2	0.8				1.8
Linnaea borealis var. americana	6.1	8.4	0.8	16.2		1.1	
Symphoricarpos spp.	0.8	0.2	5.2		6.0		2.5
Viburnum edule	7.7						
Achillea millefolium	0.1		0.3			0.2	3.2
Adenocaulon bicolor		0.1			0.8		
Antennaria racemosa	2.4			1.9			
Arnica spp.	1.0						
Aster laevis							0.2
Aster spp.	0.6	0.8	0.4	1.2	3.1	2.1	7.3
Senecio spp.		0.4	2.1			3.8	
Logs		7.3	1.2	1.0	4.3		5.9
No vegetation	10.6	6.9	40.6	24.8	23.9	7.3	17.4
Unknown forb		4.8	1.9			0.8	0.9

Table VII

RESULTS OF FOUR YEARS OF SMALL MAMMAL TRAPPING
Plot I Class IV Lodgepole Pine

Species	1953*		1954*		1955		1956	
	Summer	Fall	Summer	Fall	Summer	Fall	Summer	Fall
Microtus pennsylvanicus	8	6	7	1	-	1	-	-
Microtus longicaudus	1	1	-	-	-	-	-	-
Zapus princeps	1	-	1	-	-	-	1	-
Clethrionomys gapperi	2	14	2	11	-	3	4	13
Sorex cinereus**	-	2	2	6	3	8	1	7
Sorex vagrans	-	-	-	-	2	6	2	-
Synaptomys borealis	-	1	-	-	-	-	-	-
Eutamias amoenus	-	-	-	-	-	-	-	1
TOTAL	12	24	12	18	5	18	8	21

Dates Set
1953: July 19 (Summer) and September 14 (Fall).
1954: August 2 (Summer) and October 16 (Fall).
1955: June 24 (Summer) and September 9 (Fall).
1956: June 10 (Summer) and September 11 (Fall).

Plot II Class IV Mixed Type

Species	1953*	1954*		1955		1956	
	Fall	Summer	Fall	Summer	Fall	Summer	Fall
Microtus pennsylvanicus	3	1	-	-	-	-	-
Microtus longicaudus	9	10	2	-	-	-	1
Clethrionomys gapperi	53	3	27	10	19	3	26
Peromyscus maniculatus	5	4	4	1	7	3	7
Sorex cinereus**	-	14	-	1	9	-	-
Sorex vagrans	-	-	-	-	1	-	-
Zapus princeps	-	-	-	1	-	-	-
Phenacomys intermedius	-	-	-	-	-	1	-
TOTAL	70	32	33	13	36	7	34

* Trapped by Hawley.
** Shrews identified to genus in 1953 and 1954.

Dates Set
1953: September 18 (Fall).
1954: August 10 (Summer) and October 10 (Fall).
1955: July 4 (Summer) and September 5 (Fall).
1956: June 7 (Summer) and September 18 (Fall).

investigation. 2. Clethrionomys gapperi was the most abundant small mammal taken in 1953 and 1954, but the 1955 catch was low. It regained its former level in the 1956 catch. 3. Shrews (Sorex spp.) were more abundant in 1955 when fewer Clethrionomys gapperi were captured.

Plot II was first trapped in September 1953, and produced the largest catch to date. Seventy captures were made of the following species: Clethrionomys gapperi, Microtus longicaudus, Peromyscus maniculatus, and Microtus pennsylvanicus. The summer trapping in 1954, produced 32 animals; 14 of which were shrews. The October trapping did not show an increase over the summer's catch, although 27 Clethrionomys gapperi were caught. Two Microtus spp. were taken at this time but none were trapped again until the fall of 1956, when a single Microtus longicaudus was taken. Clethrionomys gapperi did not regain its 1953 abundance during the course of the study, although it appeared to be increasing in the fall of 1956. During the two years of trapping, a total of 394 small mammals were captured (Table VIII).

Clethrionomys gapperi was the most abundant small mammal captured on the seven plots. Sorex cinereus ranked second and Peromyscus maniculatus third. Relatively few of the other species were represented.

Discussion of Small Mammal Trapping Results

The Calhoun method of sampling small mammal populations does not provide an estimate of population density, but rather gives an index of the relative abundance of the animals in the different types sampled. A snap-trapping method will usually give a higher density estimate than actually exists because of the influx of small mammals

Table VIII

SUMMARY OF SMALL MAMMAL TRAPPING*
1955 - 1956

Species	1955 Summer No.	%	1955 Fall No.	%	1955 Total No.	%	1956 Summer No.	%	1956 Fall No.	%	1956 Total No.	%	1955-1956 Total No.	%
Clethrionomys gapperi	23	44.2	44	29.1	67	33.0	19	39.6	90	62.9	109	57.1	176	44.7
Microtus longicaudus									1	0.7	1	0.5	1	0.2
Microtus pennsylvanicus									1	0.7	1	0.5	1	0.2
Phenacomys intermedius	2	3.8	1	0.7	3	1.5	3	6.2	1	0.7	4	2.1	7	1.8
Synaptomys borealis									1	0.7	1	0.5	1	0.2
Peromyscus maniculatus	8	15.4	23	15.2	31	15.3	9	18.7	23	16.1	32	16.7	63	16.0
Sorex cinereus	15	28.8	69	45.7	84	41.4	6	12.5	20	14.0	26	13.6	110	27.9
Sorex vagrans	2	3.8	13	8.6	15	7.4	6	12.5	4	2.8	10	5.2	25	6.3
Eutamias amoenus	1	1.9	1	0.7	2	1.0	1	2.1	2	1.5	3	1.6	5	1.3
Zapus princeps	1	1.9			1	0.5	4	8.3			4	2.1	5	1.3
Total Captures	52		151		203		48		143		191		394	

* By number captured and per cent occurrence on all plots.

into the vacuum created by the removal of the resident population (Stickel, 1946). Recovery of trapped plots is also thought to be faster than would be possible by reproduction alone (Calhoun, 1951). The seven small mammal plots sample representative types which comprise a large portion of the study area. Minor vegetative changes may occur in some areas because of different microclimates, but do not alter the environment appreciably.

An attempt was made to correlate the number of small mammals caught on each plot with the results of the ground vegetation survey. The criteria used in the correlation tests were: the per cent of grass, fallen logs, and bare ground. The only strong correlation (r=.87) obtained, was between the percentage of fallen logs on the plots and the number of mice caught.

Although only two of the plots have been trapped for four years, it appears from the catch that populations of two species of voles, (Microtus pennsylvanicus and Microtus longicaudus) declined abruptly in 1954. This decline may be explained by the fact that Microtus is a cyclic genus, subject to a population fluctuation every three to four years. It was also apparent that the Clethrionomys gapperi catch declined on Plot II during this same period, but it was not evident on Plot I until 1955. The catch returned to a level comparable to the 1953-1954 catch in the fall of 1956. Clethrionomys gapperi may be subject to fluctuations, but they are not of the extreme nature as exhibited by Microtus spp. populations.

It is difficult to explain the variation in the number of shrews captured during the four years. They do not seem to follow a pattern

similar to microtines, and it is not uncommon to capture shrews in greater abundance the second, or even the third day, whereas the higher catches in the microtines usually occur the first and second days.

Three species comprised 88.6 per cent of the total catch. Clethrionomys gapperi was the most common with 44.7 per cent; Sorex cinereus was second with 27.9 per cent; and Peromyscus maniculatus was third with 16 per cent. The seven other species captured comprised the remaining 11.4 per cent. Clethrionomys gapperi was caught in all types except the open burn (Plot VII). Sorex cinereus was captured on all plots, but Peromyscus maniculatus was noticeably absent from Plots I, III and VI. The dominant tree species on these plots is lodgepole pine, and it is highly probable that the cones do not open readily enough to provide a sufficient food supply for Peromyscus. The remaining microtine rodents were not readily captured and only five Zapus princeps were caught.

There is a possibility that certain species of small mammals were present in greater numbers than trapping data indicate. Red-backed voles (Clethrionomys gapperi), and deer mice (Peromyscus maniculatus) are relatively easy to capture by snap-trapping (Edwards, 1951) and it is reasonable to assume that they are present in numbers comparable to the trapping take. Phenacomys intermedius, Synaptomys borealis and Zapus princeps are thought to be "trap shy" and may not be taken in relation to their abundance (Edwards, 1951). These animals have been captured more readily by bucket traps than by snap-trapping and thus a true picture of their densities was probably not obtained.

Zapus princeps hibernates in the fall and may have been missed during the trapping in October 1954 and 1956. These animals hibernate any time after the middle of September, depending on their physical condition (Quimby, 1951).

Small Mammals Not Sampled by Trapping

Five species of small mammals; red squirrels (Tamiasciurus hudsonicus), snowshoe hares (Lepus americanus), Columbian ground squirrels (Citellus columbianus), flying squirrels (Glaucomys sabrinus) and chipmunks (Eutamias amoenus) were present in varying numbers. Of these, ground squirrels, flying squirrels and chipmunks were not subjected to any type of census. Ground squirrels were active from late March until the middle of August. They are relatively abundant, but their habitat is limited to openings in the forest, old burns, and abandoned fields. Only one flying squirrel was observed; it was captured in a marten live-trap. Five chipmunks were caught while trapping small mammals, and frequent observations made during the summer and fall months indicated that they were abundant. Higher densities were observed in the mature timber types. Snowshoe hares were relatively rare. One was observed in dense lodgepole pine. A few tracks were seen in the winter, mainly in areas of heavy spruce and lodgepole pine reproduction. Pellet counts were taken in the fall of 1956 on six of the small mammal plots. Fifty samples were taken at random on each plot, using a frame which covered one square foot. All pellets within the boundary of the frame were counted. Pellets were found on only two plots. Plot II, in dense lodgepole reproduction, produced 15 for an index of 0.30 pellets per square foot. Plot V, in a Class III mixed

type, produced two for an index of 0.04 pellets per square foot. Both sign and pellet counts seem to indicate that snowshoe hare are not numerous.

Red squirrels were abundant throughout most of the study area. An attempt was made to obtain a population index by counting tracks and squirrels observed during the winter. During the fall of 1956, time-area counts were taken in the vicinity of the six small mammal plots located in the wooded sections. Neither method appears to give adequate results. Weather, time of day, and frequency of fresh snowfalls tends to govern the activity pattern of the squirrels. Deep snow in the winter appears to keep the animals in the vicinity of their food caches. This restricted movement limits the amount of observable sign. During the winter when snow conditions were favorable, an average of 2.41 tracks per mile were observed, while in the summer and fall of 1956, an average of 1.16 squirrels per mile were either seen or heard. The data derived from the time-area counts which were taken in the different forest types are not adequate enough to obtain a census estimate. Squirrels were either seen or heard on each count, but the different variables encountered with this type of census do not allow a comparison to be made of the population densities in the different forest types. A satisfactory census method was not found during this investigation.

Larger Animals

Several species of larger animals are found in abundance on the study area. Some may affect the marten population through predation or interspecific competition. Although no evidence of predation was

observed; coyotes, lynx, horned owls and golden eagles are all capable of killing marten (Marshall, 1942). The coyote, being the most numerous, may exert the greatest pressure. Marshall (1942) reports that Murie found a marten skull in a coyote dropping. Little else can be found in the literature concerning predation on marten by these other species except for widely distributed trappers' reports. Predation is obviously low as four marten which were first captured in 1952 remained as a segment of the population when trapping terminated in the fall of 1956.

Deer (Odocoileus spp.), elk (Cervus canadensis) and moose (Alces americana) indirectly affect the marten's food supply when they overgraze forbs and grasses which furnish food and cover for small mammals. They also act as competitors, browsing heavily on fruit bearing shrubs such as Amelanchier alnifolia, thus reducing the food available to the marten. A large portion of these shrubs were badly overbrowsed in the Anaconda Creek area. Black bear consume great quantities of huckleberries, but this competition is probably unimportant except in poor fruit bearing years.

Weasels, coyotes, badgers, and birds of prey are direct competitors of marten for animal food. Columbian ground squirrels are probably the main prey of the badger. These squirrels occur in openings in the forest and do not constitute a major portion of the marten's diet. Coyotes, weasels and raptors are capable of taking small rodents, birds and snowshoe hare. The ecological niche of the two weasels (Mustela frenata and Mustela erminea) closely approximate the marten's. Both are mustelids and are nearly of comparable size. The comparatively low

weasel population on the study area may be a result of interspecific strife. The marten being the larger and more aggressive, is currently holding the advantage.

The herbivores play a dual role, for, although competitors they also furnish food in the form of carrion. Elk and deer losses are high on the overbrowsed range during severe winters and this food may be important to the marten at a time when small mammals are less abundant. Table IX lists the species of larger mammals present with their abundance rating.

Birds

Several investigators have shown that birds make up varying portions of the marten's seasonal diet (Cowan and Makay 1950; Jurgenson 1951; Lensink, Skoog and Buckley 1955; Marshall 1946; Newby 1951; Quick 1955). The bird population in the Anaconda Creek area fluctuates markedly with the seasons, many more being present in the summer. Table X lists the species observed, together with relative abundance, and seasonal status. This list is not complete, but contains the more conspicuous birds that occur regularly.

Table IX

LARGER MAMMALS
RELATIVE ABUNDANCE RATING

Species	Abundance*
Black Bear (Ursus americanus)	C
Grizzly Bear (Ursus horribilis)	R
Marten (Martes americana)	A
Shorttail Weasel (Mustela erminea)	UC
Longtail Weasel (Mustela frenata)	UC
Mink (Mustela vison)	R
Wolverine (Gulo luscus)	R
Badger (Taxidea taxus)	C
Coyote (Canis latrans)	C
Gray Wolf (Canis lupus)	R
Mountain Lion (Felis concolor)	R
Lynx (Lynx canadensis)	R
Beaver (Castor canadensis)	UC
Elk (Cervus canadensis)	A
Mule Deer (Odocoileus hemionus)	UC
Whitetail Deer (Odocoileus virginianus)	C
Moose (Alces americana)	C

* A: Abundant
C: Common
UC: Uncommon
R: Rare

Table X

RELATIVE ABUNDANCE AND SEASONAL STATUS OF BIRDS COMMON ON THE STUDY AREA

Species	Ab*	S[1]	W[2]
Mallard (Anas platyrhynchos)	R	X	
American Merganser (Mergus merganser)	R	X	
Red-tailed Hawk (Buteo jamaicensis)	C	X	
Golden Eagle (Aquila chrysaetos)	R	X	X
Marsh Hawk (Circus cyaneus)	C	X	
Spruce Grouse (Canachites canadensis)	A	X	X
Ruffed Grouse (Bonasa umbellus)	C	X	X
Great Grey Owl (Strix nebulosa)	R	X	X
Pigmy Owl (Glaucidium gnoma)	C	X	X
Horned Owl (Bubo virginianus)	C	X	X
Nighthawk (Chordeiles minor)	C	X	
Caliope Hummingbird (Stellula calliope)	C	X	
Belted Kingfisher (Megaceryle alcyon)	R	X	
Pileated Woodpecker (Dryocopus pileatus	C	X	X
Arctic Three-toed Woodpecker (Picoides arcticus)	C	X	X
Downy Woodpecker (Dendrocopus pubescens)	A	X	X
Hairy Woodpecker (Dendrocopus villosus)	A	X	X
Red-shafted Flicker (Colaptes cafer)	C	X	X
Rough-winged Swallow (Stelgidopteryx ruficollis)	C	X	
Canada Jay (Perisoreus canadensis)	A	X	X
Stellar's Jay (Cyanocitta stelleri)	C	X	X
Clark's Nutcracker (Nucifraga columbiana)	C	X	X
Raven (Corvus corax)	A	X	X
American Magpie (Pica pica)	R	X	
Black-capped Chickadee (Parus atricapillus)	A	X	X
Mountain Chickadee (Parus gambeli)	A	X	X
Red-breasted Nuthatch (Sitta canadensis)	A	X	X
Robin (Turdus migratorius)	A	X	
Varied Thrush (Ixoreus naevius)	C	X	
Olive-backed Thrush (Hylocichla ustulata)	C	X	
Oregon Junco (Junco oreganus)	A	X	X
Pine Grosbeak (Pinicola enucleator)	C	X	X

* Abundance
A- Abundant; C- Common; R- Rare
1 Summer
2 Winter

Scat Collection

Before scats were collected from the study area, all the old scats remaining from the previous fall, winter and spring were removed and discarded. This made it possible to catalogue all future collections as to approximate date of deposition, as well as location and date of collection. After the trails and lines had been cleared once, future collections were easily classified. Scats collected on areas adjacent to the study area were taken only if they appeared to have been deposited recently. The only collections made outside the boundary of the study area were during the month of August, 1955. All trails on the area were cleared at the close of each field investigation. This made it possible to catalogue the scats found after returning to the study area. They were also collected from trap sites and these could be catalogued to the exact date of deposition.

Marten may have certain areas that serve as "latrines"; sometimes after a trail had not been cleared for at least a month, several scats could be found within a small area along the trail. Logs and trail junctions also appeared to be favored locations for defecation. Frequent snows made it difficult to find scats during the winter. Only 54 were collected at this time and many were taken from trap sites. Captured marten appear to empty their digestive tracts within a 24 hour period. They chewed the straps holding the canvas trap covers and pieces of the strap were later found when the scats were analyzed. All scats collected were put into manila envelopes and stored until

analysis. A total of 561 scats were collected; 488 from the study area and 73 from trails adjacent to the study area. These scats were classified as summer, winter or fall. A group taken in the spring of 1956, were classed as winter or spring. Thoroughly bleached scats appeared to be from the winter and those retaining some color were thought to have been deposited in the spring.

Techniques and Methods

In order to do a thorough food habits analysis, an adequate reference collection of small mammal skins, skeletal material and seeds of fruits is needed for comparative purposes. Hairs from all species of mammals known to inhabit the area were mounted on microscope slides. Oil of cedar was used as a temporary mounting medium when making slides of unknown hair specimens. A Bausch and Lomb comparison-ocular was used. It could be attached to two identical compound microscopes, making it possible to compare two hairs by bringing them both into the same field of vision through the use of a common eyepiece. Hair widths were measured with an ocular micrometer.

Scats were analyzed after drying, without previous washing. They were placed in a Petri dish and separated with a BB forceps under a binocular dissecting microscope. All different food items to be identified were set to one side for later identification. When this was completed, the items were entered on Unisort Analysis Cards.

The presence of teeth in a scat made possible positive identification of mammalian food items. Seeds were usually identified by comparison with the reference collection. In rare instances, an unknown seed was found and these were sent to the United States Fish and

Wildlife Service Food Habits Laboratory in Denver, Colorado, for identification. They identified one seed as Polygonatum spp. but this genus does not occur in western Montana and the seed was probably Smilicina or Disporum. Insects were usually identifiable to order if the fragments were large.

In most cases hair from cervids, hares, squirrels, shrews and jumping mice were readily identified by their characteristic form, size and medullar configuration. The hair of the microtine rodents and Peromyscus maniculatus presented more of a problem; both have similar coloration, a compound medulla, and lengths of each may overlap (Mayer, 1952). The criterion used to differentiate Peromyscus hair from that of microtines was maximum width of each. Peromyscus hairs measured approximately 34 micra in width, while those of the microtines range from 58 to 65 micra (Mayer, 1952). The most difficult problem was to identify hair from the different microtines. In order to distinguish the species of Microtus, it was necessary to have upper second molars (M2). In the absence of this tooth the identification was made to genus. This accounts for the category Microtus spp. which occurred in 5.5 per cent of the scats. When no teeth were found, hair was used for identification, and because of the difficulty of identifying the species, a separate class was set up entitled "Microtine rodents". Clethrionomys gapperi could be separated from the others if enough red dorsal guard hair was present. If not, and if teeth were lacking, the hair was classed as microtine type. In many instances hairs were unidentifiable because they were badly macerated by chewing and digestion.

Feathers were almost impossible to identify to species. In most

cases they were broken into very small pieces and only if accompanied by claws or mandibles could identification of game and non-game birds be made. Usually only the relative size of the bird could be estimated.

The most efficient identification was usually performed with the aid of the binocular dissecting microscope. When only a trace of hair was present, identification was not practical or possible unless the hair was from an easily identified species of the family Cervidae or Leporidae.

Results of Scat Analysis

It was evident from the analysis data that the marten is an opportunist, taking a variety of foods. Forty-three different food items were identified. Table XI lists all food items found by number of occurrences, frequency of occurrence by scats, and percentage of occurrence by items. Debris and marten hair are deleted from the table, but occurred in 47.4 and 4.1 per cent of the scats respectivly. A more condensed form of the food habits appears in Table XII, and represents the number of occurrences and the percentage of occurrence of the food items.

Single scats commonly contained more than one small mammal and as many as four were found in some. If the animals were of the same species, it was necessary to find two or more corresponding teeth to denote their presence.

A generalized breakdown of the food items show that mammals comprised 55.4 per cent of the occurrences, birds 8.8 per cent, insects 9.8 per cent, vegetation (mostly fruit) 24 per cent and the remaining

Table XI

FOOD OF MARTEN IN GLACIER PARK
BY OCCURRENCE AND FREQUENCY OF OCCURRENCE IN 561 SCATS AND BY PER CENT OF 1282 ITEMS

	1955 Summer			1956 Winter			1956 Winter & Spring			1956 Summer			1956 Summer & Fall			1956 Fall			Total		
	O	F	%	O	F	%	O	F	%	O	F	%	O	F	%	O	F	%	O	F	%
Clethrionomys gapperi	49	21.9	8.1	21	38.9	24.7	20	24.1	11.7	34	27.0	11.9	9	34.6	18.7	31	64.6	34.4	164	29.2	12.8
Microtus spp.	13	5.8	2.1	2	3.7	2.3	2	2.4	1.2	7	5.5	2.4	4	15.4	8.3	3	6.2	3.3	31	5.5	2.4
Microtus pennsylvanicus	2	0.9	0.3	1	2.0	1.2	2	2.4	1.2	9	7.1	3.1	2	7.7	4.2	1	2.1	1.1	17	3.0	1.3
Microtus longicaudus	3	1.3	0.5	-	-	-	1	1.2	0.6	3	2.4	1.0	1	3.8	2.1	4	8.3	4.4	12	2.1	0.9
Phenacomys intermedius	8	3.6	1.3	1	2.0	1.2	5	6.0	2.9	5	4.0	1.7	7	26.9	14.6	7	14.6	7.8	33	5.9	2.6
Synaptomys borealis	-	-	-	2	3.7	2.3	1	1.2	0.6	1	0.8	0.3	-	-	-	-	-	-	4	0.7	0.3
Microtine rodent	15	6.7	2.5	6	11.1	7.0	6	7.2	3.5	5	4.0	1.7	-	-	-	7	14.6	7.8	39	6.9	3.0
Peromyscus maniculatus	5	2.2	0.8	-	-	-	5	6.0	2.9	2	1.6	0.7	-	-	-	-	-	-	12	2.1	0.9
Neotoma cinerea	1	0.4	0.2	-	-	-	1	1.2	0.6	-	-	-	-	-	-	-	-	-	2	0.3	0.2
Zapus princeps	11	4.9	1.8	-	-	-	2	2.4	1.2	26	16.3	9.1	3	11.5	6.2	4	8.3	4.4	46	8.2	3.6
Sorex spp.	23	10.3	3.8	5	9.2	5.9	11	13.2	6.4	6	4.8	2.1	3	11.5	6.2	6	12.5	6.7	54	9.6	4.2
Sorex cinereus	2	0.9	0.3	-	-	-	-	-	-	1	0.8	0.3	-	-	-	-	-	-	3	0.5	0.2
Sorex vagrans	-	-	-	-	-	-	1	1.2	0.6	-	-	-	-	-	-	-	-	-	1	0.2	0.08
Tamiasciurus hudsonicus	20	8.9	3.3	15	27.8	17.6	4	4.8	2.3	6	4.8	2.1	2	7.7	4.2	1	2.1	1.1	48	8.5	3.7
Citellus columbianus	14	6.2	2.3	-	-	-	18	21.7	10.5	3	2.4	1.0	1	3.8	2.1	-	-	-	36	6.4	2.8
Eutamias amoenus	15	6.7	2.5	-	-	-	5	6.0	2.9	5	4.0	1.7	-	-	-	2	4.2	2.2	27	4.8	2.1
Glaucomys sabrinus	-	-	-	-	-	-	1	1.2	0.6	1	0.8	0.3	-	-	-	-	-	-	2	0.3	0.2
Sciuridae	1	0.4	0.2	-	-	-	-	-	-	-	-	-	-	-	-	1	2.1	1.1	2	0.3	0.2
Lepus americanus	9	4.0	1.5	1	2.0	1.2	11	13.2	6.4	8	6.3	2.8	-	-	-	-	-	-	29	5.2	2.3
Erethizon dorsatum	3	1.3	0.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	0.5	0.2
Mustela spp.	1	0.4	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2	0.08
Cervidae (carrion)	5	2.2	0.8	16	29.6	18.8	7	8.4	4.1	2	1.6	0.7	-	-	-	-	-	-	30	5.3	2.3
Unidentified mammal	27	12.0	4.5	1	2.0	1.2	3	3.6	1.7	14	11.1	4.9	1	3.8	2.1	-	-	-	46	8.2	3.6
Game bird	1	0.4	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2	0.08
Non-game bird	7	3.1	1.2	-	-	-	1	1.2	0.6	5	4.0	1.7	-	-	-	-	-	-	13	2.3	1.0
Unidentified bird	54	24.1	9.0	3	5.5	3.5	10	12.0	5.8	13	10.0	4.5	2	7.7	4.2	-	-	-	82	14.6	6.4
Bird egg	2	0.9	0.3	1	2.0	1.2	10	12.0	5.8	3	2.4	1.0	-	-	-	3	8.3	3.3	19	3.4	1.5
Snail	2	0.9	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.3	0.2
Coleoptera	10	4.5	1.7	-	-	-	12	14.4	7.0	4	3.2	1.4	2	7.7	4.2	2	4.2	2.2	30	5.3	2.3
Hymenoptera	30	13.4	5.0	1	2.0	1.2	8	9.6	4.4	20	15.9	7.0	4	15.4	8.3	1	2.1	1.1	64	11.4	5.0
Hemiptera	2	0.9	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.3	0.2
Diptera	1	0.4	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2	0.08
Orthoptera	5	2.2	0.8	-	-	-	-	-	-	-	-	-	-	-	-	1	2.1	1.1	6	1.1	0.5
Unidentified insect	8	3.6	1.3	-	-	-	5	6.0	2.9	5	4.0	1.7	-	-	-	-	-	-	18	3.2	1.4
Fragaria spp.	51	22.8	8.5	-	-	-	-	-	-	6	4.8	2.1	-	-	-	-	-	-	57	10.2	4.4
Vaccinium spp.	112	50.0	18.6	1	2.0	1.2	1	1.2	0.6	18	14.3	6.3	3	11.5	6.2	-	-	-	135	24.1	10.5
Amelanchier spp.	6	2.7	1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	1.1	0.5
Ribes spp.	27	12.0	4.5	-	-	-	-	-	-	-	-	-	1	3.8	2.1	-	-	-	28	5.0	2.2
Aralia nudicaulus	13	5.8	2.1	-	-	-	-	-	-	14	11.1	4.9	1	3.8	2.1	-	-	-	28	5.0	2.2
Rubus parviflorus	25	11.2	4.1	-	-	-	-	-	-	12	9.5	4.2	1	3.8	2.1	-	-	-	38	6.8	3.0
Rubus strigosus	2	0.9	0.3	-	-	-	-	-	-	2	1.6	0.7	-	-	-	-	-	-	4	0.7	0.3
Crataegus douglasii	3	1.3	0.5	1	2.0	1.2	6	7.2	3.5	10	7.9	3.5	-	-	-	1	2.1	1.1	21	3.7	1.6
Rosa spp.	2	0.9	0.3	6	11.1	7.0	12	14.4	7.0	2	1.6	0.7	1	3.8	2.1	10	20.8	11.1	33	5.9	2.6
Symphoricarpos spp.	-	-	-	1	2.0	1.2	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2	0.08
Rhamnus alnifolia	8	3.6	1.3	-	-	-	-	-	-	30	23.8	10.5	-	-	-	-	-	-	38	6.8	3.0
Cornus canadensis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2.1	1.1	1	0.2	0.08
Streptopus spp.	2	0.9	0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	0.3	0.2
Polygonatum spp.	1	0.4	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2	0.08
Geranium spp.	1	0.4	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	0.2	0.08
Solanum spp.	-	-	-	-	-	-	-	-	-	1	0.8	0.3	-	-	-	-	-	-	1	0.2	0.08
Unidentified seeds	-	-	-	-	-	-	-	-	-	3	2.4	1.0	-	-	-	4	8.3	4.4	7	1.2	0.5

O = Occurrence
F = Frequency; per cent of occurrences in scats
% = Per cent occurrences by items

Dates collected:
a. 1955 summer, 224 scats collected June 27, to September 17, (73 scats from off area incl.)
b. 1956 winter, 54 scats collected January 4, to February 11, on area.
c. 1956 winter and spring, 83 scats collected June 7, to June 11, on area.
d. 1956 summer, 126 scats collected August 15, to September 20, on area.
e. 1956 summer and fall, 26 scats collected August 21, to October 10, on area.
f. 1956 fall, 42 scats collected September 21, to October 19, on area.

Table XII

MARTEN FOOD HABITS ANALYSIS EXPRESSED BY
OCCURRENCE OF ITEMS AND FREQUENCY OF OCCURRENCE

	1955						1956									
	Summer[a]		Summer[b]		Winter[c]		Winter & Spring[d]		Summer[e]		Summer & Fall[f]		Fall[g]		Total	
Items	Occ.	%	Occ.	%	Occ.	%	Occ.	%	Occ.	%	Occ.	%	Occ.	%	Occ.	%
Microtinae	27	16.0	58	18.2	29	36.2	34	21.0	56	23.2	20	44.4	44	55.0	268	24.4
Cricetinae	-	-	6	1.9	-	-	6	3.7	2	0.8	-	-	-	-	14	1.3
Zapodidae	4	2.4	7	2.2	-	-	2	1.2	26	10.8	3	6.7	5	6.2	47	4.3
Soricidae	3	1.8	22	6.9	6	7.5	12	7.4	7	2.9	3	6.7	6	7.5	59	5.4
Sciuridae	7	4.1	43	13.5	15	18.7	28	17.3	14	5.8	3	6.7	4	5.0	114	10.4
Leporidae	3	1.8	6	1.9	1	1.3	11	6.8	8	3.3	-	-	-	-	29	2.6
Erethizontidae	3	1.8	-	-	-	-	-	-	-	-	-	-	-	-	3	0.3
Mustela spp.	1	0.6	-	-	-	-	-	-	-	-	-	-	-	-	1	0.09
Cervidae (carrion)	1	0.6	4	1.2	16	20.0	7	4.3	2	0.8	-	-	-	-	30	2.7
Unidentified Mammal	12	7.1	12	3.8	1	1.3	3	1.8	14	5.8	1	2.2	-	-	43	3.9
Game Bird	-	-	1	0.3	-	-	-	-	-	-	-	-	-	-	1	0.09
Non-Game Bird	3	1.8	7	2.2	-	-	1	0.6	5	2.1	-	-	-	-	16	1.5
Unidentified Bird	21	12.4	30	9.4	3	3.7	10	6.2	13	5.4	2	4.4	-	-	79	7.2
Bird Egg	-	-	2	0.6	1	1.3	11	6.8	2	0.8	1	2.2	3	3.7	20	1.8
Gastropoda	2	1.2	-	-	-	-	-	-	-	-	-	-	-	-	2	0.2
Insecta	13	7.6	35	11.0	1	1.3	21	13.0	26	10.8	5	11.1	6	7.5	107	9.8
Vegetable	69	40.8	86	26.9	7	8.7	16	9.9	66	27.4	7	15.5	12	15.0	263	24.0

Compiled from 561 Scats and 1095 Items

a. Summer 1955, off area, collected August 5 to September 1; 73 scats, 169 items.
b. Summer 1955, collected June 27 to September 17; 151 scats, 319 items.
c. Winter 1956, collected January 4 to February 11; 54 scats, 79 items.
d. Winter and spring 1956, collected June 7 to June 11; 83 scats, 162 items.
e. Summer 1956, collected August 15 to September 20; 126 scats, 241 items.
f. Summer and fall 1956, collected August 21 to October 10; 26 scats, 45 items.
g. Fall 1956, collected September 21 to October 19; 48 scats, 80 items.

two per cent bird eggs and snails.

Microtines were the mammals most often taken. Clethrionomys gapperi which occurred in 29.2 per cent of the scats, was the most numerous species identified. It was followed by Phenacomys intermedius with 5.9 per cent, Microtus spp. 5.5 per cent (Microtus remains only identifiable to genus), Microtus pennsylvanicus 3.0 per cent, Microtus longicaudus 2.1 per cent and Synaptomys borealis 0.7 per cent.

Occurrence of microtines in scats varied seasonally and when fruits were available the microtine consumption seemed to diminish. The most noticeable period of low microtine consumption was from August 5, to September 1, 1955. During this period the fruit of huckleberries (Vaccinium spp.) and wild strawberries (Fragaria spp.) were especially abundant and 40.8 per cent of the scats contained vegetable remains. However, in 1956, the late summer, fall and winter scats contained the highest percentage of microtines. This can be explained by the apparent lack of available fruit in the winter and a poor huckleberry and strawberry crop during the summer of 1956. The small mammal population is also at its seasonal peak during the late summer and early fall.

After the microtines, the squirrels were the next most important food. Four species were identified; red squirrels, 8.5 per cent occurrence, ground squirrels, 6.4 per cent, chipmunks, 4.8 per cent and flying squirrels, 0.3 per cent. More red squirrels were found in the winter scats; 27.8 per cent contained these remains. It is possible that squirrels are more vulnerable to predation when restricted to areas in the neighborhood of their seed caches and spending

more time under the snow. Ground squirrels were more prevalent in the spring and occurred 18 times for a per cent occurrence of 21.7. These squirrels leave hibernation in early spring and they appear to be most vulnerable to predation by marten at this time. This is also the period when mice are least abundant.

Shrews were next in order, occurring in 10.3 per cent of the scats. Sorex cinereus and Sorex vagrans were the two species identified, but in most cases the species was not determined because of a lack of critical maxillary teeth.

Zapus princeps occurred in 8.2 per cent of the scats. They were most numerous in scats gathered in the summer of 1956, rising to 16.3 per cent in that period. Very few were present in the early spring and none from the winter collections.

The remains of cervids occurred in 5.3 per cent of the scats. The major proportion occurred in winter and early spring, although a few scats contained identifiable remains in the summer. These items are the result of marten feeding on carcasses of winter killed animals.

Snowshoe hare remains were found 29 times representing a 5.2 per cent occurrence. They were most abundant in the spring. This may indicate that the young are quite vulnerable to predation by marten. It was not possible to distinguish between adult and immature hares by the remains in scats.

The Cricetinae are represented by Peromyscus maniculatus (2.1 per cent) and Neotoma cinerea (0.2 per cent). The only other mammals found were porcupine (Erethizon dorsatum) and a species of weasel. The porcupine was probably carrion.

Birds occurred in 17.1 per cent of the feces and bird eggs were found in 3.4 per cent. The highest frequency of occurrence for birds was from the summer collections, while more eggs occurred in the spring. The summer scats collected in 1955 contained a higher percentage of bird remains (27.6 per cent) than did the scats collected in the summer of 1956 (14.0 per cent). Only one scat contained an identifiable grouse feather and two others contained enough to tentatively identify a winter wren and a rough-winged swallow.

Insects were common in all periods except winter. They were found in 9.8 per cent of the scats. Hymenopterans and Coleopterans were the most numerous insects found. Some insect occurrences, especially when only small fragments were found, may possibly have been taken by a bird which was later caught by a marten. In 79 scats containing bird remains, 32 also contained fragments of insects. In many cases Hymenopteran remains comprised a large portion of a single scat and in these instances there can be no doubt that marten were taking them for food.

Seeds of the common fruits occurred in numbers almost equal to those of the microtines. The highest occurrences were noted in scats collected during the summer, although rose hips (Rosa spp.) and fruit of hawthorn (Crataegus douglasii) were eaten during the winter and spring. In 1955, when huckleberries, strawberries and Ribes were abundant, they were taken in large numbers, but in 1956 relatively few huckleberries and strawberries were available and marten shifted to buckthorn (Rhamnus alnifolia). Increased occurrence was also

noted for sarsaparilla (Aralia nudicaulis) and hawthorn during this period. Some small seeds only occurred occasionally and may not have been food items. They were probably ingested accidentally as debris or were eaten by birds or mice which were later killed by marten.

Only a few direct observations were made of marten actually feeding. Upon its release from a trap, one immediately began eating huckleberries and another fed on the fruit of a wild sarsaparilla plant. A captured animal was kept in a cage for 24 hours and was fed cooked hamburger and strawberry jam, but did not eat a freshly caught deer mouse. Many were offered kippered herring while in the trap or cone and only a few refused to eat. Almost all of them uttered a peculiar growl while eating.

During the winter trapping period, two adult males were captured that had robbed bait from a nearby trap and carried it to the next set without eating it. They evidently had dropped it at the trap entrance, entered the trap for more bait and were captured. Another marten carried a shrew into a trap. The shrew was found when the trap was taken from the site. This shrew was skinned later and had been bitten, but none of it had been eaten.

Discussion of Results

Marten food habits have been studied in several localities in recent years (see Table XIII). They are: British Columbia (Cowan and Makay, 1950; Quick, 1955), Great Shantar Islands, Russia (Dulkeit, 1929), Russia (Jurgenson, 1951), Alaska (Lensink, Skoog and Buckley, 1955) Montana (Marshall, 1946), Washington (Newby, 1951) and Colorado (Remington, 1951). These studies were based on scats or digestive

Table XIII

A COMPARISON OF MARTEN FOOD HABITS BY FREQUENCY OF OCCURRENCE

	a		b		c		d	e		f		g	h	
	Present Study		Alaska		British Columbia		G.S. Is.	Montana		Wash.		Colo.	British Columbia	
Items	S	W&Sp	S	W	S	W	W	W	W	S	W	S&W	W	W
Mice	30.2	29.5	74.0	68.0	59.0	79.9	71.7	15.0	14.0	13.4	27.7	49.3	39.0	56.4
Squirrels	8.3	17.4	-	2.0	12.9	4.8	7.9	55.0	60.0	9.6	40.5	22.2	-	12.7
Shrews	4.8	7.5	-	-	2.0	0.9	2.0	-	-	1.5	2.7	7.1	7.5	5.5
Lagomorphs	2.0	5.0	-	1.0	2.0	4.8	-	20.0	5.0	5.2	2.7	12.7	-	10.9
Birds	9.6	5.8	8.0	19.0	5.9	0.9	5.9	5.0	8.0	3.0	8.1	15.1	53.5	12.8
Insects	9.9	9.1	-	-	7.9	-	-	-	1.5	54.7	-	23.8	-	-
Vegetation (berries)	28.1	9.5	18.0	9.0	5.9	3.8	0.7	-	-	8.2	2.7	7.1	-	-
Other	1.6	5.0	-	1.0	-	-	11.8	-	6.5	2.2	-	3.9	0.8	2.4
Cervidae (carrion)	0.8	9.5	-	-	-	0.9	-	-	-	0.7	8.1	-	-	-
Unidentified Mammal	4.6	1.6	-	-	4.0	3.8	-	-	-	-	-	-	1.1	-

a. Summer foods based on 854 items from 425 scats; winter and spring foods based on 241 items from 137 scats (Glacier Park).
b. Summer foods based on 469 items from 374 scats; winter foods based on 107 items in 28 scats and 64 digestive tracts (Lensink, Skoog and Buckley, 1955).
c. Summer foods based on 212 items in 112 scats and 3 stomachs; winter foods based on 104 items in 85 scats (Cowan and Makay, 1950).
d. Winter foods based on 152 items (Dulkeit, 1929). Great Shantar Islands, Russia.
e. Winter foods based on 20 items in 18 scats during 1941-42; 57 items from 46 scats in 1942-43 (Marshall, 1946).
f. Summer foods based on 134 items in 78 scats and 1 stomach; winter foods based on 37 items from 17 scats and 16 stomachs (Newby, 1951).
g. Summer and winter foods based on 126 scats (Remington, 1951).
h. Winter foods based on frequency of occurrence of 127 alimentary tracts in 1947 and on 123 alimentary tracts in 1948 (Quick, 1955).

tracts, and three investigators utilized data from both sources. Newby (1951) stated that digestive tracts are not as useful as scats because a large portion of them are either empty or contain debris or the remains of the bait used by the trapper. Quick (1955) found that 59 per cent of the alimentary tracts examined were either empty or contained debris. Bait was found in approximately two per cent and the remainder contained food items in either the stomach or rectum or in both.

It is not feasable to compare results of the different studies too closely as ecological factors may vary markedly between different geographic regions (Newby, 1951). The results of the analysis may also vary with the methods used. Prior to the present study only two investigators attempted to correlate prey abundance with a food habits examination. They were Quick (1955) and Remington (1951), but neither confined their work to one particular area. John and Frank Craighead (1956) intensively studied small mammal populations to determine the amount of food available to a collective raptor population.

Microtines were the major food item in all areas except Montana (Marshall, 1946) and Washington (Newby, 1951). Marshall found that red squirrels were the most important winter food in Montana, while Newby found that insects were the most frequent food item taken in the summer and red squirrels the more important winter food. Squirrels were also important in the Pechora Basin in Russia, but microtines led the four other districts studied (Jurgenson, 1951). Mice were not represented in the diet of the marten in Glacier Park in numbers comparable to those found in Alaska, British Columbia, Colorado and

Russia. The number of different food items, however, was greater in Glacier Park than was found in the other areas. This factor may compensate for the lower occurrence of mice in the diet.

Squirrels were second in frequency of occurrence in Glacier Park, but did not approach the 55 and 60 per cent found by Marshall during the winters of 1941 and 1942, and 1942 and 1943 along the North Fork of the Flathead River. Small mammals were not censused by Marshall so it is not feasable to compare the results of both studies too closely. In all the studies made, including the present one, squirrels occurred in winter at higher rates than at other seasons except in British Columbia (Cowan and Makay, 1950). Quick (1955) states that red squirrels are more vulnerable in the winter because they stay in the vicinity of their caches and are caught easily when found foraging under the surface of the snow. The increased frequency of squirrels in the winter scats in the present study can be attributed to the 18 occurrences of ground squirrels in the late winter and early spring scats which supplement the 27.8 per cent occurrence of red squirrels from the winter scats.

Shrews previously have been thought to be avoided by marten because of their strong odor (Cowan and Makay, 1950; Lensink, Skoog and Buckley, 1955; Newby, 1951). Remington (1952) found that although shrews were not a preferred food item, they were readily accepted by two captive marten. Shrews were a common item found by Quick (1955), Remington (1951) and in the present study. Insectivores occurred in the diet of marten in Russia (Jurgenson, 1951), but it cannot be determined whether moles or shrews or both are represented in this group.

Hares did not appear to be important in most areas. Their occurrence was most common in the winter in all areas except Washington where Newby found them more often in the summer. They do not comprise a large enough portion of the marten's food in any area to lend support to the theory that marten are a cyclic species fluctuating with snowshoe hare abundance (Elton, 1942).

Birds were taken frequently in most areas. Quick (1955) found them to be exceedingly abundant in the winter of 1947. Grouse were an important food item in many areas of Russia (Jurgenson, 1951). This was the only region where they made up an appreciable portion of the diet.

Insects were common in the summer and early spring in Glacier Park. They were the most numerous food item found in scats from Washington (Newby, 1951), comprising 54.7 per cent of the occurring items. They were also an important item in the Caucasus region of Russia, comprising 49.8 per cent of the food items (Jurgenson, 1951). Newby (1951) explains the unusually high occurrence of ants in the scats he analyzed as a result of the forest conditions. Heavy snow fells many of the less vigorous trees and the resulting stumps and logs create excellent habitat for large carpenter ants (Camponotus spp.).

The marten in Glacier Park fed on berries to a greater extent than those in the other areas except Russia where 22 to 26 per cent of the food items was made up of plant food (Jurgenson, 1951). Alaska ranked second to Glacier Park on this continent (Lensink, Skoog and Buckley, 1955). Huckleberries were the favored fruit of the marten in

Alaska and in the present study. Marten on the study area also took several other species of berries when they were available.

Carrion was taken frequently during the winter in Washington and Glacier Park, but was not important in other areas. The cervids were the main source of this food.

Reptiles and fish were reported from some sections of Russia (Jurgenson, 1951). Remington (1951) also found evidence of fish in a few scats he collected in Colorado. No reptiles or fish were found to be used as food in this study.

It is evident that marten will eat a variety of available foods and do not appear to depend on a limited number of prey species. They may be classed as "general feeders" because they take a variety of food items (J. and F. Craighead, 1956).

COMPARISON OF SMALL MAMMAL TRAPPING WITH RESULTS OF FOOD HABITS EXAMINATION

Marten Food Habits Correlated With Food Availability

The five species of microtine rodents were trapped on the small mammal plots and were all represented in the diet of the marten. Three other species were also taken by trapping. In order to effectively compare the species of small mammals trapped with their occurrence in scats, the percentage of items in scats were calculated so that the total of small mammal remains appear as 100 per cent. This allows a direct comparison of the proportion of small mammals taken in the snap trapping with those found in marten scats. These weighted percentages appear in the discussion (see Table XIV).

Clethrionomys gapperi occurred more often in the scats and was also the most frequent small mammal trapped on the study plots. It occurred in 40.6 per cent of the scats and represented 44.7 per cent of the small mammal captures. The highest frequency of occurrence was found in the late summer, fall and winter. This peak in the fall is at a time when the population should be at its seasonal peak with more voles available for the marten. The frequency attained during the winter can be explained by the fact that fewer food items are available at this time and the marten's diet is mainly carnivorous. Clethrionomys occurred in scats 164 times, of which 73 per cent were identified by teeth. It comprised 61 per cent of all microtines and it is possible some were missed when hair was the only means of identification. Ventral, lateral and leg hair is not red and could only be classed as

Table XIV

RELATION OF THE PREY SPECIES CENSUSED TO THEIR FREQUENCY OF OCCURRENCES IN SCATS

Species	No. Occ. in Scats	Freq. of Occ.[a]	% of Total Captures[b]
Clethrionomys gapperi	164	40.6	44.7
Microtus spp.	60	14.8	0.4
Phenacomys intermedius	33	8.1	1.8
Synaptomys borealis	4	1.0	0.2
Zapus princeps	46	11.4	1.3
Peromyscus maniculatus	12	3.0	16.0
Eutamias amoenus	27	6.7	1.3
Sorex spp.	58	14.3	34.2
	404	99.9	99.9

a. Frequencies calculated to appear as 100 per cent to allow comparison with trapping results.

b. Relative abundance of prey censused.

microtine. It thus appears that the species was taken in numbers comparable to its relative density as expressed by small mammal trapping.

Microtus pennsylvanicus was represented much more frequently in the scats than by trapping. One was caught by trapping while 17 were identified in the scats. Twelve Microtus longecaudus were identified in the food habits examination and only one was trapped. Thirty-one others were identified as Microtus spp. and these three classes totaled 60 for 14.8 per cent occurrence in scats, but only represented 0.4 per cent of the small mammal captures. None of the trap lines were located in optimum Microtus pennsylvanicus habitat, which may account for the failure to trap a sizeable number. From all indications marten do not enter large open areas very often, and I believe the Microtus pennsylvanicus captured by them are taken in small areas near streams where adequate grass cover is available. The small mammal trapping data show that Microtus were at a cyclic low during the period this study was carried on. They were numerous in the meadows during 1953, but all signs noted in 1955 were old. However, Hawley (unpublished) examined 89 scats taken in 1953 and found Microtus to be more numerous than any other species.

Seven Phenacomys intermedius were captured while trapping and comprised 1.8 per cent of the small mammal catch. Thirty-three were identified in the scats, to represent a 8.1 per cent occurrence. Phenacomys was trapped in a variety of types; open lodgepole, Class III, burned areas, and in Class IV mixed types. It may be more common than is indicated by snap-trapping indices. Edwards (1952) states

that it is a difficult animal to trap. Evidence of many more found in marten scats than were trapped tends to verify his statement.

One Synaptomys borealis was caught while trapping and four were identified in the marten feces. The population was evidently low on the study area. Burt (1948) states that Synaptomys cooperi may fluctuate from year to year, but that evidence of cyclic fluctuations has not been verified.

Peromyscus maniculatus was found in only 12 scats, and yet it was the third most prevalent species caught while trapping. It was evidently not taken by marten in relation to its abundance. It is not generally regarded as a cyclic species and was trapped in equal numbers both years. John and Frank Craighead (1956) found that the risk Peromyscus runs to predation by raptors is high and tends to offset a density relationship. Some factor must be operating such as, cover, alertness or period of activity to keep marten from catching a fairly abundant species in greater numbers.

Neotoma cinerea appeared twice in the scats and none were captured while trapping. It is certainly not a common species on the study area.

Zapus princeps was found in 46 scats (11.4 per cent) but only five were captured by trapping, these in a variety of types. It may be more numerous than trapping indicates. As Zapus hibernate, no evidence was found in winter scats, but it was taken frequently in the summer of 1956.

Five Eutamias amoenus were trapped, but 27 (6.7 per cent) were identified in the scats. The type of traps used were too small to

catch them regularly and they were much more numerous than the trapping data indicates.

Sorex spp. represented 34.2 per cent of the small mammal catch while appearing in 14.3 per cent of the scats. Trapping indicates they were most numerous in 1955, but the per cent occurence in scats did not vary appreciably, although the lowest occurrence in scats was during the summer of 1956. Of the 89 scats gathered in 1953 (Hawley, unpublished) Sorex were found in 13.6 per cent. Shrews were numerous during the two years of the present study, undoubtedly more so than during 1953-1954, but their occurrence in the scats does not bear this out. An adequate population index of shrews is difficult to obtain through trapping, probably because of their behavior pattern.

Marten Abundance in Relation to Available Foods

Marten were more abundant on the study area in 1953 and early in 1954 when their food supply was greater. Microtus were very abundant in 1953, but declined abruptly in 1954. It is unfortunate that all seven of the small mammal plots were not in operation when the population was at its peak. If this had been possible, a better picture of small mammal abundance would be available. The two plots which were in operation clearly show this decline. Results of analysis (Hawley, unpublished) also show that of scats collected in the spring of 1953, 38.2 per cent contained Microtus while Clethrionomys gapperi occurred in only nine per cent. This is the reverse of what was found during the present study and substantiates data derived from the small mammal plots.

Microtines have been the important food item in almost all localities where marten food habits have been studied. A marked drop in the density of Microtus may well lower the carrying capacity of the study area. Food shortage has been known to affect the population density of different predators (Lack, 1954). This could happen through failure to breed or from high juvenile mortality (Dice, 1952). Lensink, Skoog and Buckley (1955) postulate that food shortage may affect marten populations by increasing their movements or by altering their reproductive success. Emigration is another result of food shortages. To date, movements of 17 and 25 miles have been recorded of juvenile males tagged on the study area and collected outside the park. This is a fairly high return considering that animals are able to move in any direction.

Food Preference

Nearly every food habits study of a particular species of animal has shown that certain foods are taken more frequently than other foods even though they both are available in equal quantities. Little is known about food preferences of most wild animals, but it is difficult to imagine that they would pass up nutritive food, especially if hungry. A preference for one food may be correlated with a prejudice against other types (Dice, 1952). It appears that some factor is present which keeps marten from taking Peromyscus maniculatus in numbers comparable to their apparent density. They may not be as palatable as the microtine rodents or they may be more difficult to capture.

Recommendations

A major objective still unanswered is the minimum breeding age of female marten. In order to study this problem a large sample of known-age juvenile females must be trapped and marked. This cohort should be followed closely and recaptured after the breeding season the following year. In order to establish the breeding age, these marten must be sacrificed and it would be desirable if these animals could be taken from outside the park. The animals on the study area are valuable because of their known ages, sex composition and the data derived from the four years of live-trapping. Besides, it has not produced enough juvenile marten in the past two years to make a study of this type possible.

The present area should be live-trapped to follow the density, age and sex composition. The older animals are especially valuable because they represent an opportunity to establish more data on the longevity of wild marten.

The small mammal lines should be operated in an effort to determine population changes, especially in the microtines. Any increase in their densities should raise the carrying capacity of the area and could enable the marten population to climb to its former level.

Intensive trapping within a known home range of a female marten during the period in which they are likely to have young may enable the investigator to track the female marten to its den and learn what type of den sites are utilized by marten. It may also be possible to observe young marten at this time.

SUMMARY

1. A food habits study is the second phase of a long term ecological study of the marten (Martes americana) in Glacier National Park. The study was initiated by Fletcher E. Newby in cooperation with Dr. Philip L. Wright. Vernon D. Hawley was the first graduate student assigned to the study. He studied marten home ranges and completed a vegetation survey of the forest types. His work started in 1953 and terminated in 1955.
2. Field investigations consisted of marten live-trapping, small mammal census, scat collections and a survey of the ground vegetation on the small mammal plots. These investigations were accomplished in the summer of 1955, winter of 1956, summer and fall of 1956.
3. The permanent study area contains 5.43 square miles of land west of Anaconda Creek along the North Fork Truck Trail 16 miles north of West Glacier, Montana.
4. Eighty-five days were spent live-trapping marten. In all, 1940 trap units were set, which resulted in 206 captures of 45 marten (28 males and 17 females). It required 9.4 trap units to capture one marten. An average of 5.6 captures were made of each male and 2.9 captures per female. The average sex ratio for all marten captured was 185 males for every 100 females.
5. Many traps were disturbed by bear and other animals. Red squirrels were frequently captured in the live-traps.
6. At the close of trapping there were no known juveniles on the study

area and over 50 per cent of the population were at least four and one-half years of age or older.

7. A 17 mile movement was recorded of a juvenile male in the fall of 1956.

8. A yearling female was autopsied after the breeding season and she had not been bred. One adult female was three years of age when she bore her first litter.

9. The population fluctuated from 13 to 21 marten during 1955 and 1956. The highest density was recorded in the winter of 1956 when several transient marten were captured.

10. One adult male and one juvenile male were found dead in the live-traps.

11. Small mammals were censused by the method described by Calhoun (1948). Seven study plots were in operation twice yearly during 1955 and 1956.

12. Two of these plots were trapped by Hawley (1955) and a four year comparison could be made. A decline was noted between 1953 and 1954. The two species of Microtus showed the most noticeable drop and never reappeared in appreciable numbers during the small mammal trapping.

13. Clethrionomys gapperi, Sorex cinereus and Peromyscus maniculatus comprised 88.6 per cent of the catch. Seven other species comprised the remaining 11.4 per cent.

14. The methods used for obtaining an index of red squirrel abundance were not satisfactory.

15. Snowshoe hares were not numerous on the study area.

16. Presence of teeth in scats made it possible to positively identify prey species. The hair of microtine rodents could be differentiated from Peromyscus maniculatus by their maximum widths. Birds were difficult to identify because feathers were usually badly macerated.

17. Forty-three different food items were identified in the 561 scats analyzed. Clethrionomys gapperi was the most abundant small mammal identified and Vaccinium spp. were the fruits taken most often by marten.

18. Mammals comprised 55.4 per cent of the occurrences in scats, birds 8.8 per cent, insects 9.8 per cent and berries 24 per cent.

19. Winter killed elk and deer may be an important food item when prey species are not abundant.

20. Marten appear to take Clethrionomys gapperi in numbers comparable to their relative abundance as shown by small mammal trapping indices. Small mammals that were more difficult to trap were represented in greater numbers in scats. Peromyscus maniculatus is relatively easy to trap, but appears to be more difficult for marten to catch.

21. The study should be continued to attempt to determine the minimum breeding age of female marten. Small mammal trapping should be continued to see if an increase in the small mammals will raise the carrying capacity of the area. Marten live-trapping will continue to be the best means of checking the population composition on the study area.

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APPENDIX

SUMMARY OF SMALL MAMMAL TRAPPING

PLOT I*

Lodgepole Pine Class IV

Species	1955 Summer	1955 Fall	1956 Summer	1956 Fall
Microtus pennsylvanicus		1		
Zapus princeps			1	
Clethrionomys gapperi		3	4	13
Sorex cinereus	3	8	1	7
Sorex vagrans	2	6	2	
Eutamias amoenus				1
Total	5	18	8	21

Dates set: 1955 June 24 (summer); September 9 (fall).
1956 June 10 (summer); September 11 (fall).
* Trapped four days because of rain.

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PLOT II

Mixed Type Class IV

Species	1955 Summer	1955 Fall	1956 Summer	1956 Fall
Microtus longicaudus				1
Clethrionomys gapperi	10	19	3	26
Peromyscus maniculatus	1	7	3	7
Sorex cinereus	1	9		
Sorex vagrans		1		
Zapus princeps	1			
Phenacomys intermedius			1	
Total	13	36	7	34

Dates set: 1955 July 4 (summer); September 5 (fall).
1956 June 7 (summer); September 18 (fall).

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PLOT III

Lodgepole Class II

Species	1955 Summer	1955 Fall	1956 Summer	1956 Fall
Clethrionomys gapperi	2	2	5	26
Phenacomys intermedius	1			
Sorex cinereus		15		
Sorex vagrans		2	2	1
Total	3	19	7	27

Dates set: 1955 July 4 (summer); September 5 (fall).
1956 June 7 (summer); September 18 (fall).

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PLOT IV

Mixed Class IV

Species	1955 Summer	1955 Fall	1956 Summer	1956 Fall
Clethrionomys gapperi		4	1	6
Peromyscus maniculatus	4	10	3	5
Sorex cinereus		3		1
Phenacomys intermedius				1
Eutamias amoenus			1	
Total	4	17	5	13

Dates set: 1955 July 4 (summer); September 5 (fall).
1956 June 7 (summer); September 18 (fall).

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PLOT V

Mixed Class III

Species	1955 Summer	1955 Fall	1956 Summer	1956 Fall
Clethrionomys gapperi	9	14	4	19
Peromyscus maniculatus	1	3	3	4
Sorex cinereus		12	2	3
Sorex vagrans		1		2
Total	10	30	9	28

Dates set: 1955 June 30 (summer); September 9 (fall).
1956 June 10 (summer); September 22 (fall).

PLOT VI

Lodgepole-Ponderosa Pine Class III

Species	1955 Summer	1955 Fall	1956 Summer	1956 Fall
Clethrionomys gapperi	2	2	2	
Phenacomys intermedius			2	
Synaptomys borealis				1
Microtus pennsylvanicus				1
Sorex cinereus		4	2	
Sorex vagrans			1	
Total	2	6	7	2

Dates set: 1955 June 20 (summer); September 2 (fall).
1956 June 7 (summer); September 11 (fall).

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PLOT VII

Burn

Species	1955 Summer	1955 Fall	1956 Summer	1956 Fall
Peromyscus maniculatus	2	3		7
Zapus princeps			3	
Sorex cinereus	11	18	1	9
Sorex vagrans		3	1	1
Eutamias amoenus	1	1		1
Phenacomys intermedius	1			
Total	15	25	5	18

Dates set: 1955 July 20 (summer); September 9 (fall).
1956 June 10 (summer); September 22 (fall).

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