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Ecological and physiological study of pine marten

Charles J. Jonkel
The University of Montana

ECOLOGICAL AND PHYSIOLOGICAL STUDY OF PINE MARTEN

by

CHARLES J. JONKEL

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Approved by:

R. L. Wright
Chairman, Board of Examiners

Ellis Waldron
Dean, Graduate School

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Date

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INTRODUCTION

This study is the third phase of a long-term study of the pine marten (Martes americana) which was initiated in 1952 on Anaconda Creek in Glacier National Park. Fletcher Newby, Biologist with the State of Montana Fish and Game Department, working with Dr. Philip L. Wright, Department of Zoology, Montana State University, undertook the preliminary investigations. A suitable study area was located on the basis of habitat, marten density, and accessibility. Live-trapping and handling methods were developed and arrangements were made with the National Park Service for use of the study area and of Park facilities at Anaconda Creek cabin. A cooperative research program to work on various phases of marten life history was then instituted between the Montana Cooperative Wildlife Research Unite and the Montana State Fish and Game Department.

There have been two phases of the problem completed by Montana State University graduate students previous to this study. Vernon Hawley undertook the initial phase during 1953 and 1954. His work was concerned principally with perfecting marten live-trapping and handling techniques, surveying and mapping the Park study area, classifying and mapping vegetation on the area, and determining marten home ranges. He calculated that male marten had a mean home

range of 0.86 square miles, while for females it was 0.23 square miles (Hawley, 1955). He also began work on population dynamics and food relationships. Two small mammal plots were established on the study area and the small mammal density was sampled.

Richard Weckwerth worked on the second phase of the study in 1955 and 1956. He obtained data on marten population dynamics and finished the major part of the food habits study. A drop in the density of the small mammals noted between 1953 and 1954 and the marten density between 1954 and 1955 continued through this period. A correlation of fluctuations in the small mammal and marten densities of the area could not then be completed. It was determined that the red-backed mouse (Clethrionomys gapperi) is taken by the marten in numbers comparable to the apparent density of this species, as determined by trapping the small mammal plots. In relation to other small mammals, Microtus pennsylvanicus and M. longicaudus had a frequency of occurrence in the marten scats 37 times their apparent density on the small mammal plots. It should follow, therefore, that any great population increase in these species would increase the food supply of the marten considerably.

The present phase of the study was begun in June of 1957. The objectives were:

1. To determine the minimum breeding age of female marten in the wild and to check sperm development of

yearling males.

2. To determine the time of implantation of the embryos in the female marten uterus and the period of time between implantation and parturition.

3. To further investigate the relationship between small mammal and marten population densities.

4. To continue gathering and evaluating general life history information on the pine marten.

Field work began in June of 1957, continued to September of 1957, started again in June of 1958, and continued through December of 1958.

Most of the data on population fluctuations of small mammal and marten populations are taken from Hawley (1955) and Weckwerth (1957). The population information obtained by them from 1953 through 1956 was continued to obtain long-term trends.

A second study area, the Coal Creek drainage on the east side of the Whitefish mountains near Big Creek Ranger Station, was located and live-trapped during this study in addition to the area already established in Glacier National Park.

THE STUDY AREA

The live-trapping activity on the two study areas (see Figure 1) differed, so a varying emphasis has been placed on their respective descriptions. Since the Coal Creek study area was primarily used in procurement of laboratory animals, it was not as thoroughly investigated as the Anaconda Creek study area.

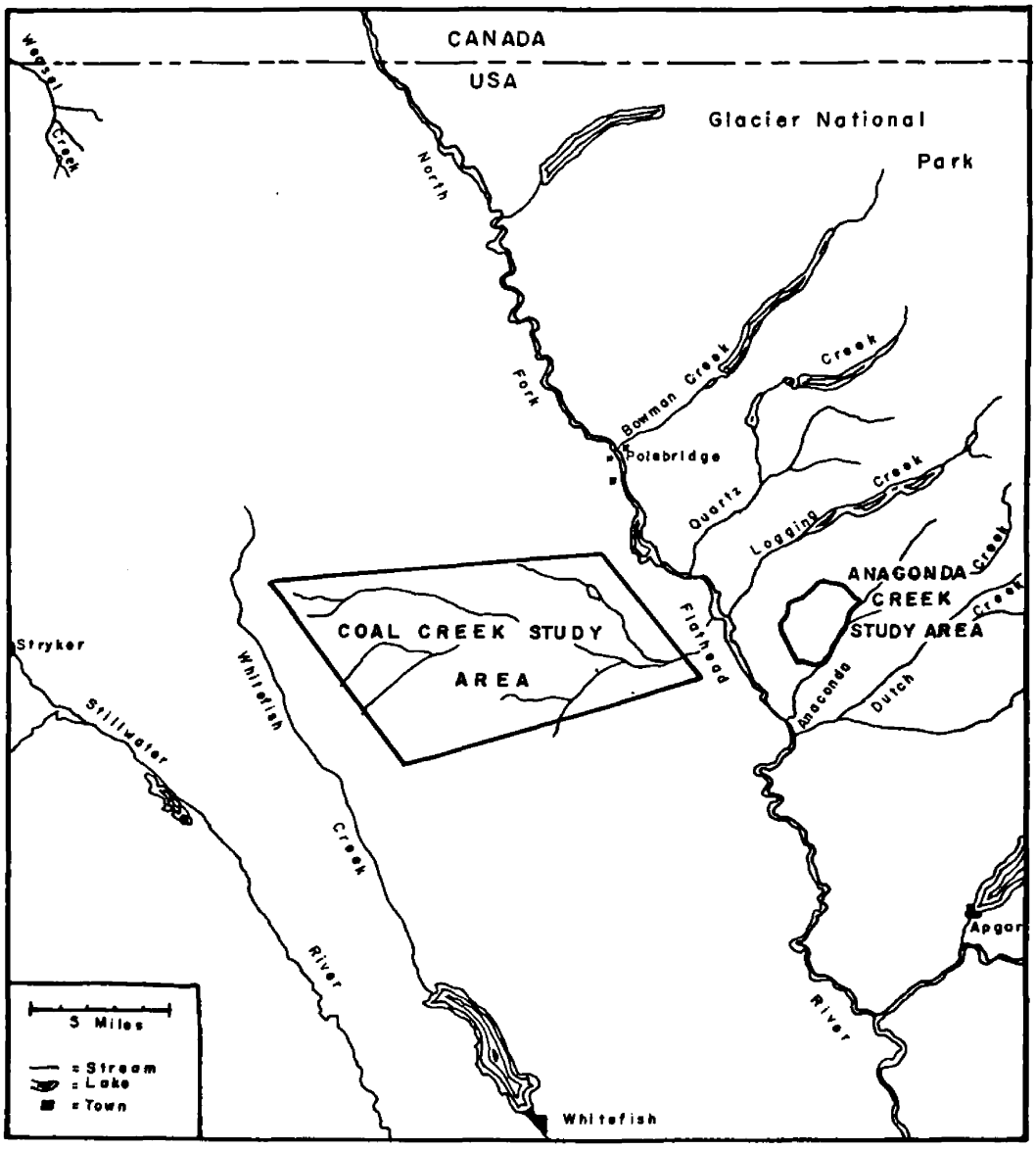
COAL CREEK

Coal Creek drains approximately 80 square miles of the Whitefish Range east slope. The drainage includes Mathias, Cyclone, and Deadhorse Creeks (see Figure 2). It flows in an easterly direction into the North Fork of the Flathead River, a south-flowing stream that parallels the Whitefish Range. The valley walls average nearly 7,000 feet and reach their highest point (7,521 feet) at Moose Peak. The stream flows into the North Fork River at 3,400 feet. The main part of the stream has an average gradient of about 100 feet per mile.

The Whitefish Range is an uplift associated with the Livingston Mountains that form the Continental Divide in Glacier Park to the east. The Whitefish Divide is roughly parallel to the strike of the underlying beds. Therefore, while the more weathered extreme heads of the Coal Creek have exposures of Grinnel argillite (gray quartzitic argil-

FIGURE 1

THE LOCATION OF THE ANACONDA CREEK AND COAL CREEK STUDY AREAS



Prepared from Forest Service Maps

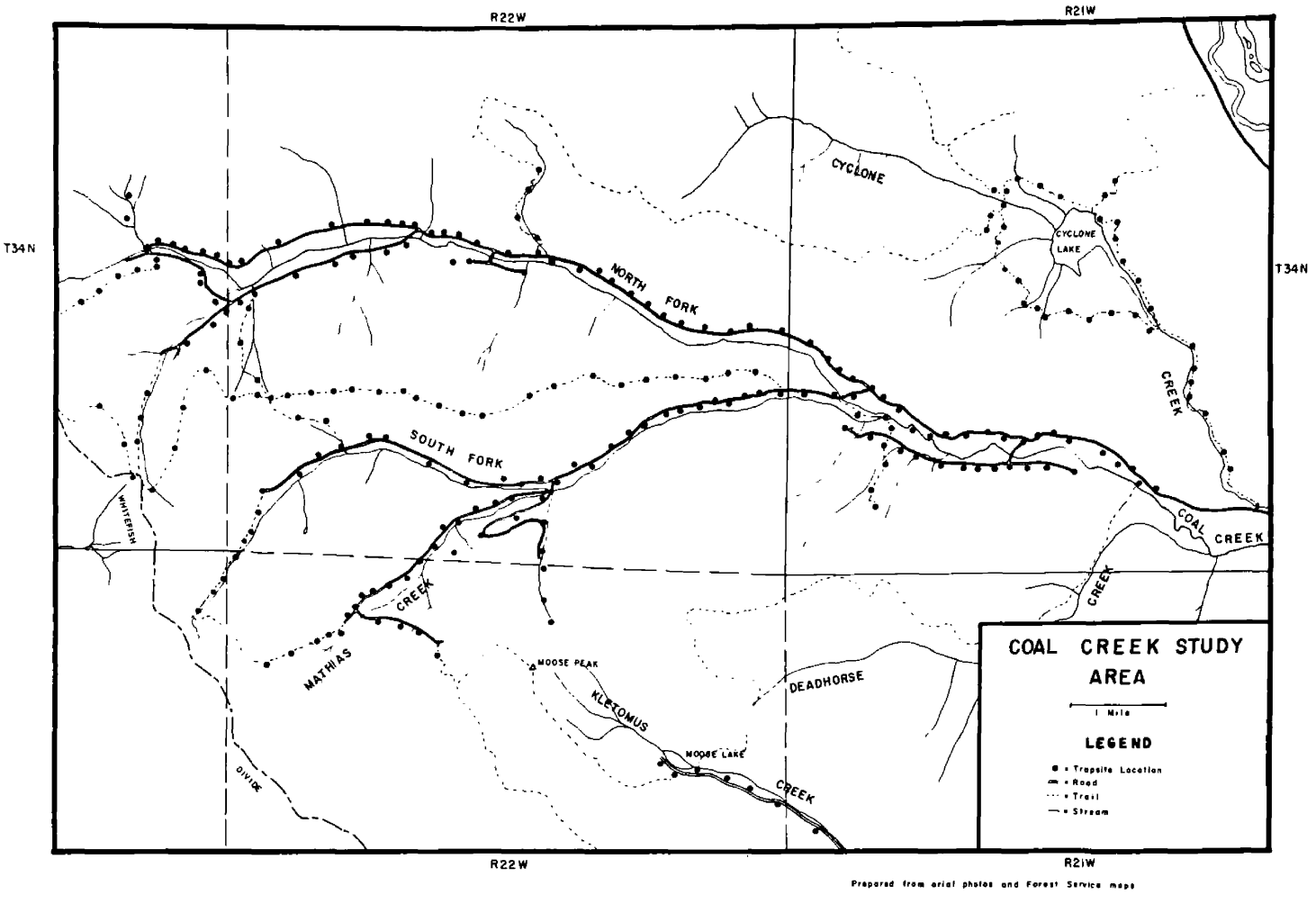


FIGURE 2. DETAIL OF THE COAL CREEK STUDY AREA

lite and quartzite), further downstream the Piegan Group (predominantly carbonate-bearing rocks) remains as the surface exposure. The lower one-half of the drainage is still covered by the Missoula Group (argillite, sandy or quartzitic argillite, impure quartzite, and limestone), and the main valley floor is covered with glacial drift (Ross, et al., 1955. There are basaltic intrusions along the ridge between the north and south forks of Coal Creek, but none of these are extensive.

The forest cover of the Coal Creek drainage varies from lodgepole pine (Pinus contorta) flats on the lower end to subalpine and alpine conditions at the drainage heads. The dense lodgepole flats on the lower part of the drainage are the result of extensive burns in 1926. South slopes above the burn are covered with Douglas fir (Pseudotsuga menziesii) interspersed with lodgepole pine to about one or two miles upstream from the confluence of the North and the South Forks of Coal Creek. The creek bottoms and north slopes above and below this ecotone and the south slopes above this ecotone support a climax stand of spruce (Picea englemanni) and mature larch (Larix occidentalis). This extends to between 5,000 and 6,000 feet elevation, except for a large part of Dead Horse Ridge, which was burned in a 1910 fire. This burned area is now covered with seedling and sapling spruce and larch reproduction. Above 6,000 feet there are subalpine forests of alpine fir (Abies lasiocarpa) and limber pine

(Pinus flexilis). On a few steep north slopes and on the highest peaks there is typical alpine vegetation.

Logging activity has altered much of the bottom and side-hill vegetation. The mature spruce stands have been greatly reduced the entire length of the drainage by clear-cutting practices.

The climatic conditions also vary much from the lower to the upper reaches of Coal Creek. The climatic variation in the principal marten habitat, the spruce and spruce-larch zone, is less, however. The Whitefish Range lies in the Pacific storm path and considerable snow is received. The maximum annual precipitation for the Range is approximately 35 inches in the vicinity of Canyon Creek to the south. Near the Canadian border the precipitation is about 25 inches according to information received at Big Creek Range Station. From this, it can be estimated that Coal Creek, which lies intermediate to these two points, would average approximately 30 inches annually. The variation in precipitation from the upper reaches to the lower reaches of the marten habitat is unknown.

ANACONDA CREEK

The Anaconda Creek study area is located in Glacier National Park six miles east of the Coal Creek study area. This study area is a roughly rectangular tract bordered on the east by Anaconda Creek and on the south by the North Fork

Truck Trail (see Figure 3). It encompasses about 5.43 square miles. Anaconda Creek drains from the western slope of the Livingston Range and flows into the North Fork River five miles below the mouth of Coal Creek on the opposite bank. The North Fork Truck Trail is a Park Service road running north-west from Apgar, on McDonald Lake, to Polebridge. The exact location of the study area is: s½S13, s½S14, S23, S24, S25, S26, n½S35, n½S36 of T34N R20W; w½S19 and nw ¼S30 of T34N R19W, Flathead County, Montana (Hawley, 1955).

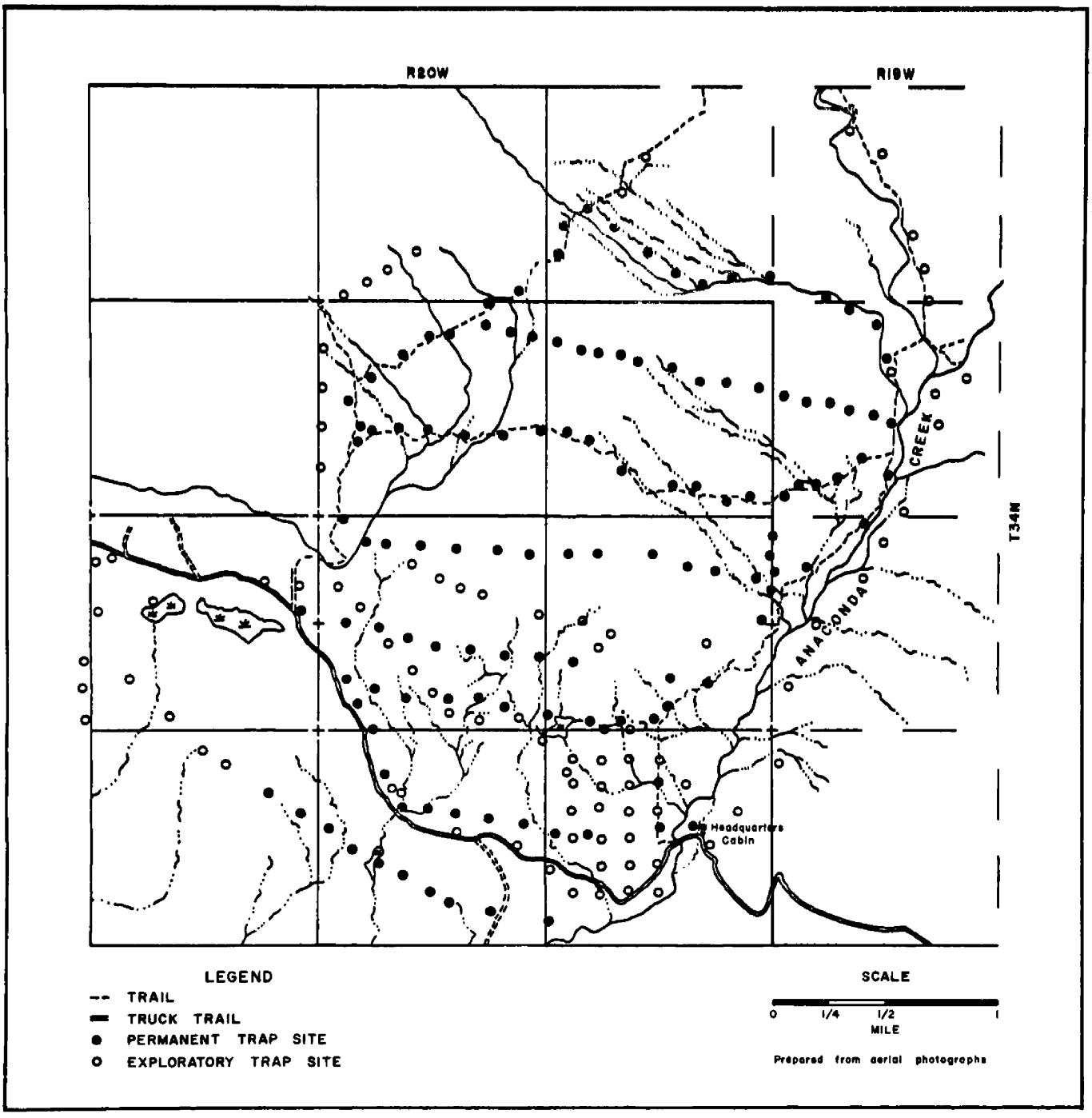
The study area is a well-forested network of ridges and glacial moraines with a very complex drainage pattern. While the terrain is highly variable, there are no extremes in elevation, there being about 1,000 feet change in elevation from the lowest to the highest point on the area. The forest cover is quite dense, except in those areas burned in a 1926 fire. The annual precipitation on the area is estimated to be about 20 to 30 inches from data recorded at Polebridge 15 miles to the north-west of the area, and at Belton, 16 miles to the south-west of the area. A more detailed description of the topography, climate, and vegetation can be obtained from Hawley (1955).

OTHER AREAS

Several other areas were utilized in the course of the study. Logging, Quartz, and Bowman Creeks, which are all in Glacier National Park, were live-trapped in both 1957 and 1958. These drainages are all west and north of Anaconda

FIGURE 3

DETAIL OF ANACONDA CREEK STUDY AREA



Creek and also flow into the North Fork of the Flathead River. Weasel Creek, which flows into Canada 16 miles northeast of Eureka, Montana, and the South Fork of Skalkaho Creek, east of Hamilton, Montana, were also live-trapped to varying degrees.

PROCUREMENT OF ANIMALS

A study of a wild population usually has multiple objectives. The specific objectives of this study were mentioned in the introduction. The success of these objectives was dependent on one principal technique, that of animal procurement. Since the principal part of the field work and methods of this study involved the procurement of animals, this technique was treated as a separate phase of the study.

Objectives

This study involved both initial capture and recapture or recovery of marten. The goals during all live-trapping periods were to capture and mark the maximum number of marten. The recovery program was designed primarily for the return of marked yearling animals.

Methods

Initial capture and capture of experimental animals were by live-trapping. Recovery was by live-trapping and obtaining carcasses from commercial trappers. Both of these

recovery techniques involved previously marked animals.

Live-trapping techniques had been refined before this study commenced. Vernon Hawley, Biologist with the Fish and Game Department, familiarized me with the procedure at the onset of the study. A folding wire-mesh live-trap manufactured by the National Live-trap Company of Tomahawk, Wisconsin, was used. Two lengths, an 18 inch trap and a 24 inch trap, were used. The 24 inch trap was used in Glacier National Park on the permanent study area, as some of the previously captured animals were able to enter the 18 inch trap and back out without being captured. At a trapsite, traps usually were set wherever it was most convenient. Many natural cavities along logs or in stumps were utilized and often a hole was chopped in a log or stump for the trap. In the Park permanent holes had been chiseled into logs and stumps for the traps (Hawley 1955). The roots of mature spruce often form a natural trapsite enclosing the trap on two sides and the back. Bark or small poles were used to finish covering the sides, back, or top of the trap. The trap had to be completely covered on all sides, except the front, to protect the captured marten during inclement weather and prevent marten from taking the bait without entering the traps. In the winter, the traps were placed on a bark platform to prevent the captured marten from clawing snow into the trap. The traps were baited with one third of a four ounce can of kippered herring snacks. A scent of

rotten fish juice was squirted on bushes and trees surrounding the trapsite. The traps were visited once every 24 hours and if no capture was made, the bait was checked and the trap left in place. A site was usually trapped for five consecutive days to insure capturing any marten in the area. When trapping for recovery of marked animals, special trapping emphasis was placed on areas where a desired animal was originally captured and on areas known to be especially good marten habitat.

The location of trapsites was based on surveyed lines, the size of marten home range as determined by Hawley (1955), accessibility, and quality of habitat. On the Anaconda Creek study area the trapsites were placed approximately on a grid. The grid conformed to existing trails and natural boundaries rather than to surveyed lines, the surveyed lines merely filled in between these existing lines. All the trapsites used on the Anaconda Creek study area were permanent and had been established in 1953 or 1954. On the Coal Creek study area and elsewhere, trapsites were located in such a manner that the maximum number of different marten could be captured. A great majority of the trapping was done along logging roads at 0.2 mile intervals in what was believed to be good marten habitat. The 0.2 mile interval was based on the 0.23 square mile minimum home range of female marten determined by Hawley (1955). Easily accessible trails in good marten habitat were also trapped.

All handling, inspection, and marking of marten were done with the aid of a collapsible wire cone (see Figure 4) adapted to marten by Vernon Hawley. The canvas extension of the cone was put over the end of the trap, the gate opened, and the marten were allowed to enter or forced in. While in the cone, the animals were classified as juveniles or adults according to size, development of the baculum, and development of the sagittal crest (Hawley, 1955). They were weighed to the nearest 25 grams with a spring scale. A small numbered metal fingerling tag was placed near the base of the leading edge of each ear and an identifying number was punched into each ear with a specially designed tattoo pliers. The identifying number was then impregnated with tattoo ink by rubbing the ear between fingers dipped in the ink. During the breeding season, the condition of the testes and vulva was recorded according to the methods of Enders and Leekley (1941).

Data were recorded on the trap check and individual capture forms used earlier in the six year project (see Figures 5 and 6). This included the above information, trap performance, and related information. A duplicate copy of the field individual capture forms was transferred to punch cards (Unisort Analysis Cards manufactured by Charles Hadley Company, Los Angeles, California) and integrated with the permanent files of the Fish and Game Department. The punch cards were used in analysis of data.

FIGURE 4

EQUIPMENT USED FOR LIVE-TRAPPING MARTEN

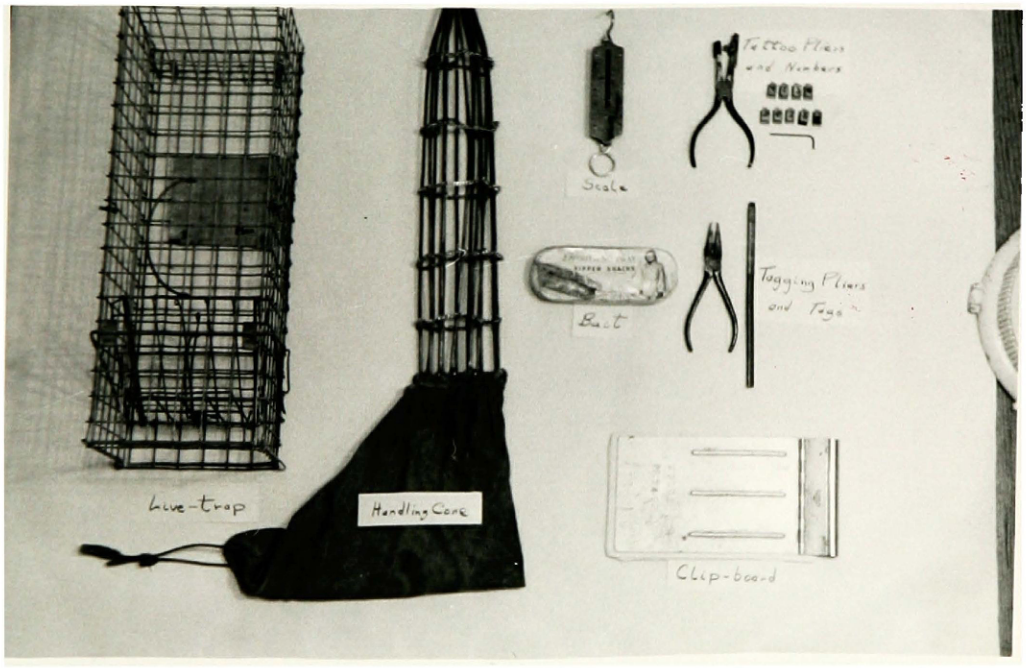


FIGURE 5

TRAP CHECK FORM

TRAPPING FIELD NOTES

Date:_____195__ Location_____

Weather_____

TmLvHdqs_____TmRetHdqs_____DistTrv_____

TRAP CHECK

No	C	S	F	A	U	R	TS	No	C	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 responsible for snapped trap
U: Trap snapped or a trap failure from unknown causes
R: Trap reset
TS: Trapsite

FIGURE 6

INDIVIDUAL CAPTURE FORM

MARTEN CAPTURE NOTES
(Martes americana)

Date:_____195__ Time Cpt. Ntd._____

Location:_____

Weather:_____

Tag Nos. L___, R___; Sex ♂♀ ; Weight_____grams

Sagittal crest:_____

Baculum:_____

Mammae:_____

Age:_____

Description:_____

_____

Breeding Condition_____

_____

Behavior in Trap_____

_____

Behavior on Release:_____

_____

REMARKS AND SKETCHES (Use other side if necessary)

Carcass collection was coupled with the annual Fish and Game Department carcass collection program. Each year commercial trappers of marten in the Whitefish Range were contacted and arrangements were made to pick up carcasses to be used in population studies by the Fur Division. A special effort was made to recover tagged animals.

Results

Live-trapping success varied with the area trapped and with the season during which the trapping was carried out. During the winter, trapping success increased considerably. Perhaps the marten ranged further in search of food during this time and this increased their probability of capture. A more limited food supply may also have decreased the wariness of any trap-wise animals.

Three hundred and forty-eight captures were made of 161 individual marten and the overall success for the 4,902 trap units (one trap set for 24 hours) set during this study was 7.1 per cent (see Table 1). This compares with 13.2 per cent during 1953 and 1954 (Hawley, 1955) and 10.1 per cent during 1955 and 1956 (Weckwerth, 1957).

Most trapping during the present study was done during the summer and fall, and some less suitable marten habitat outside of the Park was also trapped in the belief that juvenile marten would be more plentiful in such areas. These two factors probably contributed to the lower trapping

TABLE 1

TRAPPING SUCCESS AND TRAP UNITS PER MARTEN CAPTURE

Period	Trap Units	Trapping Success in per cent	Trap Unit per Marten Capture
1953-1954*	3,502	13.2	8
1955-1956**	1,940	10.6	9.4
1957-1958 (Anaconda Creek)	1,807	7.8	12.7
1957-1958 (total)	4,902	7.1	14.1

*Hawley, 1955.
**Weckwerth, 1957.

success during this period, along with a lower marten population density. Actually, live-trapping success was much higher than recorded in previous studies in other areas (de Vos, 1952; de Vos and Guenther, 1952; Miller, Ritay, and Edwards, 1955).

Seventy-nine of the 161 marten were females and 82 were males. Twenty-nine of the males and 33 of the females were classified as juveniles at the time of their first capture. Four females were recorded as possible juveniles. Twelve of the 161 marten had been captured and tagged previously by either Hawley or Weckwerth. Five adult females died from unknown causes while in the traps or during transfer,

although food and water were present in sufficient quantities to insure survival. Six animals, two males and four females, were removed from the study area for further study in the laboratory. Three adult females were captured in December 1957 and January 1958 and held for laboratory study. Two of these animals were released by the Fish and Game Department at the site of a marten plant in the Belt Mountains, and one escaped from the Stockner Mink Ranch west of Missoula.

There were also many species of small vertebrates captured in the live-traps and many traps were torn out or tripped by bears (Ursus americanus or U. horribilis), marten, or unknown animals in search of the bait. Other animals occuring in the traps and listed in Table 2 were red squirrels (Tamiasciurus hudsonicus), Northern flying squirrels (Glaucomys sabrinus), Columbian ground squirrels (Citellus columbianus), snowshoe hares (Lepus americanus), chipmunks (Eutamius amoenus), Bushy-tailed woodrats (Neotoma cinerea), mink (Mustela vison), porcupines (Erethizon dorsatum), and toads (Bufo spp.). The total captures of these species were 82. The details of these disturbances and the marten captures by area are recorded in Table 2.

The carcasses of ten previously tagged animals were returned by commercial trappers during this phase of the study. Five of these were collected and turned over to me by the Fish and Game Department during the 1957-1958 trapping season. The other five were among 55 carcasses collected by

TABLE 2. THE RESULTS OF MARTEN LIVE-TRAPPING

	Anaconda Creek	Coal Creek	Lolo Creek	Weasel-Wigwam Creeks	Skalkaho Creek	Quartz-Bowman Logging	Total
Days trapline tended	69*	110	--	9	9	5	202
Trap units	1807	2743	1	143	100	108	4902
Captures	142	185	1	24	8	8	348
Individuals captured:	37	92	1	17	6	8	161
Adult males	15	24	--	63	3	5	53
Adult females	5	25	1	3	--	--	34
Non-Juv. females	2	3	--	2	--	1	8
Juvenile males	6	17	--	3	2	1	29
Juvenile females	9	19	--	3	1	1	33
Poss. juv. females	--	4	--	--	--	--	4
Pine squirrels	9	33	--	--	1	--	43
Flying squirrels	1	18	--	--	--	--	19
Ground squirrels	9	1	--	--	--	--	10
Snowshoe hares	1	1	--	--	--	--	2
Chipmunks	--	2	--	--	--	--	2
Wood rats	--	1	--	--	2	--	3
Mink	--	--	--	2	--	--	2
Toads	--	1	--	--	--	--	1
Trap failures	2	10	--	1	--	--	11
Traps torn out:							
Bear	224**	147	--	--	2	--	373
Marten	1	9	--	1	--	1	12
Unknown	2	7	--	--	--	--	9
Total	227	163	--	1	2	1	394
Traps snapped:							
Marten	18	32	--	1	--	--	51
Porcupine	--	1	--	--	--	--	1
Mail	--	5	--	--	--	--	5
Unknown	126	254	--	3	2	4	379
Total	144	292	--	4	2	4	436

*Part of this time two men tended traplines

**Six of these contained marten.

me during the 1958-1959 commercial trapping season. None of these ten previously tagged animals were known-age yearlings. Seven of the ten animals returned were juveniles and were used in evaluating dispersal of young. The remaining three animals were routinely tagged non-juveniles. One marten carcass from the South Fork of the Flathead River was used in the laboratory when it was found to have a calcified embryo lying in the body cavity. Information as to sex, age, weight, condition, reproduction, and location of capture was recorded from all marten carcasses and the skeletons were sent to the Fish and Game Department Laboratory for cleaning.

Summary

The success of all phases of the study was dependent on the results of the animal procurement program. A trapping success of 7.1 per cent with 4,902 trap units resulted in 348 captures of 161 marten. There was much interference with the live-trapping program by other animals, primarily squirrels and bears. The collection of carcasses from commercial trappers resulted in the recovery of 10 tagged animals.

DETERMINATION OF SEXUAL MATURITY

The minimum breeding age of captive female marten has been reported by Markley and Bassett (1942) to be approximately 15 months. In 50 per cent of the cases, however, they found the breeding age to be 27 or 39 months. These findings were substantiated by Schmidt (1934) reporting on captive sable and marten (M. zibellina and M. martes) in Europe. The minimum breeding age in wild populations, however, is not known. Ponomarev (1938) said the sable does not reach sexual maturity until two years old. Hawley (1955) reported a yearling wild female marten as being in apparent full heat on July 31, 1954. He reported that yearling males examined during the breeding season were apparently sexually mature, as evidenced by enlargement of the testes. Weckwerth (1957) reported that a two-year old wild female recaptured in January did not show evidence of having been suckled, but this animal did have young the following spring at three years of age. He also found that a yearling female, sacrificed after the breeding season, was not pregnant as evidenced by the lack of corpora lutea.

Objectives

The main objective of this phase of the study was to establish when sexual maturity is attained in wild marten. Juvenile marten were to be live-trapped and marked in 1957

and recaptured as known-age yearlings in 1958. Recovered animals were to be sacrificed and their reproductive tracts preserved for further study. From this material it was to be determined if sexual maturity were attained.

Methods

The methods of initial capture, marking, aging, and recovery were discussed above under Procurement of Animals. When trapping specifically for recovery of yearlings, special emphasis was placed on three general habitats; the area the animal was originally captured in, known superior marten habitat in the vicinity of initial captures, and marginal marten habitat in adjoining previously untrapped areas. Earlier studies by Hawley (1955) and Weckwerth (1957) showed that on the Anaconda Creek study area some of the juveniles born in a certain area take up permanent residence there, if population pressures permit. These earlier studies also showed that there is often a dispersal of young from the place of birth. Additional indication of this tendency will be presented later in this paper. Trapping returns to the Fish and Game Department by commercial trappers also show a great majority of the marten returned from marginal marten habitat outside of the climax spruce forest to be juveniles. This was the third habitat type trapped intensively for return of yearlings, on the assumption that these animals moved into marginal habitat as a result of population pressures.

Recovered yearlings were identified by both the ear tags and the numbers tattooed in their ears. They were then transported back to camp in the trap and killed with ether. The reproductive tracts were removed and fixed in Bouins fluid. The skeletons were sent to the Fish and Game laboratory in Bozeman for cleaning since the skulls and femurs were needed for further determination of age.

Microscopic sections were made of parts of the testes and the epididymides and of the entire ovaries. These were stained with iron hematoxylin and examined microscopically. The testes and epididymides were examined for the presence of sperm and the ovaries were examined for corpora lutea.

Results

As is shown in Table 3, twenty-nine juvenile males, 33 juvenile females, and four probable juvenile females were captured and marked in 1957 and 1958. Those juveniles first captured in 1958 did not become yearlings in time to be used in this phase of the study. Two males and six females of the 1957 group were recaptured in 1958 as yearlings.

One of these tagged and tattooed yearling males was residing on the Anaconda Creek study area and was not sacrificed because his role in the long-term population study was deemed more important. The second male was killed and returned to the laboratory during the breeding season. Microscopic examination of the testes of this second animal

TABLE 3

PROCUREMENT OF KNOWN-AGE ANIMALS

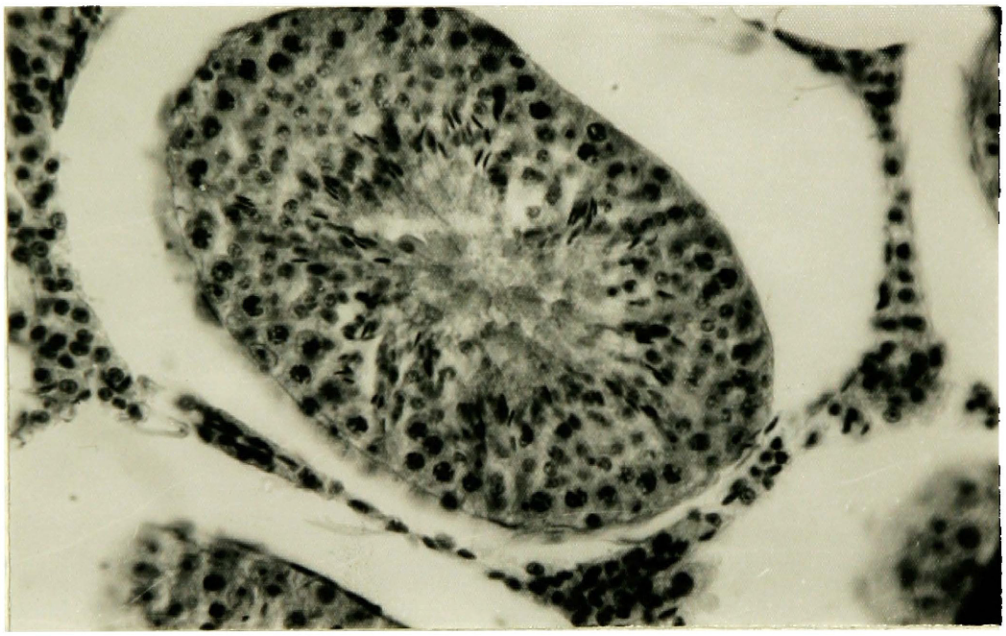
	Males	Females
Juveniles captured in 1957	16	23
Probable juveniles captured in 1957	0	4
Juveniles captured in 1958	13	10
Total captured in 1957 and 1958	29	37
Juveniles recaptured by commercial trappers in 1957 and 1958	3	4
Yearlings recaptured in 1958	2	6

revealed active spermatogenesis in progress and the presence of sperm (see Figure 7). The lumina of the epididymides also contained numerous mature sperm throughout their length. The testes of this animal at the time of capture were enlarged and by palpation seemed to be as fully developed as those of known adult male marten. An unmarked male marten collected concurrently for comparison exhibited the same degree of development. This marten, though apparently sexually mature, was not a known-age animal and could also have been a yearling. It is recommended that sometime in the future a known-age adult male be collected during the breeding season and the development and size of sperm in this animal be compared microscopically with the above specimens.

Three of the six females recaptured in 1958 as yearlings

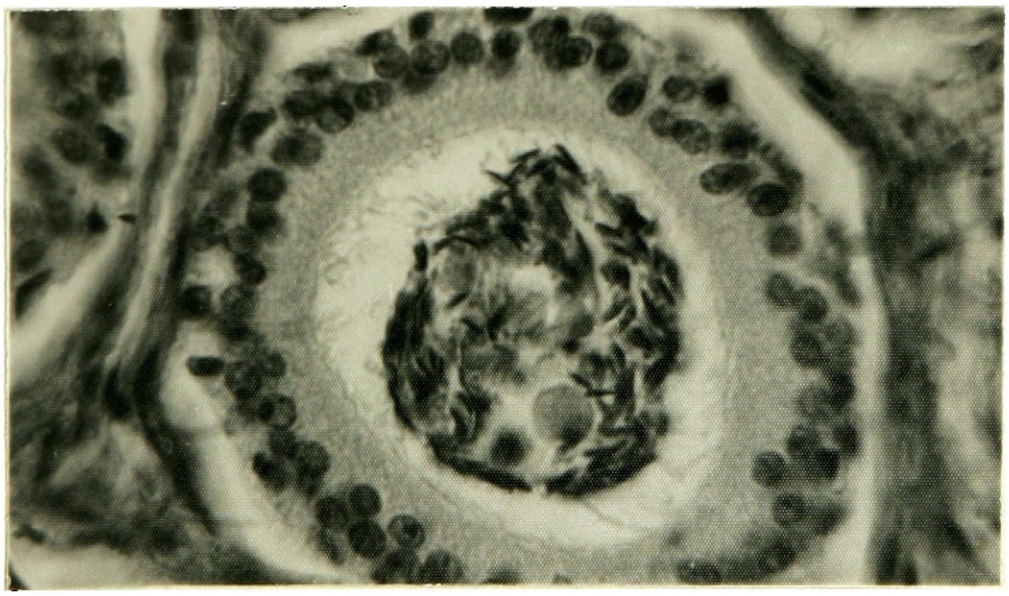
FIGURE 7

MICROSCOPIC SECTIONS OF THE TESTES AND EPIDIDYMIDES OF A YEARLING MALE MARTEN



Testes showing spermatogenesis

430X



Epididymis showing mature sperm

970X

were not sacrificed. One of these three females, though recaptured both before and after the breeding season in 1958, was also residing on the Anaconda Creek study area and so was released. The other two were recovered during the breeding season, but could not be recaptured later to determine if they had been successfully bred. These animals were examined closely, however, and one that had been originally classed as a probable juvenile was in a stage of full heat.

The remaining three female marten were all originally classified as juveniles in 1957 and were recaptured and sacrificed after the breeding season in 1958. Two of these three animals were considered definite juveniles in 1957 and the third was classified as a juvenile, but with some question. Since it is difficult to classify some marten from external features and palpation alone, the skeletons of these animals were cleaned and used in a further attempt to establish a definite aging technique. Examination of the sagittal crest and femur tuberosity of the cleaned material, using a method developed for mink by Ken Greer of the Fish and Game Department and adapted to marten by Fletcher Newby and Dr. P. L. Wright (unpublished), showed one of the animals classified as a definite juvenile in 1957 to be intermediate to juvenile and adult in 1958. The second animal classified as a definite juvenile in 1957 was lost when the carcass was sent to the Bozeman laboratory for cleaning. The third animal, which was classified as a juvenile in 1957, but with some question,

exhibited more sagittal crest development and less femur development than the first.

The first two animals mentioned above were not pregnant when they were autopsied as yearlings. Careful examination of microscopic sections of both ovaries of the two animals revealed no corpora lutea (see Table 4). The third animal, the one not definitely established as a juvenile when first captured, had corpora lutea (see Figure 8).

TABLE 4

FEMALES RECOVERED AS YEARLINGS

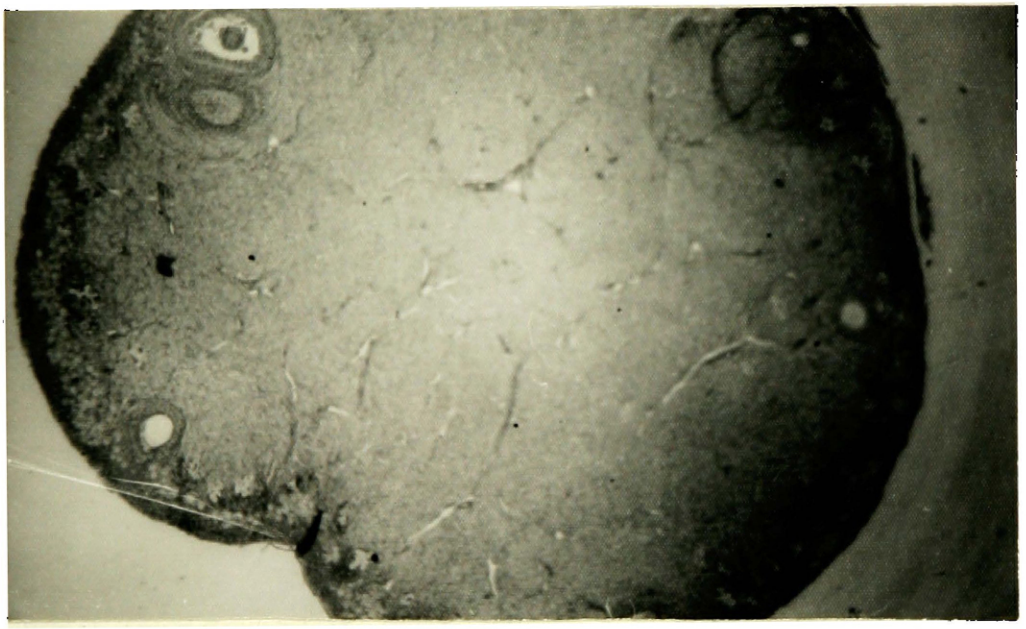
Marten Number	First Capture	Classified as a: Prob. Juv.	Def. Juv.	Recapture Date	Corpora Lutea
701-700*	8/3/55		x	8/31/56	0
1094-1095	8/23/57		x	10/17/58	0
A387-A396	9/13/57		x	10/23/58	0
A392-A397	9/15/57	x		10/24/58	2

*Marten captured by Weckwerth

It is suggested that more animals be examined, but this will be a difficult job, since, as shown above, intensive trapping for 27 female marten marked as juveniles or probable juveniles resulted in only three recaptures after the breeding season of the following year. Mortality is believed to be high in this age class. Almost 11 per cent of the 66 marked juvenile marten were taken by commercial trappers before they became

FIGURE 8

REPRESENTATIVE MICROSCOPIC SECTIONS OF OVARIES OF MARTEN SHOWING AN OVARY WITHOUT CORPORA LUTEA (MARTEN 1094-1095 AND A387-A396) AND AN OVARY WITH CORPORA LUTEA (MARTEN A392-A397)



Ovary Without Corpora, 43X

Ovary With Corpora, 43X

yearlings. Juveniles are unestablished animals and are probably often forced into marginal habitat. Dispersion of young has been shown to take place in the population. Since dispersion can take place in any direction and since the young marten travel as far as 25 miles (Hawley, 1955), the marked yearling class could be spread over a considerable area.

Summary

There is no conclusive evidence that wild female marten become pregnant as yearlings. One animal, which may have been developed more than the average juvenile when first examined, was pregnant, as evidenced by the presence of corpora lutea. There is ample evidence that some wild yearling females do not become pregnant as yearlings. Microscopic examination of serially sectioned wild yearling male marten testes and epididymides showed the presence of mature sperm. More animals should be examined further to investigate this subject.

IMPLANTATION OF BLASTOCYSTS AND TIME TO PARTURITION

The marten has long been known to breed in July and August and not produce its young until the following spring (Ashbrook and Hanson, 1930); delayed implantation was suspected. Wright (1942) demonstrated the presence of blastocysts in the uterus, and Marshall and Enders (1942) reported that marten killed as late as January still had

unimplanted blastocysts, but the time of implantation and the length of time elapsing between implantation and parturition was unknown. Wright (1948) found that in the long-tailed weasel (Mustela frenata) implantation took place in one animal less than 27 days before parturition, and it was thought that the marten would be similar. Ashbrook and Hanson (1927), Brassard and Bernard (1939), and Schmidt (1934) report that M. americana and M. martes usually produce litters during the first half of April.

Objectives

The purpose of this aspect of the study was to establish the time of implantation and the interval of time to parturition in the marten. Adult female marten were to be live-trapped prior to the estimated time of implantation and operated on periodically to determine if implantation had taken place. The interval between implantation and the birth of the young was then recorded.

Methods

The trapping was done in the winter on top of the snow, and this involved some additional techniques in trapping. Much more care had to be taken to protect the animals from inclement weather, and areas were live-trapped specifically for non-juvenile females. The Weasel Creek, Skalkaho South Fork, and Coal Creek drainages were trapped during December,

1957, and January, 1958. These areas were trapped because of their accessibility and because they were known to be good marten habitat.

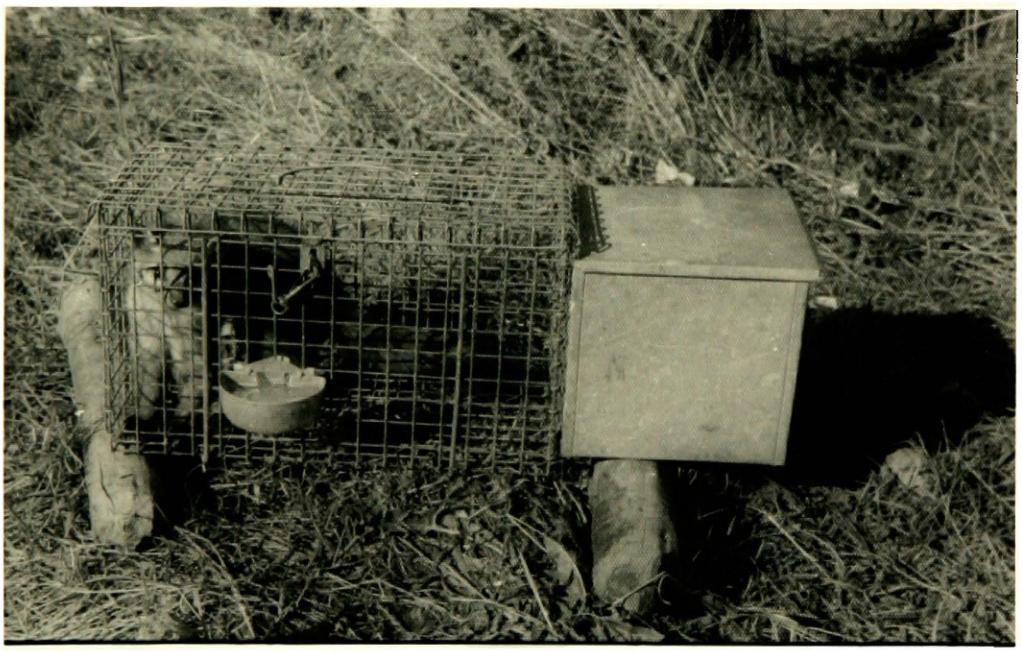
Captured animals were transported to Missoula in holding cages (see Figure 9). They were given canned dog food and snow or ice. Arrangements were made with the Stockner Mink Ranch for housing and care throughout the length of the study. At times, to lessen the danger of pneumonia, the animals were held indoors after an operation.

For some time before the first operation, the animals were examined externally for evidence of implantation. The animals were put in the handling cone, mammary development was observed, and the region of the uterus palpated to determine if there was any uterine development. The examinations were sometimes done with the animal anesthesized with ether. The examinations were much more successful under these conditions since contracted stomach muscles made the uteri of unanesthesized animals very difficult to palpate.

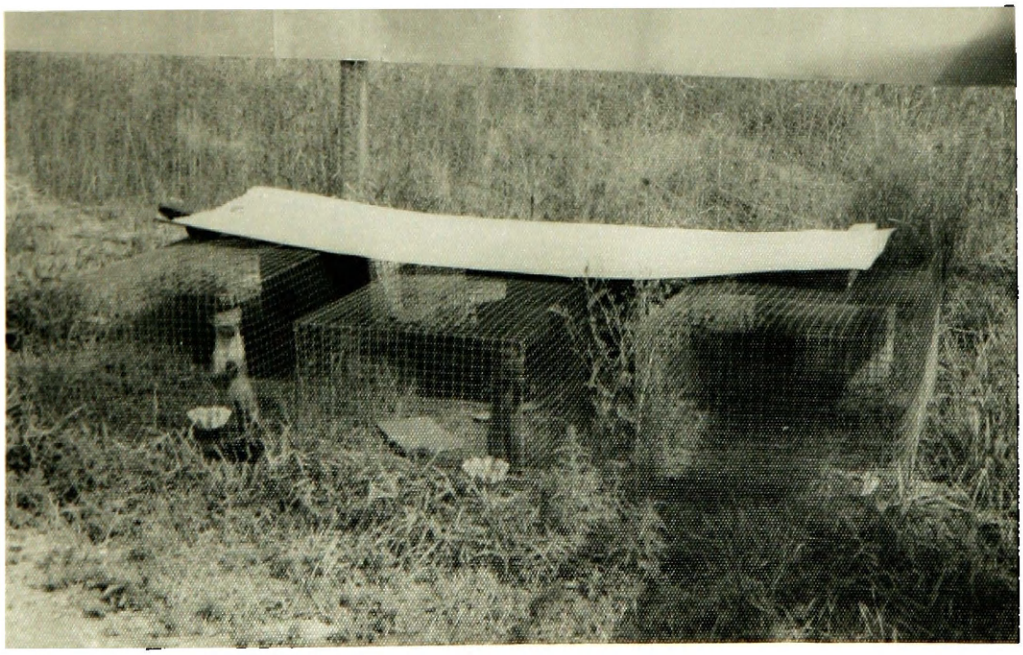
The first laparotomy was performed on February 15th. From this time on, a weekly operation was performed on one of the animals, and the others were closely inspected so that any change in uterine or mammary development could be observed. Ether was used for the anesthetic. The animals were placed in a large desiccator and ether was poured in. When the animals were sufficiently anesthesized, they were placed on their backs and further anesthesia was administered

FIGURE 9

HOLDING CAGE USED FOR TRANSPORTING MARTEN AND THE HOUSING PENS AT STOCKNER'S MINK RANCH



Holding cage with marten inside



Housing pens

by hand. The fur was clipped at the site of the incision and the skin was bathed with 70 per cent alcohol. A one to two centimeter incision was made through the skin and muscle layers just anterior to the pubic region and about five millimeters lateral to the abdominal gland (see Figure 10). A blunt forceps was then used to probe for and lift out one horn of the uterus. The color and diameter of the horn was noted and it was inspected for implantation sites, as characterized by swellings. The uterus was then replaced approximately in its original position and the incision closed with several stitches. Number one cat-gut was used in sewing the muscle layers and fine silk thread was used for sewing the skin. The tied ends were clipped close to minimize chewing by the marten, and then the entire area was again washed with 70 percent alcohol. The animals were allowed to recover quietly and then returned to the holding pens. The wound usually healed within about four days, although there was one case of infection. This animal did not recover for 11 days, despite being in a warm place.

When it was established by palpation or by means of a laparatomy that an animal had implanted its blastocysts, she was returned to the holding pen and observed at the time of the daily feeding until the young were born.

FIGURE 10

LAPAROTOMY ON A FEMALE MARTEN

Results

Five animals were obtained for this part of the study, but while in transit to Missoula two died, apparently from shock, in the manner described by Hawley and Newby (1957). Of the remaining three, one (1050-1051, from Lolo Creek) had the right front foot missing, but was otherwise in remarkably good condition. When first examined, this marten and the one captured on Coal Creek (A326-A349) appeared to have reared litters the previous spring. The mammae of these two animals were well-developed, about three millimeters long, and slightly flabby. The third female (1133-1134), captured on Weasel Creek, did not appear to have produced a litter previous to 1958 because the mammae of this animal were very small, approximately one millimeter long, and light pink.

The progress of these three marten is presented in table form (see Tables 5 and 6). Marten number 1050-1051 (see Table 5) implanted much earlier than the marten from the Whitefish Range. This marten was of a different sub-species than the two from the Whitefish Range. Although Hagmeier (1958) maintains the sub-species concept does not apply to the marten of North America, a great difference in pelage was noted between this animal and the others, and it is possible from these findings, that earlier implantation is also a characteristic of the more southern marten. It should also be noted that this was the animal that had an injured leg. Since this was a recent wound that was in the process of healing at the time of implan-

TABLE 5

MARTEN NUMBER 1050-1051

	Date	Condition	Remarks
First examination	2/8/58	No mammary development; no embryo development by palpation	--
First laparotomy	2/22/58	Mammae enlarged; uterus 4-5 mm. in diameter; no swellings	Implantation probably took place within 1-2 days
Second laparotomy	3/1/58	Embryo approximately 15 mm.	Embryo probably 5-6 days old
Litter born	3/20/58	3 young	--
Maximum time from implantation to parturition			25-28 days

TABLE 6

MARTEN NUMBER 1133-1134

	Date	Condition	Remarks
1st examination	2/8/58	No mammae development; no embryos by palpation	--
1st laparotomy	2/15/58	No mammae development; uterus slightly swollen and 2-3 mm. in diameter	--
2nd laparotomy	3/1/58	No mammae development; uterus slightly swollen and 3 mm. in diameter	--
2nd, 3rd, 4th and 5th examination	3/15, 24, 28, 31, 58	No mammae development; no embryos by palpation	--
6th examination	4/11/58	Mammae development; no embryos by palpation	--
7th examination	4/14/58	Mammae development; embryos 10-15 mm. by palpation	Implantation estimated 4 days previously
Litter born	5/7/58	3 young, 2 died	Female nervous
Maximum time from implantation to parturition	--	--	Approximately 27 days

tation of the embryos, the possibility of this inflamation affecting the rather delicate estrogen and progesterone quantitative relationship that is probably necessary for implantation, should not be ruled out.

Implantation in marten 1133-1134 (see Table 6) occurred after parturition had taken place in the above marten (1050-1051). When the embryos were noted, they had apparently been implanted about four days. From the data on the first marten it was estimated that this marten would produce her litter on or before May 8th. She was observed to have young on the morning of May 7th.

The third marten (A326-A349) progressed in approximately the same manner as the marten from Weasel Creek (1133-1134). She first showed mammary development on March 4th. From this time until April 28, her mammae were alternately swollen and regressed. Laparotomies on April 14 and 17 showed possible uterine development. On April 28 her mammae were regressed, and since it was two weeks after marten 1133-1134 had implanted, it was assumed that this marten had either implanted and lost her embryos, or was not going to implant. Shortly after the first mammary development was noted on this animal, the site of the last laparotomy became infected and badly inflamed, and it was felt that this condition could have caused her to lose her young (Enders and Pearson, 1943). In order to determine the animal's condition, a unilateral ovariectomy was performed on the left ovary on April 28. The uterus at this time was

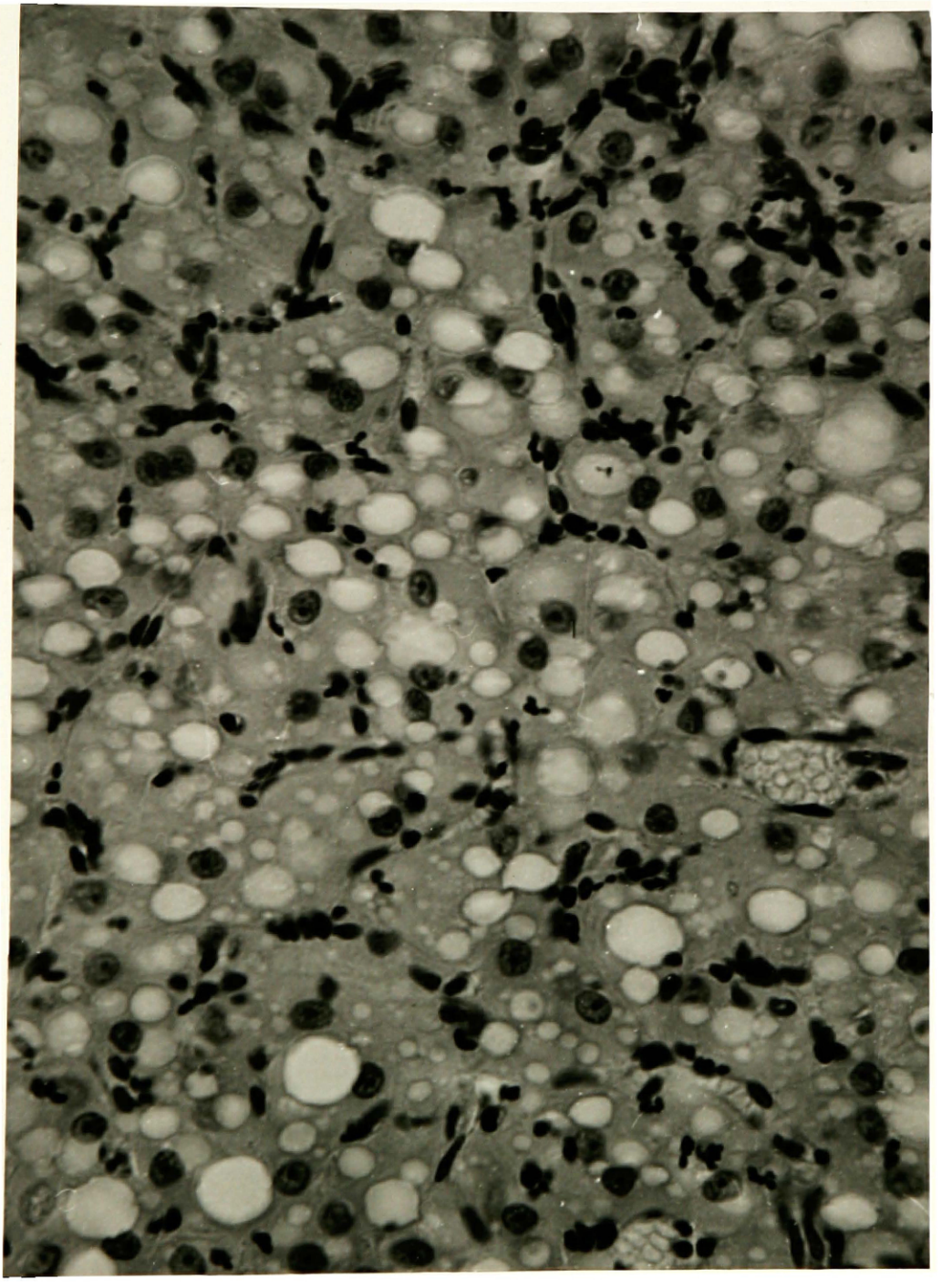
pinkish and measured 6 millimeters in diameter. When the ovary was sectioned and examined microscopically, it was found that the corpora lutea were not yet fully developed. They had large vacuolated, inactive cells (see Figure 11), and from this it was suspected that she was still pregnant at the time. The degree of development of the uterus at the time of the ovariectomy indicated that the animal was approaching implantation on April 28. She did not produce a litter, however, probably as a result of the ovariectomy.

Summary

Wild adult female marten were captured during December 1957 and January 1958 to be used in determining the time of implantation of the blastocysts and the interval between implantation and the birth of the young. A marten from the Bitterroot Range of the subspecies M. a. caurina implanted about February 22. A marten from the Whitefish Range of the subspecies M. a. abietinoides did not implant until approximately April 10. Another marten from the Whitefish Range had not yet implanted her blastocysts on April 28, and an investigative ovariectomy apparently interfered with the development of the young. The interval of time between implantation and parturition was determined to be between 25 to 28 days for the first marten and approximately 27 days for the second.

FIGURE 11

SECTION OF AN OVARY FROM FEMALE A326-A349 SHOWING CORPORA LUTEA WITH LARGE VACUOLATED CELLS



430 X

MARTEN AND SMALL MAMMAL FOOD RELATIONSHIPS AND POPULATION FLUCTUATIONS

A population is comprised of the individuals found on a given area at or during a given period of time (Dice, 1952). A natural population tends to fluctuate around a mean and the amplitude of this fluctuation may range from slight to large.

Many interacting factors are involved in the fluctuations of a wild population. Basically they are natality, mortality, emigration, and immigration, but each of these factors can be influenced in turn by an indefinite number of causes to an unlimited degree. One of these, minimal breeding age, has been discussed above; small mammal and marten food relationships will be discussed next; and additional factors will be treated less extensively later in this paper.

Certainly small mammals as a food supply are not always a controlling influence on a marten population, but the probability of their sometimes being a controlling influence is well-illustrated by the important role they play in the marten diet. Table 7 summarizes the results of various studies on the use of mice and shrews by Martes as a source of food. Dulkeit (1929) worked with the Russian sable (M. zibellina) on Great Shantar Island north of Japan, and the rest of the research was done in North America. Heckwerth (1957), working in Montana, carried out the most extensive study. He reported the frequency of occurrence of mice in the marten diet to be

TABLE 7

THE USE OF SMALL MAMMALS AS A SOURCE OF FOOD BY THE MARTEN

		Material Used		Number Items	Mice	Shrews
		Scats	Digest. Tracts	Based on	%	%
Weckwerth, 1957 Glacier National Park	Summer	425	--	854	30.2	4.8
	Winter and Spring	137	--	241	29.2	7.5
Lensink, et. al 1955 Alaska	Summer	374	--	469	74.0	--
	Winter	28	64	107	68.0	--
Cowan & Makay, 1950 British Columbia	Summer	112	3	212	59.0	2.0
	Winter	85	--	104	79.9	0.9
Dulkeit, 1929 Ort. Shantar Isl.	Winter	--	--	152	71.7	2.0
Marshall, 1946 Montana	Winter	18	--	20	15.0	--
	Winter	46	--	57	14.0	--
Newby, 1951 Washington	Summer	78	1	134	13.4	1.5
	Winter	17	16	37	27.7	2.7
Lexington 1951 Colorado	Summer and Winter	126	--	--	49.3	7.1
Quick, 1955 British Columbia	Winter	--	127	--	39.0	7.5
	Winter	--	123	--	56.4	5.5

Adapted from Weckwerth, 1957.

lower than that reported by other researchers, but as Newby (1951) pointed out, the ecology of the marten probably does vary in different regions. However, he still found mice to be the single most important item in the diet (30 per cent for the entire period), despite a high use of red squirrels in the winter and spring (17.4 per cent) and berries in summer (28 per cent). The microtines were used most, since for the two year period, 23.3 per cent out of the 30.0 per cent occurrence of small mammals in the marten diet were microtines. Clethrionomys gapperi was the single most important species, showing a use of 12.8 per cent, and was followed by Microtus spp. with 3.7 per cent use.

From a study of rather limited material, Marshall (1947) found red squirrels to be the primary item in the diet of the marten in the Whitefish Range, Montana (55.0 per cent in 1941 and 1942 and 60.0 per cent in 1942 and 1943), while the use of mice was 15 and 14 per cent on consecutive years. In Washington, Newby (1951) found red squirrels to be predominant in the diet in the winter (40.5 per cent) and insects in the summer (54.7 per cent). In British Columbia, Quick (1955) studied the alimentary tract contents in the winter of 1947 and found bird remains to occur most frequently (53.5 per cent); he did not, however, find such a peak in 1948. Also, Cowan and Makay (1950), with scat analysis as a basis, found no use of birds in British Columbia. Despite considerable use of these other food items, it is believed

that in all cases small mammals comprised a sufficient portion of the marten diet to be a potential limiting factor to the associated marten population.

The Anaconda Creek study area was the center of study for this phase of the project. Records on the marten population of the area have been kept since 1952 and the indices of the small mammal population have been recorded since 1953.

Objectives

The objectives of this aspect of the study were to determine if small mammal density was a limiting factor in marten population fluctuations. The possibility of some climatic or other factor affecting both the small mammal and marten population in a constant manner was recognized, but it was believed that a marten population fluctuation induced by the small mammals as a food supply would be of such magnitude that it could be recognized. The problems involved, then, were to sample the small mammal populations and get an index to the small mammal density throughout a complete population fluctuation, to determine annually the marten density on the area, and to attempt to correlate a marten population fluctuation with the small mammal population fluctuation if it occured. At the start of the present study, this had been accomplished by Hawley and Heckwerth during a small mammal population high in 1953 and a low from 1954 to 1956. This study, then, was to be continued through a contemplated return of the small mammal

population to a high and its subsequent drop.

Methods

The marten density on the area was established by live-trapping, as discussed above. The area was trapped in a systematic manner using the permanent trapsites established by Hawley (1955).

Indices to the small mammal density of the area were obtained by sampling the populations on census plots as described by Calhoun (1948). These plots were of a standard form. They consisted of two parallel lines 475 feet long, 200 feet apart, and they ran through a continuous habitat type. Twenty stations at 25 feet intervals were located along each line and marked with a stake. Three traps were then set within two and one-half feet of the point. Victor and McGill four-way traps were used and baited with a mixture of rolled oats and smooth peanut butter. The traps were set for three days and checked once every twenty-four hours. These plots were trapped twice yearly, in the summer and in the fall. Two of these plots (number one and number two) were set up by Hawley in 1953, and five more were established by Beckwerth in 1955. A detailed description of the plot locations and habitat types sampled can be obtained from Hawley (1955) and Beckwerth (1957). The sample plots were all located on the Anaconda Creek study area.

Results

The results of both the marten live-trapping and the small mammal snap-trapping are most useful when presented along with earlier trapping results. The study area has been live-trapped for marten annually since Newby first investigated it as a study area in 1952. Since that time the area has been live-trapped at least once each year. Table 8 shows the periods the area was live-trapped. In 1952 and through May of 1953, only the main trails on the study area were trapped by Newby (Hawley and Newby, 1957). All of the small mammal plots have been snap-trapped twice yearly since 1955. During 1953 and 1954 only small mammal plots 1 and 2 were trapped.

During the course of this study 37 different marten were captured on the Anaconda Creek study area (see Table 2 page 21). Twenty-one of these were males and 16 were females. Fifteen of the 37 were juveniles.

The yearly results of marten live-trapping from 1952 through 1958, based on actual capture data, are presented in Table 9. In adapting the capture data to table form, only the maximum numbers of animals from each quarter year are given. These maximums are based on the daily trapping record and were obtained by plotting the captures of all animals for each quarter and then choosing the trapping day when the most animals were present on the area. This method does not allow for a marten being on the area any length of

TABLE 8

MARTEN LIVE-TRAPPING INTENSITY AND PERIODS OF TRAPPING

Year	Period	Days	Trap Units
1952*	August 25-September 13	20	348
	October 17-October 19	3	44
	December 20-December 23	4	45
	Total	27	437
1953**	March 28-March 29	2	13
	May 15-May 17	3	31
	June 16-September 25	102	1431
	November 25-November 28	3	57
	Total	110	1532
1954**	January 12-March 16	64	318
	June 13-October 29	139	1386
	November 20-December 29	40	320
	Total	243	2024
1955***	July 25-August 11	18	
	September 15-September 17	3	
		21	421
1956***	January 3-January 15	13	425
	January 22-February 11	20	
	August 19-September 14	27	487
	October 4-October 19	16	300
	Total	76	1212
1957	March 23-March 25**	3	86
	June 15-June 19	5	
	June 23-July 2	8	402
	September 12-September 21	10	
	September 26-September 30	5	
	October 12-October 13	2	43
	Total	33	972
1958	June 16-June 19	4	477
	June 22-July 6	15	
	August 27-September 1	6	
	September 3-September 7	5	444
	September 10-September 15	6	
	Total	36	921
	Grand Total	546	7519

*Newby

**Newby through May, 1953; Hawley from then on.

**Weckwerth

Data through 1954 was adapted from Hawley and Newby (1957).

TABLE 9. MARTEN LIVE-TRAPPING RESULTS FROM 1952 TO 1958 BASED ON THE HIGHEST DAILY MARTEN DENSITY OF EACH QUARTER

		Transients					Temporary Residents					Permanent Residents					
		Male		Female		Total	Male		Female		Total	Male		Female		Total	Grand Total
		J	N-J	J	N-J		J	N-J	J	N-J		J	N-J	J	N-J		
1952	S	1	2	1	--	4	--	--	--	--	--	--	2	--	4	6	10
	F	--	2	--	--	2	--	--	--	--	--	--	4	--	5	9	11
1953	W	--	1	1	--	2	--	--	--	--	--	--	5	--	6	11	13
	Sp	--	1	--	--	1	--	--	--	--	--	--	5	--	7	12	13
	S	--	1	--	2	3	--	--	--	--	--	5	7	2	9	23	26
	F	--	--	1	--	1	--	--	--	--	--	6	8	2	9	25	26
1954	W	--	--	--	--	--	1	--	1	--	2	7	9	2	9	27	29
	Sp	--	--	--	--	--	--	--	--	--	--	--	15	--	10	25	25
	S	--	1	--	--	1	2	--	1	--	3	--	16	--	8	24	28
	F	--	--	1	--	1	--	--	--	--	1	1	15	--	7	23	25
1955	W	--	--	--	--	--	--	--	--	--	--	1	12	--	6	19	19
	Sp	--	--	--	--	--	--	--	--	--	--	--	13	--	6	19	19
	S	--	--	1	--	1	--	--	--	--	--	--	12	1	7	20	21
	F	--	--	--	--	--	--	--	--	--	--	--	10	1	7	18	18
1956	W	--	2	--	--	2	--	--	1	--	1	--	10	2	7	19	22
	Sp	--	--	--	--	--	--	--	--	--	--	--	10	--	9	19	19
	S	--	--	--	--	--	1	--	--	--	1	--	10	--	9	19	20
	F	--	--	--	--	--	--	--	--	--	--	--	10	--	7	17	17
1957	W	1	1	--	--	2	--	--	--	--	--	--	6	--	5	11	13
	Sp	--	--	--	--	--	--	1	--	--	1	--	6	--	5	11	12
	S	1	--	1	--	2	--	--	2	1	3	1	6	1	3	11	16
	F	--	--	--	--	--	1	--	2	1	4	--	4	--	5	9	13
1958	W	--	--	--	--	--	--	--	--	--	--	--	4	--	5	9	9
	Sp	--	--	--	--	--	--	--	--	--	--	--	4	--	5	9	9
	S	1	--	2	--	11*	--	--	1	--	1	--	3	--	5	8	20

*Status of these animals will depend on 1959 trapping results.

time before and after the first and last captures, except for the summer of 1958. The resident status of the animals first captured in the summer of 1958 will be unknown until the next trapping period of 1959. Animals classed as permanent or temporary residents were assumed to be resident on the area until the time of their last capture. This method, however, has its shortcomings, which will be discussed later.

The age classification is based on the biological year. A juvenile first captured during January, February, or March was classed as a juvenile of the previous year and a non-juvenile first captured during these months was similarly classed as a non-juvenile of the previous year.

A marten may be classed as a transient, a temporary resident, or a permanent resident of an area. Actual capture of an animal is the only positive information available on its whereabouts, so an attempt was made to classify each animal on its capture record. In Table 9, a transient is defined as a marten captured only during a period of less than one week, a temporary resident is a marten captured during a period of from one week to three months, and a permanent resident is an animal captured over a period longer than three months. This classification is arbitrary, but practical.

When Hawley worked on marten ecology in 1953 and 1954, the entire area was live-trapped for a much longer period of

time and with greater intensity than it had been before or has been since. More individual marten were captured during this period of intensive trapping than during any comparable period of the study (see Table 9). This can be attributed to either a higher population density, or the longer and more intensive trapping period. If, as Table 9 indicates, there was a high population density on the area in 1953 and 1954, the capture of the greater number of animals is self-explanatory.

The period and intensity of live-trapping does, however, affect the number of marten captured on the area in several ways. Transient marten that move across the area can be captured only during a short time and the longer and more intense the live-trapping, the greater is the probability of such transients being captured. Also, established marten have definite home ranges, but evidently travel beyond them occasionally and even establish temporary home ranges elsewhere (Heckwerth, 1957). There is indication, too, that there is a seasonal variation in the size of the home range. Marten that are resident near the study area are therefore more likely to be captured occasionally on the area during long periods of intense trapping. They may be classified as transients, temporary residents, or even permanent residents according to the system used. During a quarter when there is no live-trapping activity, only permanent residents captured again at a later date were considered to be on the area. Some actual permanent residents may even have been

missed if they were living temporarily off the area during a trapping period or were resident between trapping periods. Also, marten that appear on the area as transients or temporary residents during a short period of trapping may inhabit the area long enough to be classed as permanent residents during a long period of trapping. It is felt, therefore, that the intensity of trapping during 1953 and 1954 did contribute to the apparent population high at that time.

An attempt to minimize the effects of varying trapping pressures was made by the classification discussed above and by the selection of a single daily high for each quarter. To complete the information known of the marten population trend over these seven years of trapping, the marten population was graphed to show the yearly increment and decrement to the population and to show the yearly juvenile increment and decrement (see Figures 12 and 13).

Figure 12 shows the yearly population increment, the composition of each yearly contingent, and eventually the population turnover. It demonstrates only a slight increment in 1956. This coincides with what was apparently a drop in marten density from 1954 through 1956, as shown by Table 9.

The production of juveniles on the area should be an indication of the condition of the population. In Figure 13 the total number of juveniles captured in each quarter is presented. However, as Hawley (1955) and Heckwerth (1957) pointed out, there is movement of juvenile animals into, out

FIGURE 12

YEARLY MARTEN POPULATION INCREMENT AND COMPOSITION ON THE ANACONDA CREEK STUDY AREA BASED ON A DAILY HIGH FOR EACH QUARTER

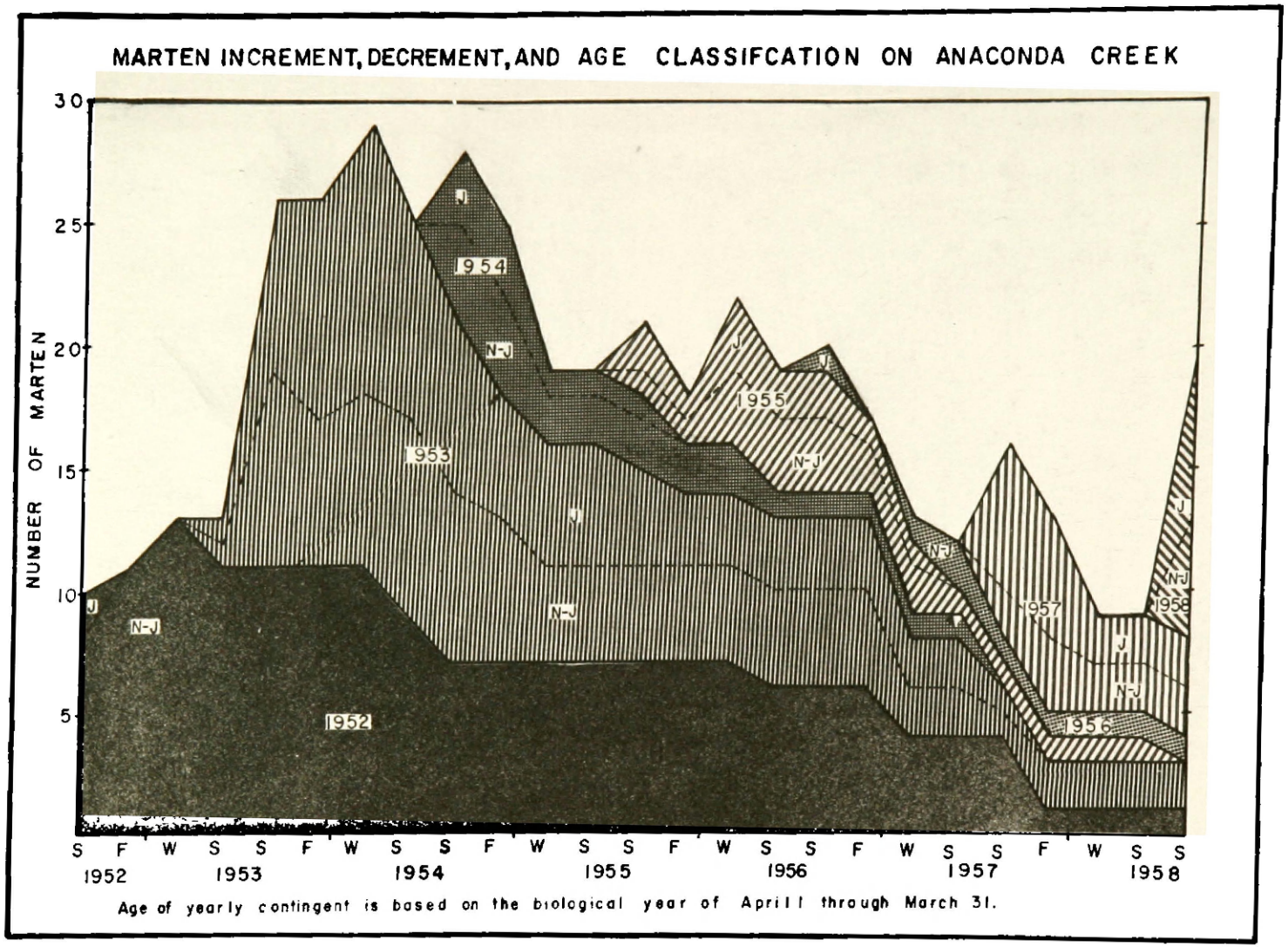
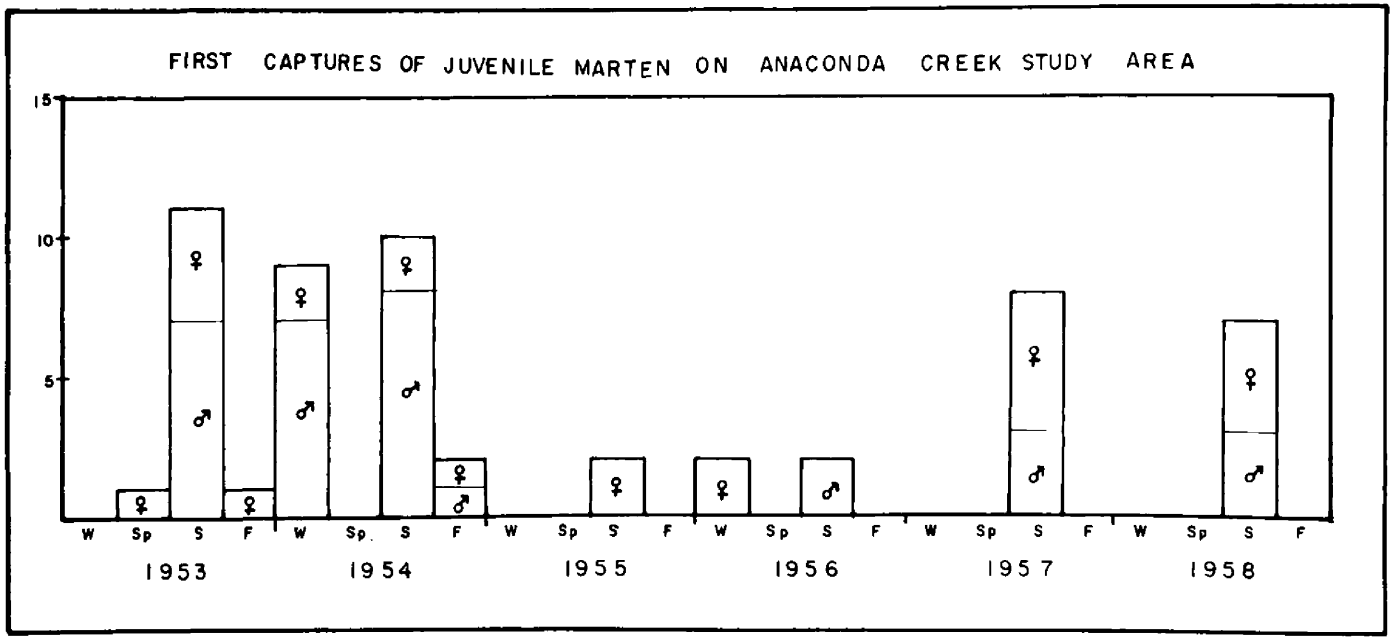


FIGURE 13

THE YEARLY JUVENILE INCREMENT ON THE ANACONDA CREEK STUDY AREA



of, and across an area. Using live-trapping techniques, it is difficult to label properly such a shifting population. Trapping intensity again becomes a factor in the number of animals captured, as transient juveniles are captured only over a short period of time. Juvenile marten apparently are very dependent on their mothers for food and care through July and August. Although they are most certainly active in the vicinity, juvenile marten are seldom captured earlier than the middle of July. One capture of a juvenile on June 22 was reported by Hawley, but the female was present at the time and attempted to carry the young animal away when it was released. Throughout the study it has been found that significant numbers of juveniles are not captured until August and September. Hawley (1955) reported a 25 mile emigration by a juvenile marten as early as October 14. Probably, then, the juvenile marten captured on the area before the end of September of each year most accurately represent the production of young for the area and trapping intensity during this period would not appreciably affect the number of juvenile captured. Juveniles captured during the fall and winter quaaters are more likely to be transients. When only the juvenile marten captured through the summer quarter are considered, a distinct low is observed during 1955 and 1956. This again coincides with a population decline from 1954 through 1956, as shown in Table 9.

The status of the small mammal populations on the area is much more simple to demonstrate. The trapping intensity from year to year was uniform and the beginning trapping dates coincided roughly. The most important information to be secured on the populations was the number and species of animals snap-trapped. Table 10 presents the total snap-trapped results for the small mammal plots. In the six years of trapping 1,216 small mammals have been captured. A complete tabulation of the captures for each small mammal plot and each species is presented in the Appendix. The data for summer trapping are complete for plots one and two from 1953 through 1958 and for all seven plots from 1955 through 1958.

The correlation between small mammal population fluctuations and marten population fluctuations is presented in Figure 14. The representative curves of the marten population shown in Table 9 and Figure 12, the yearly juvenile production of the area (see Figure 13), the yearly increment of permanent residents, and the combined Clethrionomys gapperi-Microtus spp. fall population level are given for comparison. The curve of abundance for the Clethrionomys gapperi-Microtus spp. population is presented alone because these species comprise almost the entire percentage of small mammals in the marten diet. Figure 14 demonstrates a population high for these species in 1953, a gradual fall to a population low in 1955, and a return

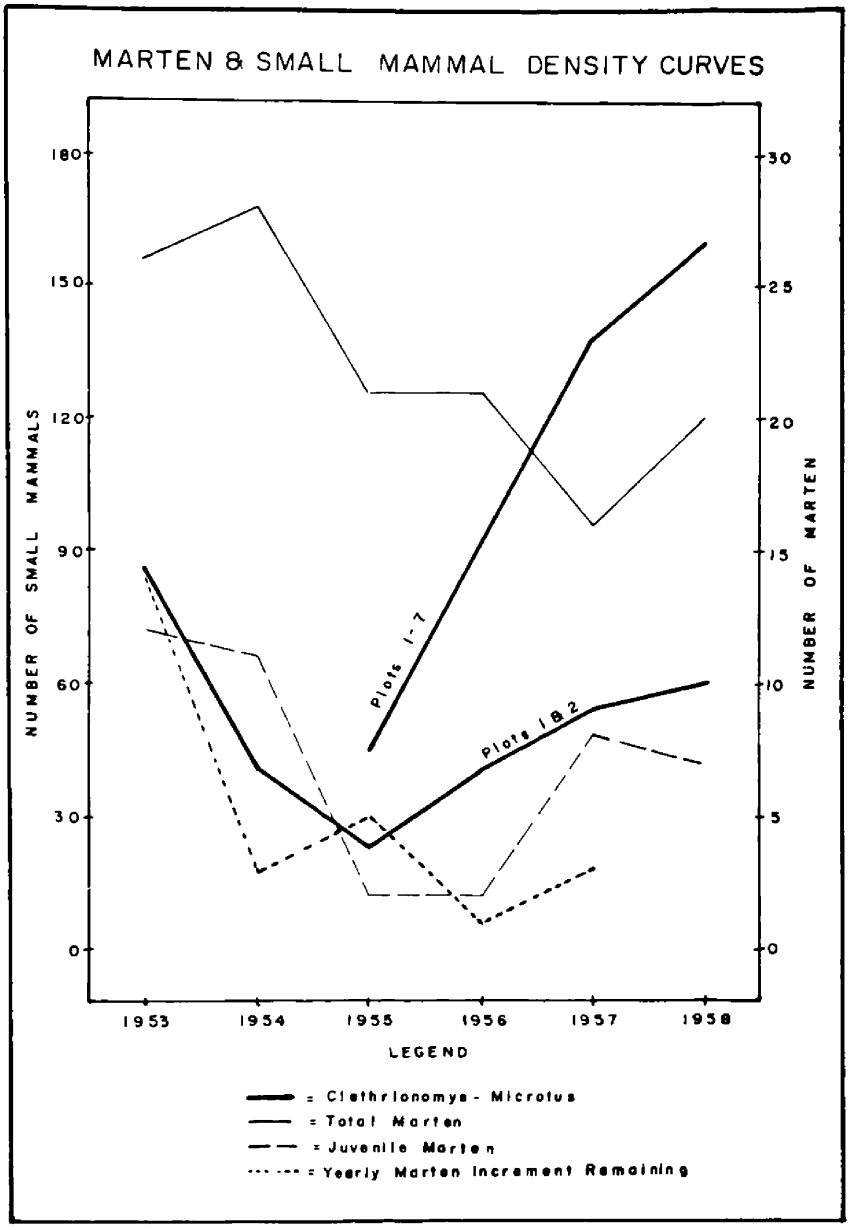
TABLE 10

SUMMARY OF SMALL MAMMAL SNAP-TRAPPING ON PLOTS 1-7 FROM 1953 TO 1958

Plot	1953 S	1953 F	1954 S	1954 F	1955 S	1955 F	1956 S	1956 F	1957 S	1957 F	1958 S	1958 F
I	12	24	12	18	5	18	8	21	13	20	7	37
II*	--	70	32	33	13	36	7	34	19	54	16	50
III**	--	--	--	--	3	19	7	27	14	37	14	36
IV**	--	--	--	--	4	17	5	13	14	30	4	47
V**	--	--	--	--	10	30	6	24	17	41	9	40
VI**	--	--	--	--	2	6	7	2	2	20	13	8
VII**	--	--	--	--	15	25	5	17	6	21	13	27
TOTAL	12	94	44	51	52	151	45	138	85	223	76	245

S - Summer
F - Fall
* - This plot was not trapped in the summer of 1953.
** - These plots were not trapped previous to 1955.

FIGURE 14. MARTEN AND SMALL MAMMAL POPULATION CURVES



to a population high through the years 1956 to 1958.

The comparable marten population curve shows a high marten density in 1953 and 1954. From this time on there was a continual drop in the population density through the spring of 1958. As discussed above, however, this curve is undoubtedly much modified by intensity of trapping.

A second curve, representing the yearly contingent of marten that remained on the area as permanent residents, more closely represents the yearly change in the marten population. This curve is also influenced by the trapping intensity, but to a lesser degree, since two captures over a three month period establish residence and subsequent captures do not change it. In this curve, only one member of the 1956 contingent remaining as a permanent resident is significant.

The third marten population curve, the yearly juvenile production, is believed to be least affected by live-trapping intensity and duration. The production capacity of the area shows a definite low in the years 1955 and 1956 and a return to a high in 1957 and 1958. This probably reflects both the survival of young through the summer months up to separation from their mothers and the number of adult female marten on the area.

The sum of these three curves describing the marten population indicates a marten population fluctuation that coincided with the small mammal low in 1955. Whether the

total marten population will recover to a high density coinciding with the small mammal population return to a high will depend on the results of later trapping.

Summary

Since 1953 a marten live-trapping project has been in progress on the Anaconda Creek study area. One purpose of this trapping has been to determine the yearly marten population density of the study area. From a population high in 1953 and 1954, the density has apparently undergone a gradual decline on the area through 1955 and 1956 and other data, juvenile production and yearly population increment, indicates that the marten population began a recovery in 1957 and 1958. This coincides with a small mammal population high in 1953, a low in 1955, and a return to a high in 1957 and 1958. Yearly variation in marten live-trapping intensity prevented a more perfect examination of the correlation between the marten and small mammal populations.

GENERAL LIFE HISTORY INFORMATION

During the course of this study, data were gathered on many incidental items of marten life history. Several hundred scats were collected in the Anaconda Creek study area and turned over for analysis to Vernon Hawley of the Montana Fish and Game Department. This material will be added to the marten food habits study being completed by Hawley and Weckwerth. Information on marten home ranges on the Anaconda Creek study area was gathered and will also be added to the work by Hawley on this subject.

The subjects of marten life history which will be treated in this section are movement and dispersal, age and sex composition, weights and condition, and an extra-uterine pregnancy. Some earlier data will be presented jointly to substantiate these findings.

Movement and Dispersal

Dispersal of marten from the Chapleau Crown Game Preserve in Canada into depleted areas was reported by de Vos (1951). Since that time Hawley (1955) and Weckwerth (1957) have reported both dispersal of tagged juvenile animals and movements involving changes of home range among tagged animals. Dice (1952) advanced the theory that when animals compete for space or food, intraspecific strife takes place. On the basis of this, Hawley suggested that movement and dispersal

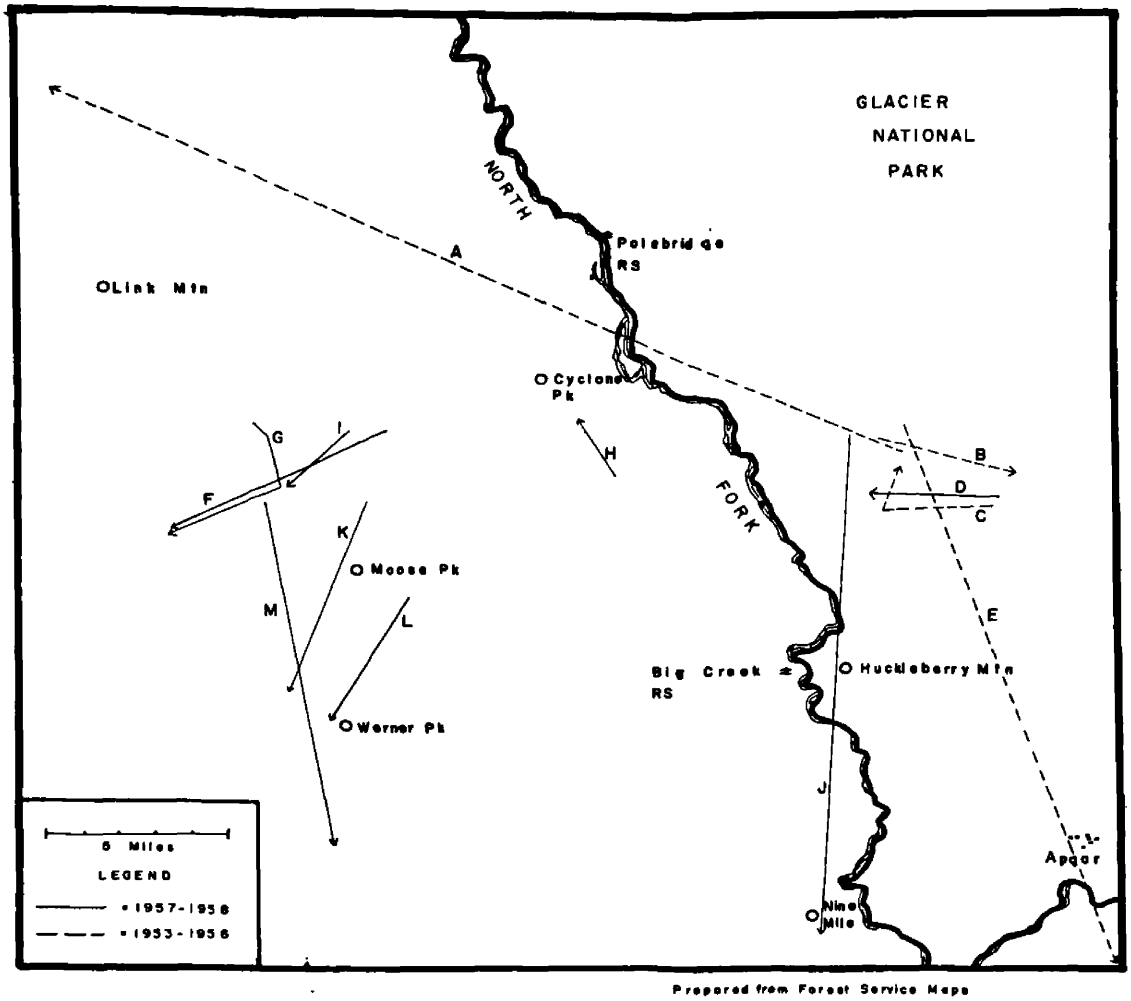
of the marten was in search of adequate home ranges.

During this study additional movements of animals tagged by previous workers, as well as movements of animals tagged by me, have been noted. Figure 15 shows all the movements of marten from or into the Anaconda Creek and Coal Creek study areas. Animals C and D in Figure 14 were adult males and apparently are cases of a change in home range. The remaining animals were all juveniles and probably all represent dispersal. Only animals F, G, H, and J were females. Male B was first captured in March 1954 and was believed to be a migrant from another range moving across the study area. The emigration distance shown in Figure 14 for this animal would therefore probably represent only part of the distance covered. Males K, M, and L may also represent only partial emigration distances since they were first captured in October and November, 1958. The greatest straight-line dispersal, approximately 25 miles, was by male A as reported by Hawley (1955).

Some of the juveniles establish home ranges near their place of birth. Thirteen of 44 animals thought to have been born on the Anaconda Creek study area are known to have remained on the area as permanent residents (see Figure 13). One of the juvenile females tagged in 1957 on Coal Creek was captured in 1958 within a quarter of a mile of the original capture site. Logically, one would expect more juveniles to remain as residents in the vicinity where they

FIGURE 15

MARTEN MOVEMENT AND DISPERSAL



A	-	Juvenile	male:	25	miles		
B	-	"	"	4	"		
C	-	Adult	"	5	"		
D	-	"	"	4	"		
E	-	Juvenile	"	17	"		
F	-	"	female:	7	"		
G	-	"	"	6	"		
H	-	Juvenile	female:	2	miles		
I	-	"	male:	2	"		
J	-	"	female:	15	"		
K	-	"	male:	6	"		
L	-	"	"	4	"		
M	-	"	"	10	"		

were born if sufficient food were available. This did occur on the Anaconda Creek study area in 1953 when the small mammal population was at a peak.

Age and Sex Composition

The sex and age composition of the marten on the Anaconda Creek study area is presented by quarterly periods in Table 9, page 50. At the close of this study there still had not been a complete population turnover of the 1952 population. As is shown in Table 11, one adult female first tagged as an adult in 1952, was still classed as a permanent resident of the area. When last captured in September, 1958 this animal was at least 7½ years old. The 1953 contingent was still represented by two animals 6½ years or older. The last individuals of the 1954 contingent dropped out in 1957, but an animal tagged in 1954 on Dutch Creek, approximately four miles to the east, appeared on the study area in September, 1958. One adult male of the 1955 contingent remained on the area as a permanent resident, but none of the 1956 contingent did. Of the four animals remaining of the 1957 contingent, two were non-juvenile and so at least 2½ years old, and two were juveniles. These two 1957 juveniles and four non-juveniles first captured in the fall of 1958 were a minimum of 1½ years old at the end of this study. The seven juveniles and four non-juveniles first captured in the fall of 1957

TABLE 11

MINIMUM AGE OF THE MARTEN POPULATION AT THE CLOSE OF TRAPPING IN SEPTEMBER, 1958

	Years							
	½	1½	2½	3½	4½	5½	6½	7½
Males	3	5	1	--	1	1	1	--
Females	4	1	1	--	--	--	1	1

TABLE 12

RATIOS OF MALE MARTEN TO FEMALES AND NON-JUVENILES TO JUVENILES

	Anaconda Creek			Outside Park
	1953-1954*	1955-1956**	1957-1958	1957-1958
Sample size	69	45	37	113
Males to females	188:100	165:100	131:100	90:100
Non-juveniles to juveniles	97:100	350:100	147:100	146:100

*Hawley
**Weckwerth

and the 1954 non-juvenile first captured on the area in the fall of 1958 are tentatively classed as transients.

As shown in Table 2, page 21, thirty-seven marten were captured on the Anaconda Creek study area during this study. The ratio of non-juveniles to young for the two years was 146:100. Table 12 presents the non-juvenile to young ratios of earlier trapping. Apparently 1953-1954 was a very favorable period for the production of young since the live-trap catch was more than 50 per cent juveniles. It is interesting to note that in 1957-1958 the ratio of non-juveniles to young for Anaconda Creek was essentially the same as for areas outside of the Park.

The ratio of males to females was lower outside the Park during the 1957 and 1958 trapping periods. This would indicate that conditions for the production of young were similar, despite a slightly depleted non-juvenile population in commercially trapped areas. Since the males have an appreciably larger home range than the females, under conditions of light trapping they would have a greater probability of being captured by the commercial trappers, who generally trap along roads. This would influence the live-trapped male-female ratio to show a preponderance of females, as was the case outside the Park in 1957 and 1958.

Weights and Condition

Marten weights vary considerably during the different seasons of the year, as shown by Hawley (1955). He found the mean weight of both females and males to be much lower during the winter months of November through February. This is probably a result of low availability of food, as is shown by the gain in weight of three non-juvenile females which were captured in late December of 1957 and early January, 1958, and fed a normal mink ration in captivity. One animal showed a gain from 675 grams at the time of capture to 800 grams in one week. One of the others had reached 850 grams at the time she implanted her embryos, while the third animal weighed 1,000 grams at the time of implantation. The highest weight recorded for wild female marten during this study was one 775 gram record.

During this phase of the study enough animals were captured outside the boundaries of Glacier National Park to compare the mean weights of the two populations. Only the weights at the time of the first capture in a trapping period were used in the analysis, since it was shown earlier by Hawley (1955) that individual marten weights drop rapidly when a marten is live-trapped repeatedly. The results of this comparison show that there was no significant difference in weights between marten populations in the Park and in commercial trapping areas in 1957 and 1958. The average

weight of non-juvenile males in the Park was 1,026 grams (sample size 33) and in commercial trapping areas the average weight was 1,027 grams (sample size 41). Non-juvenile female marten in the Park had a mean weight of 656 grams (sample size 19), while their counterparts in commercial trapping areas averaged 668 grams (sample size 34). The range in the weights for the non-juvenile males was 750 to 1,225 grams and for non-juvenile females, it was 550 to 775 grams. In 1953 and 1954 Hawley found the mean weights of non-juvenile males from the Park to be 955 grams and of non-juvenile females to be 594 grams with sample sizes of 158 and 58 respectively. Even though weights were recorded only to the nearest 25 grams, it seems apparent that the marten were in poorer condition in 1953 and 1954 than in later years. This relates back to the data presented earlier in this paper on population density. Since the marten density was very high in the years 1953 and 1954, the marten decline which followed the small mammal decline in 1954 and 1955 may have been related to the availability of food.

An Extra-uterine Pregnancy

The carcass of a female marten collected in the animal procurement program was found to contain a calcified embryo in the body cavity. It appeared to have been implanted or attached to the greater omentum. The ovaries of this animal

were serially sectioned, stained, and examined microscopically for corpora lutea. The left ovary contained one corpus luteum and the right ovary contained five corpora. The uterus was then sectioned, stained, and examined microscopically. Six unimplanted blastocysts were found. A thin area in the uterine wall may have been the site of a rupture during a previous pregnancy.

The embryo was largely calcified and appeared to be approximately three quarters developed. It lay just anterior to the right kidney and was partially surrounded by the greater omentum. A further attempt to determine if the embryo was implanted in this position will be made by examining the vascular of the greater omentum.

SUMMARY

An ecological and physiological study of the pine marten (Martes americana) was carried out during 1957 and 1958. This was the last phase of a long-term study initiated in 1952 on Anaconda Creek in Glacier National Park under the auspices of the Department of Zoology at Montana State University, the Montana Cooperative Research Unit, and the Montana Fish and Game Department.

During this phase of the study the Anaconda Creek study area and a new area on Coal Creek outside of the Park were intensively live-trapped for marten. In the two years 4,302 trap units were set and 94 captures were made of 101 marten, with a trapping success of 7.1 per cent.

Microscopic examination of the reproductive tracts of known-age yearling marten revealed no conclusive evidence that yearling females become pregnant, but the testes of a yearling male exhibited active spermatogenesis and the lumina of the epididymides contained mature sperm.

It was determined by external examination, palpation, and laparotomies, that implantation in one wild adult female marten occurred approximately February 22, and in another approximately April 10. The period to parturition for the first animal was between 25 and 28 days, and for the second, approximately 27 days.

A study of marten population fluctuations involving marten live-trapping and small mammal snap-trapping on the Anaconda Creek study area has been conducted for six years. During these last two years of the study the marten density began a recovery, after declining from a peak in 1953 and 1954 to a low in 1955 and 1956. This coincided roughly with a small mammal peak in 1953, a low in 1955, and a return to a high in 1957 and 1958.

Data were gathered on a number of incidental items of marten life history and the results are listed below.

1. There was a great incidence of emigration among juvenile marten.

2. There has not been a complete population turnover on the Anaconda Creek study area between the years 1952 and

1958. The oldest known-age marten residing on the Anaconda Creek study area, a marked female, has reached a minimum of 7½ years of age.

3. The non-juvenile to juvenile ratio was the same in the Park and in commercially trapped areas, but there was a predominance of females in commercially trapped areas.

4. The production of juveniles on the Anaconda Creek study area went from a peak during 1953 and 1954, to a low during 1955 and 1956, and back to a peak in 1957 and 1958.

5. Marten mean weights were essentially the same in the Park as in commercially trapped areas, but they were much higher than weights recorded in the Park during 1953 and 1954.

6. A calcified embryo that appeared to be the result of a uterine rupture was found in the body cavity of a female marten carcass.

LITERATURE CITED

Ashbrook, F. G., and K. B. Hanson
1927. Breeding martens in captivity. Jour. Heredity 18(11): 499-583.

Ashbrook, F. G., and K. B. Hanson
1930. The normal breeding season and gestation period of the marten. U.S.D.A. Circular 107 7 pp.

Brassard, J. A., and R. Bernard
1939. Observations on breeding and development of marten. (Martes american). Canadian Field Nat. 53(2): 19-21.

Calhoun, J.
1948. North American census of small mammals: release No. 1 (Announcement of program). Rodent Ecology Project, John Hopkins Univ., pp. 1-8, mimeographed.

Cowan, I. McT., and R. H. Mackay
1950. Food habits of the marten (Martes americana) in the Rocky Mountain region of Canada, Canadian Field Nat. 64(3): 100-104.

deVos, A.
1951. Overflow and dispersal of marten and fisher from wildlife refuges. Jour. Wildlife Mgt. 15(2): 164-175.

deVos, A., and S. E. Guenther
1952. Preliminary live-trapping studies of marten. Jour. Wildlife Mgt. 16(2): 207-214.

Dice, L. R.
1952. Natural communities. Univ. of Mich. Press, Ann Arbor, Mich. 547 pp.

Dulkeit, G. D.
1929. Biologie and Gewerbejahd des Zobels auf den Schantrskii-Inseln. Bull. Pacific Fishery Res. Station 3(3): 1-119.

Enders, R. K., and J. R. Leekley
1941. Cyclic changes in the vulva of the marten (Martes americana). Anat. Rec. 79(1): 1-5.

Enders, R. K., and O. P. Pearson
1943. Shortening gestation by inducing early implantation with increased light in the marten. Amer. Fur Br. 15(7): 18.

Hagmeier, E. M.
1958. Inapplicability of the subspecies concept to North American marten. Syst. Zool. 7(1): 1-8.

Hawley, V. D.
1955. The ecology of the marten in Glacier National Park. Unpub. M.S. Thesis, Mont. State Univ. 131 pp.

Hawley, V. D., and F. E. Newby
1957. Marten home ranges and population fluctuations. Jour. Mamm. 38(2): 174-184.

Lensink, C. J., R. O. Skoog , and J. L. Buckley
1955. Food habits of marten in interior Alaska. Journ. Wldl. Mgt. 19(3): 364-368.

Markley, M. H., and C. F. Bassett
1942. Habits of captive marten. Am. Midl. Nat. 28(3): 604-616.

Marshall, W. H.
1946. Winter food habits of the pine marten in Montana. Jour. Mamm. 27(1): 83-84.

Marshall, W. H., and R. K. Enders
1942. The blastocyst of the marten (Martes americana). Anat. Rec. 84(3): 307-310.

Miller R. G., R. W. Kitay, and R. V. Edwards
1955. Live-trapping Marten in British Columbia. Murrelet.36(1): 1-8.

Newby, F. E.
1951. Ecology of the marten in the Twin Lakes Area, Chelan County, Washington. Unpubl. M. S. Thesis, The State Coll. of Wash. 38 pp.

Ponomarev, A. L.
1938. On the variability and inheritance of color and pattern in the sable, Martes zibellina L. Zool. Zhurnal. 17(3): 482-504.

Quick, H. F.
1955. Food habits of marten in northern British Columbia. Canadian Field Nat. 69(4): 144-147.

Remington, J. D.
1951. Food habits of the marten (Martes caurina origenes Rhoads) in Colorado as related to small mammal availability. Unpubl. M.S. Thesis. 94 pp.

Riley, R. M., and R. V. Edwards
1955. Live trapping marten in British Columbia. Murrelet 36(1): 1-8.

Ross, C. P., Andrews, D. A., and Witkind, I. J.
1955. Geologic Map of Montana. Prepared by the United States Geological Survey in Cooperation with the Montana Bureau of Mines and Geology.

Schmidt, F.
1934. Ueber die Fortpflangzungebiologie von Sibirischen Zobel (Martes zibellina L.) und Europaischen Baummarder (Martes martes L.) Zeitshr. fur Saugetierk. 9: 392-403.

Steckwarth, R. P.
1957. The relationship between the marten population and the abundance of small mammals in Glacier National Park. Unpubl. M.S. Thesis. Mont. State Univ. 76 pp.

Wright, P. L.
1942. Delayed implantation in the long-tailed weasel (Mustela cicognani), and the marten (Martes americana). Anat. Rec. 83: 341-349.

Wright, P. L.
1948. Preimplantation stages in the long-tailed weasel (Mustela frenata). Anat. Rec. 100 (4): 593-608.

APPENDIX

TABLE 13

RESULTS OF SMALL MAMMAL SNAP-TRAPPING ON PLOT I

Species	1953		1954		1955		1956		1957		1958	
	S	F	S	F	S	F	S	F	S	F	S	F
Clethrionomys gapperi	2	14	2	11		3	4	13	6	15	5	22
Microtus longicaudus	1	1										
Microtus pensylvanicus	8	6	7	1		1			3		1	1
Phenacomys intermedius									1	2		
Synaptomys borealis		1										
Peromyscus maniculatus												1
Zapus princeps	1		1				1		2			
Sorex cinereus		2	2	6	3	8	1	7	1	3	1	8
Sorex vagrans					2	6	2					5
Eutamias amoenus								1				
Total	12	24	12	18	5	18	8	21	13	20	7	37

S - Summer
F - Fall
Dates set: 1957 June 28 (Summer); September 26 (Fall).
1958 July 3 (Summer); September 8 (Fall).

TABLE 14

RESULTS OF SMALL MAMMAL SNAP-TRAPPING ON PLOT II

Species	1953	1954		1955		1956		1957		1958	
	F	S	F	S	F	S	F	S	F	S	F
Clethrionomys gapperi	53	3	27	10	19	3	26	7	37	12	37
Microtus longicaudus	9	10	2				1		2		
Microtus pensylvanicus	3	1									
Phenacomys intermedius							1	1	2		2
Peromyscus maniculatus	5	4	4	1	7	3	7	5	6	3	4
Zapus princeps				1				1		1	
Sorex cinereus		14		1	9			5	7		5
Sorex vagrans					1						2
Total	70	32	33	13	36	7	34	19	54	16	50

S - Summer
F - Fall
Dates set: 1957 June 21 (Summer); September 17 (Fall).
1958 June 26 (Summer); September 3 (Fall).

TABLE 15

RESULTS OF SMALL MAMMAL SNAP-TRAPPING ON PLOT III

	1955		1956		1957		1958	
	S	F	S	F	S	F	S	F
Clethrionomys gapperi	2	2	5	26	12	18	12	33
Phenacomys intermedius	1					1		
Peromyscus maniculatus					1			
Sorex cinereus		15				18	1	3
Sorex vagrans		2	2	1	1		1	
Zapus princeps								
Total	3	19	7	27	14	37	14	36

S - Summer
F - Fall
Dates set: 1957 June 21 (Summer); September 17 (Fall)
1958 June 27 (Summer); September 4 (Fall)

TABLE 16

RESULTS OF SMALL MAMMAL SNAP-TRAPPING ON PLOT IV

	1955		1956		1957		1958	
	S	F	S	F	S	F	S	F
Clethrionomys gapperi		4	1	6	2	20	3	22
Phenacomys intermedius				1		2		
Peromyscus maniculatus	4	10	3	5	11	2	1	14
Sorex cinereus		3		1	1	6		9
Microtus longicaudus								2
Eutamias amoenus								2
Total	4	17	5	13	14	30	4	47

S - Summer
F - Fall
Dates set: 1957: June 21 (Summer); September 17 (Fall)
1958: June 27 (Summer); September 4 (Fall)

TABLE 17

RESULTS OF SMALL MAMMAL SNAP-TRAPPING ON PLOT V

Species	1955 S	1955 F	1956 S	1956 F	1957 S	1957 F	1958 S	1958 F
Clethrionomys gapperi	9	14	4	19	15	29	6	29
Microtus longicaudus								2
Peromyscus maniculatus	1	3				4		4
Sorex cinereus		12	2	3	2	8		4
Sorex vagrans		1		2			3	
Eutamis amoenus								1
Total	10	30	6	24	17	41	9	40

S - Summer
F - Fall
Dates Set: 1957 June 27 (Summer); September 25 (Fall)
1958 July 1 (Summer); September 8 (Fall)

TABLE 18

RESULTS OF SMALL MAMMAL SNAP-TRAPPING ON PLOT VI

Species	1955 S	1955 F	1956 S	1956 F	1957 S	1957 F	1958 S	1958 F
Clethrionomys gapperi	2	2	2			5	5	5
Microtus pennsylvanicus				1		5	4	1
Phenacomys intermedius			2					
Synaptomys borealis				1				
Peromyscus maniculatus						1		
Sorex cinereus		4	2		2	9	4	2
Sorex vagrans			1					
Total	2	6	7	2	2	20	13	8

S - Summer
F - Fall
Dates set: 1957 June 27 (Summer); September 25 (Fall)
1958 July 2 (Summer); September 8 (Fall)

TABLE 19

RESULTS OF SMALL MAMMAL SNAP-TRAPPING ON PLOT VII

Species	1955 S	1955 F	1956 S	1956 F	1957 S	1957 F	1958 S	1958 F
Clethrionomys gapperi						2		
Microtus longicaudus						2	3	1
Microtus pennsylvanicus						3	6	7
Phenacomys intermedius	1					2		
Peromyscus maniculatus	2	3		7		2		6
Zapus princeps			3		1		3	
Sorex cinereus	11	18	1	9	5	10	1	10
Sorex vagrans		3	1	1				1
Eutamias amoenus	1	1						2
Total	15	25	5	17	6	21	13	27

S - Summer
F - Fall
Dates set: 1957 June 28 (Summer); September 25 (Fall)
1958 July 1 (Summer); September 8 (Fall)