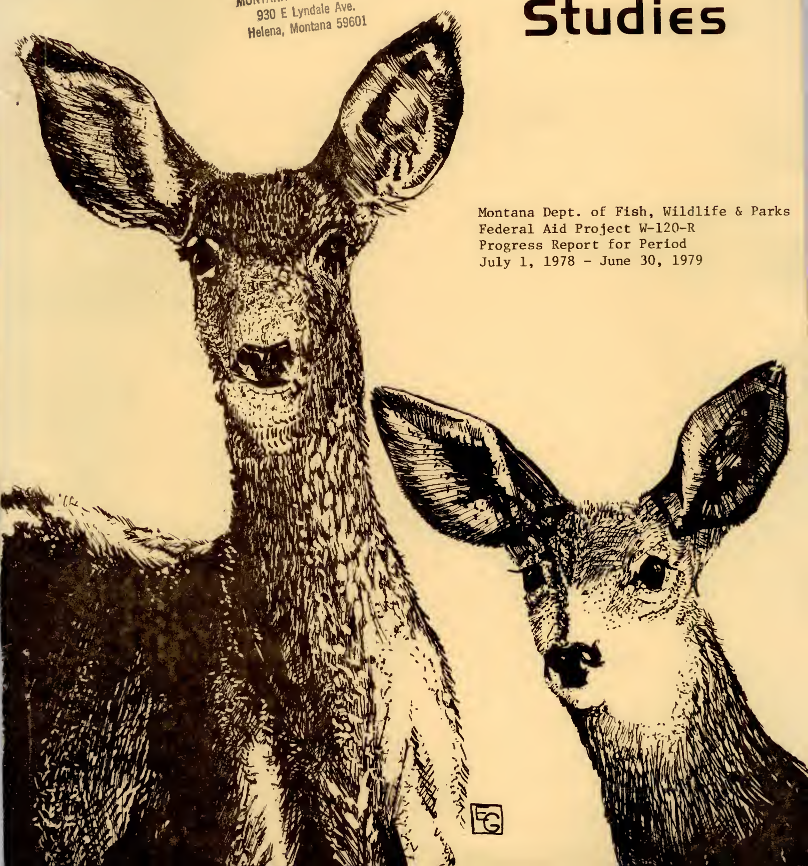
Montana Deer Studies



Montana Dept. of Fish, Wildlife & Parks
Federal Aid Project W-120-R
Progress Report for Period
July 1, 1978 - June 30, 1979

JOB PROGRESS REPORT

RESEARCH PROJECT SEGMENT

State of Montana

Project W-120-R-10 Name Statewide Wildlife Research

Study No. BG-1.00 Title Statewide Deer Research

Job Nos. 1, 2, 3, 4

Period Covered: July 1, 1978 - June 30, 1979

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INTRODUCTION

In 1975 a statewide deer research program was initiated in Montana. Broadly, the objectives of this program were to:

1. Provide a more detailed understanding of the population biology and habitat relationships of deer and of the factors limiting deer numbers in the diverse environments in which deer occur in Montana;

2. Develop new or improved methods for measuring deer population and habitat parameters, new guidelines for applying existing information and technology more effectively, and/or new criteria for interpreting field data in terms of management needs; and

3. Establish new guidelines for consideration of the habitat requirements and relationships of deer in other game, range, forest, and land management programs and practices in Montana.

The study entails concurrent, comparative investigations on the population ecology and habitat relationships of both mule deer and white-tailed deer in all of the major ecological or broad habitat types on which the two species occur. It includes both descriptive and evaluative research. The former is required to provide essential baseline information concerning deer behavior, habitat requirements and relationships, to clarify existing knowledge, and to develop hypotheses concerning the environmental requirements and relations of deer. The study also involves efforts to promote, assist in, and generally coordinate more extensive and pilot deer management studies across the State, and to draw together and relate findings of these studies to those of more intensive investigations and to the overall study objectives.

Current deer studies are located on the accompanying map of Montana (Fig. A). Solid circles denote deer research study areas from which findings are included in this report. Open circles denote management and other special study locations. Those inscribed with a T are management studies involving only deer population trend and classification measurements to date, though more intensive effort may be planned. Completely open circles denote studies which may also involve tagging and marking, or monitoring radio-collared deer, food and range use habits, and/or other habitat relations. Circles inscribed with an X denote special studies conducted by the Ecological Services Division of the Fish and Game Department and other agencies. The latter include the Decker Deer Study conducted by the U. S. Fish and Wildlife Service and deer studies in Glacier National Park.

Findings from management surveys and investigations are reported independently in Montana Department of Fish and Game Regional Progress Reports under project W-130-R and as other special progress reports from the Ecological Services Division or the Agency concerned.

This report compiles individual study and job progress reports for investigations conducted on or directly in conjunction with the intensive study areas during 1978-79. Individual study reports outline specific job objectives and procedures and present and discuss current findings in relation to information obtained previously as well as through supplementary thesis research projects associated with them.

Several separate publications and reports presented findings or other information resulting from the Statewide Deer Study. These include:

Hamlin, K. L. and L. Schweitzer. 1979. Observations of coyote pairs attacking mule deer fawns. J. Mamm. 78(4).

Hamlin, K. L. 1978. Deer, coyote and alternate prey relations in the Missouri River Breaks Montana. Ann. Conf. N.W. Section, TWS, Portland, OR, Feb. 1979.

Mundinger, J. G. *In press*. Reproductive biology of white-tailed deer in the Swan Valley, Montana. J. Wildl. Manage.

Mundinger, J. G. 1979. The Swan Valley: whitetail country. Mont. Outdoors 10(5):35-41.

Mackie, R. J., K. H. Hamlin and D. F. Pac. *In press*. The mule deer. Chapter 44. In: Game, Pest and Furbearing Mammals of North America. J. A. Chapman (ed.) J. Hopkins Univ. Press.

Mackie, R. J. 1979. "Competition" and the future of wild ungulates on Montana rangelands. Joint Meeting of the Mont. Chapters Soil Cons. Soc. of Amer., Amer. Fisheries Soc., Soc. Amer. Foresters and The Wildlife Society, Missoula, MT, Jan. 31-Feb. 1, 1979.

While all of the studies described are still in progress, and thus most findings are only preliminary or tentative, results to date have provided much new information on the general biology and ecology of deer. Included are a much better and more detailed understanding of distributional characteristics and patterns and their significance in the ecology of natural populations. Also included is a better knowledge of reproductive characteristics and relationships in natural populations as well as the roles of fawn production and survival, population sex and age structure, and mortality patterns of both fawns and adults of both sexes as they influence population size and dynamics annually and in various habitats.

These and other findings provide basis for developing hypotheses concerning effects of various environmental factors on deer populations and at the same time have significant potential for use by management. These include the role of weather, forage supplies, cover, predation, hunting, livestock grazing management and logging or timber management. Some of these have been discussed in past or the present reports; others will be outlined in separate papers and/or in future reports as current concepts are evaluated in light of continued investigation and findings.

The studies reported in this document required the efforts of numerous individuals, both with the Montana Department of Fish and Game and in other agencies. The cooperation of personnel of the U. S. Forest Service, Bureau of Land Management and the U. S. Fish and Wildlife Service, C. M. Russell Wildlife Range, has been especially appreciated. Without their combined interest and effort this study would not be possible. Gratitude is also expressed to numerous private individuals who have, as landowners, provided access to their lands and study areas or otherwise provided assistance in the investigations.

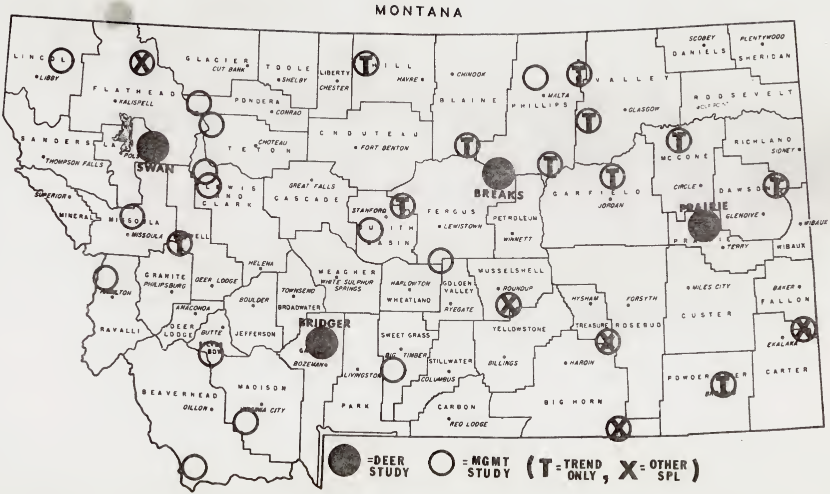

Figure A. Current deer studies in Montana.

JOB TITLE: Population ecology and habitat relationships of white-tailed deer in coniferous forest habitat of northwestern Montana.

ABSTRACT:

Studies to evaluate factors affecting populations of white-tailed deer *(Odocoileus virginiana)* in the Swan River Valley, Montana were continued during 1978-79. Data were collected at two checking stations during the 1978 hunting season. Eight marked deer were harvested and reported from a minimum sample of 136 marked deer known to be alive during the hunting season. Distribution of hunting pressure and harvest is discussed. Weights and body measurements of hunter-killed deer indicated growth patterns. Population parameters were determined from a harvest sample of 145 deer, a trapping sample of 120 deer, a roadkill sample of 27 deer, and observations of 3,100 deer. Fawns comprised 26% of the harvest during the either-sex portion of the season and 16% of the total harvest. Fawns comprised 42%, 33%, and 27% of the trapping, roadkill, and winter classification samples, respectively. Yearlings represented 18%, 15%, and 41%, respectively, of these same mortality factors. Reproductive tracts were collected from 18 adult female deer. No pregnant fawns were examined. Fetal and ovulation rates of 2½-year-old-and-older does were 1.7 and 1.9 per doe, respectively. Patterns of reproductive suppression, determined from a sample of marked does, are discussed. Survival of marked deer also is discussed. The winter range was a diverse community, occupied by a mature sub-climax forest. Fire apparently perpetuated this condition. Winter observations of deer typically occurred in mixed stands of timber, dominated by Douglas fir, western larch, and lodgepole pine. Several habitat types were represented. Use of natural openings and clearcuts was minor. Winter food habits are discussed. Definitive winter home range of marked deer were less than 160 acres. Each home range included a small activity center. Home range area was influenced by winter severity. Patterns of summer dispersal, determined from radio-equipped deer, are discussed. Summering areas of individual deer were typified by an interspersion of mature coniferous timber with natural openings and wet sites. Preliminary timber management recommendations are presented.

JOB TITLE: Population ecology and habitat relationships of white-tailed deer in coniferous forest habitat of northwestern Montana.

JOB OBJECTIVE: To determine the environmental requirements of white-tailed deer and factors regulating white-tailed deer populations in the coniferous forest habitat of northwestern Montana.

To determine the effects of various potentially competing land use and management practices upon white-tailed deer in northwestern Montana.

To develop new and improved guidelines for management of northwestern Montana white-tail populations and their habitats.

INTRODUCTION:

The white-tailed deer *(Odocoileus virginiana)* is the most important big game species in northwestern Montana where its distribution is closely associated with the coniferous forest. The Swan River Valley is representative of that habitat. A study to evaluate factors affecting the Swan white-tail population was initiated during November, 1975. During FY-79, the emphasis on obtaining data basic to distribution, movements, habitat use, and population dynamics continued. The Swan Valley study is one phase of Montana Statewide Deer Research.

STUDY AREA

The upper Swan River Valley extends from Swan Lake south to the Swan-Clearwater Divide (Figure 1). The valley lies between the Swan Mountains to the east and the Mission Mountains to the west. The valley is bisected by the Swan River and by Highway 209 which parallels the river. Most of the winter range in the upper valley lies between Goat Creek and Condon. Condon is approximately 65 mi southeast of Kalispell. A description of this area was presented by Hildebrand (1971). The history of game populations in the Swan Valley and summaries of the early studies are included in Weckwerth 1958, Hildebrand 1971, and Mundinger 1976.

Winter extends from mid-November through March. Snow cover generally is continuous during that period. Thaws and cool rain are typical during January and February. A mild winter occurred during 1975-76. Winter severity indices (WSI)(Picton and Knight 1969), for the period 15 November-31 March, were caluclated for the latter three winters from the Swan Lake Weather Station data. The 1976-77 winter was unusually mild (WSI=2,100). Three major snowstorms occurred and snow persisted from 25 November through 9 April. Yet, snow accumulations never were heavy and portions of the winter range frequently were bare. One thaw occurred during January and daily maximum temperatures were above freezing throughout February and March. The 1977-78 winter was normal (WSI=12,445). That year eight major snowstorms occurred and snow persisted from 17 November through 8 April. Snow accumulations were heavy from late

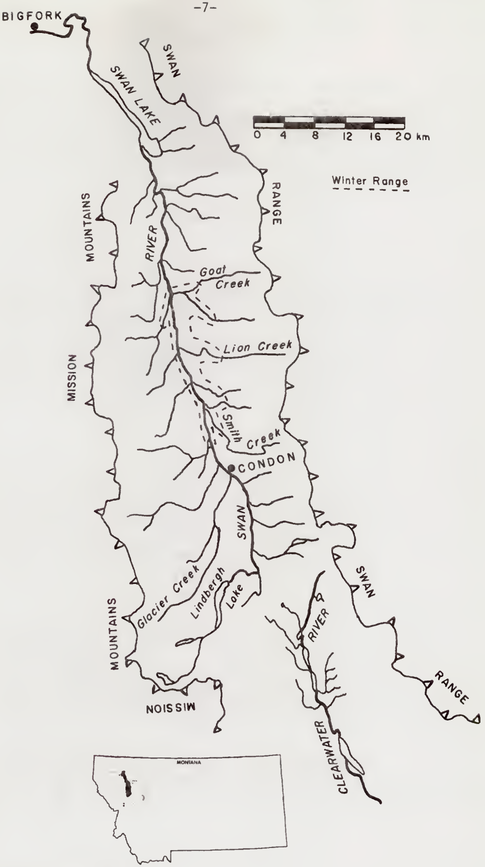

Figure 1. Map of study area.

December through mid-March. Temperatures were normal. A severe winter occurred in 1978-79 (WSI=26,457). Eight major snowstorms occurred and snow cover persisted from 13 November through early April. Snow accumulations were heavy through mid-March. That winter temperatures were unusually cold throughout December and January. The first that did not occur until early February. Thereafter, temperatures were normal.

METHODS

Hunting Season

Two part-time checking stations were operated during the 1978 hunting season. Hunters were interviewed to determine hunter origin, drainages hunted, time hunted, and animals observed. Locations of animals harvested were plotted on a map, as accurately as possible. Ages of white-tailed deer, mule deer *(Odocoileus hemionus)*, and elk *(Cervus canadensis)* were determined by criteria of eruption and wear of teeth of the lower jaw (Severinghaus 1949; Robinette et al. 1957; Quimby and Gaab 1957). First incisors were collected from deer for analysis of annuli in the cementum layer (Gilbert 1966). Weights and measurements of deer also were collected.

Production

Information concerning fawn production was determined from the classification of 3,064 white-tailed deer during the period of December, 1977 through April, 1978. This was supplemented with classification of animals in the harvest, roadkill, and trapping samples. The reproductive status of 77 marked adult does were determined from ground observations. The reproductive histories of 28 individual does were determined in more than one winter. Reproductive tracts were collected from 18 adult does.

Distribution and Movements

All observations of deer were plottted according to the legal description of the location. A general description of the surrounding habitat also was made. Animals were classified according to age. Attempts were made to classify adult deer according to sex. Because large numbers of deer were not observed until the bucks had dropped their antlers, these data were not reliable. Additional information resulted from the relocation of animals marked for individual recognition.

Migratory patterns and summer range use data were determined by radio telemetry. Radio-equipped deer frequently were relocated from a fixed-wing aircraft. This information was supplemented with ground relocations of these animals and reconnaissance of areas used.

Food Habits

Food habits were determined by rumen analysis. Rumen contents were examined according to Wilkins (1957). Analysis of these data followed the aggregate percentage method described by Martin et al. (1946).

RESULTS AND DISCUSSION

Hunting Season

The 1978 hunting season in the Swan Valley extended from 22 October through 26 November. Either-sex deer and elk hunting was permitted until 29 October, thereafter only bucks and bulls were legal game. Weather conditions generally were poor for hunting, except during the last week of the season when moderate snowfall occurred. The lower Swan checking station was operated daily during the either-sex portion of the season and on weekends thereafter. The Swan Divide station was operated on weekends only.

During the season, 3,684 hunter-trips were recorded. Totals of 145 white-tailed deer, 15 mule deer, and 32 elk were examined. That included 3,016 hunters, 124 white-tailed deer, 12 mule deer, and 29 elk checked at the lower Swan station and 668 hunters, 21 white-tailed deer, 3 mule deer, and 3 elk checked at the Swan Divide station.

According to the 1978 hunter questionnaire, the Swan Valley, Hunting District 130, provided 18,963 man-days of deer hunting, and 12,690 man-days of elk hunting. The indicated harvest was 625 white-tailed deer, 69 mule deer, and 135 elk. Deer hunter success was 18%.

Hunting season parameters, as determined from the questionnaire and the lower Swan station, are presented for the four hunting seasons in Table 1. Similar checking station effort occurred in 1976-78, but the station was operated only on weekends in 1975. The 1978 questionnare data may not be wholly comparable with previous years because Hunting District 131 was eliminated and that area included with Hunting District 130 that year. Also, the format of the questionnaire was changed in 1978.

The questionnaire and checking station data indicated comparable trends in the harvest of white-tailed deer. Between 1976 and 1978, the indicated rates of change were similar. Trends in numbers of elk harvested also were similar, but the magnitude of change was different between data sets and the differences were not consistent.

The questionnaire indicated greater hunting pressure during 1975 and 1977, years with larger elk harvests. That trend was not evident in the checking stations. The questionnaire suggested that hunting pressure varied more with the numbers of elk hunting trips than with numbers of deer hunting trips. Elk and deer hunters were not distinguished at the checking station.

The majority of hunters checked were local residents. In all years, residents of Flathead, Lake and Missoula Counties comprised more than 90% of the hunters.

Eight marked deer were harvested and reported during the 1978 season. Three of those were recorded at the checking station and five were reported elsewhere. A minimum of 136 marked deer left the winter range in spring 1978. Population estimates were derived from the marked sample, the number of animals checked, and the questionnaire harvest data (Overton and Davis 1969). Those ranged from

Table 1. Comparisons of checking station and hunter questionnaire data.

	1975	1976	1977	1978
Hunter Days				
Questionnaire	40,511	33,606	39,691	31,653
Check Station	2,750	3,317	3,239	3,016
W-T Deer Harvest				
Questionnaire	635	523	736	625
Check Station	98	104	154	124
Mule Deer Harvest				
Questionnaire	70	94	86	69
Check Station	13	15	24	12
Elk Harvest				
Questionnaire	293	125	222	135
Check Station	51	29	39	29
W-T, Percent Adult Males				
Questionnaire	55	74	79	79
Check Station	49	66	68	66
Deer Hunters (Questionnaire)	4,501	3,673	4,323	3,779
Percent Deer Hunter Success (Questionnaire)	17	17	20	18

5,600 to 10,600, as compared with ranges of 4,000 to 7,900 and 3,500 to 5,700 during 1976 and 1977, respectively. The maximum harvest rate was 11%, as compared with 13% and 21% during 1976 and 1977, respectively. Several factors precluded the accuracy of these population estimates. However, they suggested that current harvest rates have a minor influence on population trend. Further, trends in total harvest did not follow trends in the population estimates.

The distribution of hunting pressure and harvest, as recorded at the lower Swan station during 1976-78, is presented in Table 2. The distribution in hunting pressure was similar during all years. More than half occurred between North Lost Creek and Dog Creek in the east side of the valley. That pattern probably reflected the traditions of individual hunters.

During all years, disproportionate higher percentages of white-tailed deer, relative to hunting pressure, were harvested south of Condon Creek on the east side and south of Elk Creek on the west side of the valley. The greatest summer concentrations probably occurred in those drainages, but hunters did not respond to that availability.

Table 2. Distribution of hunting pressure and harvest, by drainage, as determined from the lower Swan checking station interviews, during the 1976, 1977 and 1978 hunting seasons.

Drainage	Hunting Parties			W-T Deer			Mule Deer			Elk		
	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
Bear Creek-Johnson Creek	107(7)[1]	50(3)	62(4)	5(5)	4(3)	4(3)						
6 Mile Creek-Bond Creek	61(4)	65(4)	56(4)	3(3)	8(5)	4(3)		1(4)		1(3)	1(3)	
West Swan Lake	124(8)	167(11)	182(12)	5(5)	13(9)	9(7)	2(13)	7(29)	1(8)	1(3)	3(8)	7(24)
N. Lost Cr. & S. Lost Cr.	153(10)	190(12)	142(9)	7(7)	5(3)	8(7)	4(27)	4(17)	1(8)	3(9)	5(14)	4(14)
Cilly Creek-Soup Creek	236(16)	258(16)	271(18)	5(5)	10(7)	6 (5)		1(4)		2(6)	5(14)	3(10)
Squaw Creek-Van Lake	283(19)	233(15)	184(12)	13(13)	20(13)	16(13)	1(7)			10(31)	4(10)	
Lion Creek-Dog Creek	117(8)	165(10)	177(12)	8(8)	20(13)	18(15)	4(27)	4(17)	3(25)		13(36)	6(21)
Condon Creek-Smith Creek	95(6)	68(4)	66(4)	18(18)	10(7)	12(10)	2(13)		1(8)			6(21)
Cooney Creek-Owl Creek	54(4)	75(5)	74(5)	10(10)	11(7)	11(9)	1(7)		1(8)	2(6)		2(7)
Subtotal - H.D. 130	1,230(82)	1,271(81)	1,214(80)	74(73)	101(67)	88(72)	14(93)	17(71)	7(58)	19(59)	31(86)	28(97)
Woodward Creek-Fatty Creek	61(4)	71(5)	85(6)	1(1)	8(5)	5(4)	1(7)	4(17)	2(17)	6(19)	1(3)	
Piper Creek-Cold Creek	129(9)	137(9)	119(8)	10(10)	17(11)	11(9)		2(8)	1(8)	3(9)	1(3)	
Elk Creek-Kraft Creek	59(4)	79(5)	74(5)	12(12)	21(14)	17(14)		1(4)	2(17)	3(9)	3(8)	1(3)
Lindbergh Lake-Beaver Creek	17(1)	14(1)	16(1)	4(4)	4(3)	2(2)				1(3)		
Subtotal - H.D. 131	266(18)	301(19)	294(20)	27(27)	50(33)	35(28)	1(7)	7(29)	5(42)	13(41)	5(14)	1(3)
TOTAL	1,496	1,572	1,508	101	151	123	15	24	12	32	36	29

[1]Percentages of the total in parentheses.

The distribution of hunting pressure in the Swan during 1976 appeared to be related to the distribution of the elk harvest. That relationship was not evident in 1977 and 1978.

Distributions recorded at the Swan Divide station are presented in Table 3. The most noteworthy trend was a decline in hunting pressure with increasing distance north from the Swan-Clearwater Divide.

A comparison of the white-tailed deer harvest distribution during 1978 and previous years is presented in Table 4. Noteworthy changes since 1959 included a reduction in the proportion of the harvest taken between Squaw Creek and Dog Creek, an average of 47% during 1948-1959 as compared with 25% in 1978; an increase in the proportion of the harvest taken from south of Condon, an average of 22% during 1948-59 as compared with 41% in 1978; and, a broader distribution of the harvest. Those differences reflect an increase in the road density throughout the valley. A probably decline in the density of deer which summers on or near the winter range was also indicated.

Weights and Measurements

Average hog-dressed weights and body measurements were collected at the check stations. Body measurements included total length, from the tip of the nose to the base of the tail; height at the shoulder; and, length of the hind foot. Data for the four hunting seasons were pooled (Table 5).

Weights and measurements of females suggested that does continued growth in wieght through 4½ years. Growth in body size increased significantly through 2½ years. Differences in body measurements between 2½- and 3½-year-old does and between 3½- and 4½-year-old does were not statistically significant, but the average length of 4½-year-old does was significantly greater than that of 2½-year-olds. It was probable that the paired t-test was not sensitive to small, biologically significant differences. Variances were large while sample sizes of 3½-years and older age-classes were small.

Significant increases in both weight and body size of males continued through 5½ years. Males evidenced large variations in size and weight within individual age classes. The range of yearling weights was 95-160 lbs and the range of total lengths for this age class was 122-170 cm. Weights and lengths of 2½-year-old males ranged between 110-180 lbs and 135-168 cm, respectively. The range of weights of 3½-year-olds was 144-213 lbs while lengths ranged between 147-173 cm. In the 4½-year-old age class, weights ranged between 145-215 lbs and lengths between 142-178 cm. A portion of this variation may have resulted from the time that each animal was harvested relative to the onset of the rut. Variations in measurements of males also seemed to be related to individual differences in growth potential because the differences were apparent at a young age.

Hog-dressed weights of Swan Valley white-tailed deer were heavier than average weights for Montana (Mackie 1964). They also were heavier than those reported for the Fisher River-Wolf Creek area in northwest Montana (Firebaugh et al. 1975).

Table 3. Distribution of hunting pressure and harvest, by drainage, as determined from the Swan Divide checking station interviews during the 1977 and 1978 hunting seasons.

Drainage	Hunting Parties		W-T Deer		Mule Deer		Elk	
	1977	1978	1977	1978	1977	1978	1977	1978
Bear Creek-Johnson Creek								
6 Mile Creek-Bond Creek								
West Swan Lake	3(1)[1]		1(2)					
North & South Lost Creeks	4(1)	4(1)	2(4)	1(5)			1(7)	
Cilly Creek-Soup Creek	5(1)	3(1)						
Squaw Creek-Van Lake	7(2)	3(1)			1			
Lion Creek-Dog Creek	21(5)	19(7)	3(6)	2(10)				
Condon Creek-Smith Creek	36(9)	17(6)	4(8)	3(14)	1			
Cooney Creek-Owl Creek	135(34)	68(23)	21(40)	2(10)	1	1	8(53)	1
Subtotal H.D. 130	211(53)	114(39)	31(60)	8(38)	3	1	9(60)	1
Woodward Creek-Fatty Creek	3(1)	2(1)						
Piper Creek-Cold Creek	22(6)	18(6)	2(4)				1(7)	
Elk Creek-Kraft Creek	70(18)	56(19)	12(23)	8(38)				1
Lindbergh Lake-Beaver Creek	90(23)	102(35)	7(13)	5(24)			5(33)	1
Subtotal H.D. 131	185(47)	178(61)	21(40)	13(62)	0	0	6(40)	2
Total	396	292	52	21	3	1	15	3

[1]Percentages of the total in parentheses.

Table 4. Comparison of the percentage of the white-tailed deer harvest, by drainage, from checking station data, 1948-1978.

	1948[1]	1949[1]	1957[1]	1958[1]	1959[1]	1962[2]	1975[2]	1976[2]	1977[2]	1977[1]	1978[1]
Sample size	48	51	255	196	196	39	91	101	151	203	144
Drainage											
East Swan Lake	27	18	4	8	3	8	9	8	8	6	6
West Swan Lake				2	5	3	2	5	9	7	7
North and South Lost Creeks		4	6	5	1	8	7	7	3	3	6
Cilly Creek-Soup Creek	4	6	7	4	7	8	8	5	7	5	4
Squaw Creek-Van Lake	31	31	21	19	32	21	22	13	13	10	11
Lion Creek-Dog Creek	23	16	22	13	25	15	8	8	13	11	14
Condon Creek-Smith Creek	4	2	5	11	5	10	22	18	7	7	10
Cooney Creek-Owl Creek	8	10	18	14	9	13	6	10	7	16	9
Subtotal H.D. 130	98	86	82	76	87	85	82	73	67	65	67
Woodward Creek-Fatty Creek	2	12	5	6	9	3	4	1	5	4	3
Piper Creek-Cold Creek			4	8	1	3	9	10	11	9	8
Elk Creek-Kraft Creek		2	4	2	1	10	4	12	14	16	17
Lindbergh Lake-Beaver Creek			4	8	2			4	3	5	5
Subtotal H.D. 131	2	14	18	24	13	15	18	27	33	35	33

[1]Data summarized from two checking stations.
[2]Data summarized from lower Swan checking station only.

Table 5. Average hog-dressed weights and body measurements of white-tailed deer harvested in the Swan Valley, 1975-78.

Sex	Age	Weight (lbs)	Height (Cm)	Length (Cm)	Hind foot (Cm)
♀♀	½	58	114	78	41
	1 ½	98*	133*	88*	46*
	2 ½	106*	139*	91*	47*
	3 ½	111	142	91	47
	4 ½	122*	144	92	47
	5 ½[1]	121	133	100	46
	6 ½	113	143	91	47
	7 ½	109	135	92	46
	8 ½	123	144	91	47
	9 +	118	146	94	47
♂♂	½	65	116	81	42
	1 ½	114*	141*	94*	48*
	2 ½	147*	151*	99*	50*
	3 ½	159*	158*	103*	50
	4 ½	176*	157	103	50
	5 ½	200*	168*	103	51*
	6 ½	181	164	104	49
	7 ½	186	166	104	50
	8 ½	192	165	102	52
	9 +	177	159	104	49

*Significantly greater, $P<0.05$, than preceding number in column.
[1]Sample size of one.

Age Data

The age distribution of the 1975-78 white-tailed deer harvests is presented in Table 6. Animals were assigned to fawn, yearling, and 2½-year-old classes according to criteria of eruption-wear (Severinghaus 1949). Older deer were assigned to age-classes according to an analysis of the dental cementum in the first incisor (Gilbert 1966), except that four deer were assigned to the 3½-year-old class by eruption-wear because the cementum analyses probably were incorrect. In addition to the animals for which age was determined, 30, 7, 7, and 9 unclassified adult deer were checked during the four respective hunting seasons. Conclusions regarding the 1975 adult age structure must, therefore, be tentative.

Table 6. Percent composition, by age-class, of the white-tailed deer harvest in the Swan Valley, 1975-78.

Age-Class	Females				Males				Total			
	1975	1976	1977	1978	1975	1976	1977	1978	1975	1976	1977	1978
½	30	14	31	26	14	12	11	12	20	12	18	16
1 ½	13	57	17	31	33	39	46	45	25	43	37	41
2 ½	17	14	25	15	25	22	16	22	22	21	19	20
3 ½	9		5	10	8	4	11	9	8	3	9	10
4 ½	9	5	9			8	10	2	3	7	10	1
5 ½			2	5	8	3	1	5	5	2	1	5
6 ½	9	5	3	3		4	3		3	4	3	1
7 ½	9			5	6	3		2	7	2		3
8 ½		5	3	5	6	4			3	4	1	1
9 ½						1		1		1		1
10 ½			3				1				2	
11 ½								1				1
12 ½												
13 ½	4								2			
14 ½			2								1	
Sample Size	23	21	64	26	36	76	135	97	59	97	199	136

Classification data suggested that fawn production was greater in 1976-77 than in 1975-76 (Table 9). This trend was not evident in the harvest data. That a smaller percentage of fawns was harvested during 1976 probably resulted from the large number of unclassified adults in the 1975 sample and yearlings in the 1976 season, and the more restrictive regulations that began in 1976. The highest rate of fawn production occurred during 1976-77 and that was consistent with the harvest trend. The lowest rate of fawn production occurred in 1978-79, but that was not indicated by the harvest.

The proportion of fawns in the male samples was influenced by the length of the either-sex season. Fawns comprised 29, 29, 24, and 29% of the male harvest during the either sex protion of the four hunting seasons, respectively.

Harvest data suggested reasonable survival of young. The 1975, 1976, and 1977 cohorts were well represented in both sex-classes during subsequent hunting seasons. Trends of older cohorts were difficult to interpret from these data.

Yearling males consistently were the dominant sex/age class. Harvests probably were biased in favor of this group.

Percentages of 3½- and 5½-year-old deer in the harvest may not have been representative of the population age-structure. Harvests probably were biased against these age-classes. Discrepancies also may have resulted from errors in age assignments.

Jaws were collected from adult white-tailed deer during the hunting seasons and from roadkills and trap casualties. They permitted a comparison between eruption-wear and dental cementum as methods for determining the age of white-tailed deer (Table 7). The sample incuded five known-age animals. The ages of three 2½-year-olds were correctly determined by eruption-wear; while one was incorrectly assigned to the yearling class by dental cementum. Both methods correctly determined the age of a 3½-year-old deer. The age of a 5½-year-old deer was correctly determined by dental cementum; that deer was assigned to the 3½-year-old class by wear characteristics. Two other marked deer of unknown age were included in the sample. The age of one was estimated as 4½ years in March 1976. She was recovered in February 1979. At that time, ages of 8½-years and 11½-years were determined by wear and dental cementum, respectively. The other deer was assigned to the 5½-year-old class in March 1976. When she was recovered in October 1977, the age determinations were 5½-years and 8½-years by wear and dental cementum, respectively.

Table 7. **Comparison of age determinations by tooth eruption and wear with age determination by dental cementum.**

Assigned Age by Dental Cementum	Assigned Age by Tooth Eruption and Wear							Sample Size
	2½	3½	4½	5½	6½	7½	8½	
1½	2							2
2½	68	4						72
3½	4	28						32
4½		19	3					22
5½		6	4	1				11
6½		2	6	7				15
7½			4	4		1		9
8½			5	4	2			11
9½				1				1
10½				2	1	1		4
11½						1	2	3
12½					1		1	2
13½						1		1
14½						1		1

Eruption-wear is assumed to be completely reliable through 2½-years. Fawns and yearlings are accurately determined by the characteristic combinations of deciduous and permanent dentition that Severinghaus (1949) described. Deer of 2½-years have a complete set of adult teeth and the lack of wear and staining are very distinctive. Ages of older deer, as determined by wear characteristics, consistently were younger than those indicated by dental cementum (Table 7). Deer from the Swan Valley apparently do not develop dental wear patterns as rapidly as those described by Severinghaus (1949).

Dental cementum probably is the more reliable technique for older animals, but this method was not always accurate. The ages of 10 of 106 animals in the 2½- and 3½-year-old classes were incorrectly determined by dental cementum (Table 7). This suggested that errors also occurred in the older-age classes, but wear characteristics were not an adequate crosscheck for these deer. Few examples of tooth sections, in which each annulation was determined with certainty, were encountered. Typically, annuli were incomplete in portions of the section and compressed in other portions. That count of annuli with the best agreement between two sections from the same tooth was, therefore, assumed to be indicative of the age of the animal.

Fawn Production

Observations of 3,100 white-tailed deer were made between January and March 1979. Of these, 3,064 were classified to fawns or adults (Table 8). The data indicated a fawn/adult ratio of 37.7/100, or a population comprised of 27.4% fawns. The recruitment rate averaged 29% for the period 1976-79. The lowest recruitment rate was recorded during 1978-79. Recruitment rates were higher and more variable in prior years (Table 9).

A sample of 113 deer was observed during the 4 replications of the upper Swan Valley trend route. The recruitment rate indicated in that sample (Table 8) was lower than that derived from observations throughout the winter. In 1977 and 1978, the estimates of recruitment derived from the trend routes had been comparable to those from observations throughout the winter (Mundinger 1978).

Individual adults that were accompanied by fawn(s) were presumed to be does. Those animals were compiled to determine the ratio of twin/singleton litters. Twinning indices were 0.32, 0.42, 0.29, and 0.19, respectively, for each of the winters, 1976-79.

Fawn/adult and fawn/doe ratios from animals harvested during the 1978 either sex hunting season were 35/100 and 69/100, respectively (Table 10). The ratios of adult males/adult females was 94/100.

Data gathered during 1978 indicated that yearlings comprised a substantial proportion of the adult population. This was consistent with the high recruitment rate recorded during 1977-78. Twelve of 32 (38%) adult females, 44 of 90 (49%) adult males, 56 of 122 (46%) adults, and 41% of the total harvest were yearlings. Respective percentages during 1978 were 24, 52, 44 and 37.

Table 8. Monthly classifications of white-tailed deer in the Upper Swan River Valley during winter, 1979.

Month	Total	Adults	Fawns	Uncl.	ff/100 Ad.	% ff
January	553	395	147	11	37	27.1
low[1]		33	9		27	
high[2]		22	9		41	
February	1,572	1,125	426	21	38	27.5
low		40	10		25	
high		17	10		59	
March	975	704	267	4	38	27.5
low		45	10		22	
high		27	19		70	
1979 Total	3,100	2,224	840	36	38	27.4
Trend Route	113	85	28		33	24.8
1978 Total	4,198	2,707	1,295	196	48	32.4
1977 Total	3,743	2,429	1,010	304	42	29.4
1976 Total	2,269	1,519	600	150	39	28.3

[1]Daily classification with the lowest fawn/adult ratio during the month.
[2]Daily classification with the highest fawn/adult ratio during the month.

Classifications of the 1979 trapping samples are compared with previous winters in Table 11 while those of roadkilled deer are presented in Table 12.

Several sources provided estimates of the fawn sex ratio (Table 13). The estimates were variable within and between years and variations were not consistent. Apparently, sample sizes were insufficient to adequately assess this parameter.

Reproductive tracts were collected from 18 adult females (Table 14), seventeen were pregnant. Fetal and ovulation rates both were 1.0/yearling doe and were 1.7/doe and 1.9/doe, respectively, for older does. Fetal rates were 1.3/doe and 1.8/doe for yearlings and adults, respectively during 1978. Higher potential productivity that year may have resulted from the extremely mild winter incurred during 1977. Three female fawns were examined and none were pregnant.

Table 9. White-tailed deer fawn/adult ratios in the Swan River Valley, 1958-1979.

Year	Adults	Fawns	Fawns/ 100 adults	Percent Fawns
1958	167	99	59	37
1959	207	68	33	25
1960	77	30	39	28
1961	19	8	42	30
1962	80	33	41	29
1963	59	31	53	34
1964	234	90	38	28
1965	188	108	57	36
1966	33	17	52	34
1967	51	26	51	34
1968	30	26	80	46
1969	122	55	45	31
1970	249	112	45	31
1971	66	28	42	30
1972	42	13	31	24
1976	1,519	600	39	28
1977	2,429	1,010	42	29
1978	2,707	1,295	48	32
1979	2,224	840	38	27

Table 10. Either-sex hunting season classifications.

Year	Fawns/100 Adults	Fawns/100 Females	Adult Males/100 Adult Females
1975	45	87	93
1976	27	55	100
1977	36	70	94
1978	35	69	94

Table 11. Percent composition by sex and age-class of white-tailed deer trapping sample.

Age-Class	Females				Males				Total			
	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979
½	24	29	26	28	55	68	66	69	35	40	39	42
1½	12	17	22	17	12	23	18	18	12	19	20	18
2½	14	9	17	9	7	5	7	3	12	8	14	7
3½	9	12	14	15	2	0	9	3	7	9	12	11
4+	41	33	22	31	24	5	0	8	35	25	14	23
Sample Size	76	58	88	81	42	22	44	39	118	80	132	120

Table 12. Percent composition by sex and age-class of white-tailed deer road-kill sample.

Age-Class	Females				Males				Total			
	1976	1977	1978	1979	1976	1977	1978	1979	1976	1977	1978	1979
½	25	28	35	32	29	33	77	38	27	30	49	33
1½	25	6	10	11	14	11	9	25	20	7	10	15
2½		17	13	16	14	33		25	7	22	9	19
3½	13	28	13	11	29		5		20	19	10	7
4+	38	22	29	32	14	22	9	13	27	22	23	26
Sample Size	8	18	48	19	7	9	22	8	15	27	70	27

Table 13. Comparative estimates of fawn sex ratios (♀♀/♂).

Year	Source			
	In utero	Check station	Trapping	Road-kill
1975-76		1.4:1	0.8:1	1.0:1
1976-77	0.5:1	0.3:1	1.1:1	1.7:1
1977-78	0.5:1	1.3:1	0.8:1	1.1:1
1978-79	1.1:1	0.8:1	0.9:1	2.0:1
1979-80	0.4:1			

The potential productivity of the Swan Valley population is depicted in Table 15. These data were summarized from 1970 (Hildebrand 1971) and 1976-79 collections. Yearlings comprised the youngest breeding age-class. Ninety-six percent of all adult does, yearling and older, was pregnant. The fetal rate for all females was 1.5/doe and 1.6/pregnant doe. The highest fetal rate was recorded for 3½-year-old does, while the highest ovulation rate occurred in the oldest age class. Comparisons with other studies (Cheatum and Severinghaus 1950; Ransom 1967; Roseberry and Klimstra 1970) indicated that the reproductive potential of the Swan Valley population is less than that reported for the species.

The reproductive performance of 19, 45, 61, and 77 individually marked does was determined from field observations during the four winters, respectively (Table 16). Most of these determinations were made between mid-January and early April. Differentially greater fawn mortality, as compared with adults, had not been detected from classifications (Table 8). Repeated observations of several doe-fawn associations also indicated high fawn survival through this period. Therefore, production rates, as determined from this sample, were estimates of recruitment.

Reproductive success of collared does was consistent with the low recruitment rate for the population as a whole. Cumulatively, 86 or 156 adult, 2½ years and older, does successfully reared 97 fawns. Productivity was 62 fawns/100 does. That represented a loss of 59% of the potential fawn production.

None of the yearlings in this sample was observed with fawns. This was consistent with the lack of pregnant fawns in the sample of reproductive tracts.

Forty-six percent of the 2½-year-old does was observed with fawns (Table 16). This contrasted with the pregnancy rate of 94% for the yearling age class (Table 15). Potential production for this class was 120 fawns/100 does. The observed fawn/doe ratio of 46/100 represented a 61% fawn loss between pregnancy and the subsequent winter.

Table 14. Summary of 1979 reproductive tract collections.

Date	Age	C. L. of Pregnancy	Embryos	C. R. Length (cm)	Weight (gm)
2/22	1½	1	1♂	16.3	123.0
2/23	1½	0	Not Pregnant		
3/22	1½	2	1♂	22.5	321.0
			1♀	21.1	285.0
1/23	2½		1 uncl.		
3/5[1]	2½		1♀	23.2	378.0
1/20	3½	2	1♂	5.7	8.1
2/11	3½		2 uncl.		
3/9	3½	1	1♀	23.3	406.0
3/14	3½		1♀		
			1 uncl.		
4/6	3½	2	1 uncl.		
			1♂	31.3	1002.0
3/9	4½		Pregnant		
2/22	5½	2	1♀	7.6	12.8
			1♂	7.6	12.6
2/25	5½		Pregnant		
2/25	5½		Pregnant		
2/26	6½	2	1♂	17.6	150.2
			1♂	17.7	155.6
3/5[1]	6½		1♂		
2/24	11½	2	1♂	21.1	28.2
			1♂	20.5	27.3
2/8	12½	2	1♂	13.5	93.0
			1♂	13.8	102.0

[1]Reproductive tract incomplete.

Table 15. Reproductive potential, by age-class, as determined from 1970[1], 1976, 1977, 1978 and 1979 collections of reproductive tracts in the Swan Valley.

Age	Sample Size	Percent Pregnant	Fetuses Per Doe	Fetuses Per Pregnant Doe	Ovulation Rate[2]
½	36	0			
1½	17	94	1.2	1.3	1.3
2½[3]	16	94	1.4	1.5	1.8
3½	25	100	1.8	1.8	1.9
4½	16	94	1.7	1.8	2.0
5+	17	94	1.6	1.8	2.1

[1]1970 data from Hildebrand (1971).
[2]Ovulation rates from 1976-79 data only.
[3]The non-parous female in this sample had aborted (Hildebrand 1971).

Forty-eight percent of the 3½-year-old does was observed with fawns, in contrast with the 94% pregnancy and 1.4/doe fetal rates recorded for 2½-year-old does. None of the does in that group had twins. The fawn/doe ratio for 3½-year-old does represented a 65% fawn loss.

Fifty-nine percent of the 4½-year-old does was observed with fawns; none had twins. That contrasted with a 100% pregnancy rate and the fact that 3½-year-old does evidenced the highest fetal rate, 1.8/doe. The observed fawn/doe ratio represented a 68% fawn loss in the 4½-year-old age class. The high rate of fawn loss for this class, despite a higher rate of reproductive success, resulted from the high fetal rate in comparison with the lack of twin fawn litters.

Sixty-three percent of all does 5½-year-old and older was observed with fawns. This group included the only females seen with twins. Eighteen percent of the old does and 28% of those which successfully reared fawns were observed with twins. Those observations contrasted with a pregnancy rate of 94%, a fetal rate of 1.64/doe, and a potential of 64% twin fawn litters for 4+-year-old does. The rate of fawn loss was 51% for old does.

The reproductive performance of individuals during two or more successive years was determined from observations of 28 adult does, 2½-years-and-older (Table 17). The sample provided 39 cases of 2-year reproductive histories. Does successfully reared fawns only in alternate years in 23 (59%) of the cases. There were 9 (23%) cases of reproductive failure and 7 (18%) cases of reproductive success during two consecutive years. Generally, does which failed in consecutive years were younger animals while those which produced fawns in consecutive years were older.

Table 16. Reproductive performance of marked does by age-class.

Age-Class	1½	2½	3½	4½	5+	Total	2+
1976							
Number of does	3	3	2	5	6	19	16
Number of successful does	0	1	1	3	5	10	10
Percent success		33	50	60	83	53	63
Number fawns		1	1	3	7	12	12
ff/100 does		33	50	60	117	63	75
1977							
Number of does	13	5	8	2	17	45	32
Number of successful does	0	1	3	2	10	16	16
Percent success		20	38	100	59	36	50
Number fawns		1	3	2	15	21	21
ff/100 does		20	38	100	88	47	66
1978							
Number of does	14	18	10	8	11	61	47
Number of successful does	0	8	8	5	8	29	29
Percent success		44	80	63	73	48	62
Number fawns		8	8	5	10	31	31
ff/100 does		44	80	63	91	51	66
1979							
Number of does	16	15	11	7	28	77	61
Number of successful does	0	9	3	3	16	31	31
Percent success		60	27	43	57	40	51
Number fawns		9	3	3	18	33	33
ff/100 does		60	27	43	64	43	54
Total							
Number of does	46	41	31	22	62	202	156
Number of successful does	0	19	15	13	39	86	86
Percent success		46	48	59	63	43	55
Number fawns		19	15	13	50	97	97
ff/100 does		46	48	59	81	48	62

Table 17. Summary of reproductive histories for 28 individual marked does.

Deer No.	Estimated Age in 1976	Number of fawns in 1976	Number of fawns in 1977	Number of fawns in 1978	Number of fawns in 1979
4-76	5½		2	0	1
27-76	2½	0	0	1	1
29-76	5½	2	2		
36-76	3½	0	1		1
41-76	6½	1	1		
44-76	½[1]			1	0
49-76	4½	1	0		
50-76	5½	2	0		
51-76	2½		0	1	0
55-76	6½	1	1		1
60-76	4½	0	0	0	1
62-76	½[1]			1	0
69-76	6½	0	1	1	
75-76	4½	1	0	1	
79-76	2½		0	1	1
85-76	2½	0	0	0	
86-76	7½	0	2	1	
92-76	4½		0	1	
100-76	6½			2	0
107-76	5½			1	0
6-77	½[1]			0	0
25-77	½[1]			0	0
60-77	2½		1	0	0
27-78	2½			1	0
41-78	1½			1	0
48-78	½			0	0
56-78	1½			1	0
103-78	½			1	0

[1]Known-aged does.

Ten does provided 12 cases of 3-year histories. There were two cases of reproductive failure in three consecutive years. Five cases each of successful production in 1 of 3 and 2 of 3 years were recorded. In no case did a doe successfully rear young during three consecutive years.

Further evidence of alternate year production by Swan Valley white-tails was provided by the reproductive rates recorded for individual cohorts during consecutive years (Table 18). The most notable was the 1973 cohort, does that were 2½-years-old in 1976. The sum of success rates in any two consecutive years did not exceed 100%. Comparable data for older cohorts could not be tabulated because of errors in age determinations and small sample sizes.

Table 18. Percent reproductive success in consecutive years by individual cohorts.

Cohort	Year			
	1976	1977	1978	1979
1971	60	40		
1972	50	100		
1973	33	38	63	33
1974		20	80	43
1975			44	27

The net productivity of the Swan Valley population was less than its potential and the difference accrued from several sources. Fetal rates for all age classes were less than the species potential. Reproductive failures were typical during the first two breeding cycles. Although does in their second and third breeding cycles frequently conceived twins, the does did not successfully rear twins. Fetal rates declined in the older age classes. Although old does were more successful than younger does in rearing twins, only 11 of the potential 40 twin fawn litters were observed with the old does in the sample. Also, one-third of the old does failed to rear any fawns. Reproductive success only in alternate years was typical in all age classes.

Less than half of the conceived fawns was reared and recruited to the adult population. How this loss occurred was not defined; however, neonatal mortality, as a result of nutritive failure (Verme 1962), probably was an important factor. The strongest evidence for nutritive failure was the tendency for alternate year reproductive success. Verme (1967, 1969) described a situation in which reproductive failure, due to nutritive failure, by does on inadequate winter nutrition, contributed to reproductive success in the following year. Murphy and Coates (1966) indicated that the post-partum survival of fawns was reduced by low levels of protein in the diet of pregnant females. Salwasser et al. (1978) estimated 50-70% mule deer fawn mortality within 4 weeks of birth. They suggested that losses were related to the nutritional quality of deer habitats during the last trimester and lactation periods.

No major cause of fawn mortality was observed in the field and neonatal mortality would have been difficult to detect directly. Verme (1962) observed high survival among fawns which had survived the first 48 hours of live. O'Pezio (1978) observed fawn losses of 22% and 19% for does 2-years-old and 3-or-more-years-old, respectively, during the first 2 weeks of post-parturition. Fawn losses were negligible during the two month period thereafter. Mortality factors were not defined.

Verme (1977) suggested that the ratio of fawns to adult does, 2½-years and older, in the either sex harvest was correlated with estimated neonatal losses. He associated harvest ratios of 1.23 fawns/doe and 0.64 fawn/doe with neonatal mortality estimates of 10% and 50%, respectively. Harvest samples from the Swan Valley were too small to compare with his data. However, a ratio of 0.62 fawn/adult doe was observed with the composite sample of marked does. This was associated with an estimated 59% loss of potential fawns.

A relationship between productivity and age was suggested. Weights and body measurements of hunter-killed deer indicated that females did not attain physical maturity until they were four-year-olds (Table 5). Thus, does were sexually mature as yearlings, but they continued to grow through their third breeding cycle. Reproductive suppression in physically immature does was evidenced by reduced fetal rates for yearlings and 2½-year-olds and reduced rates of reproductive success for 2½- and 3½-year-old does. It therefore appeared that the immature doe was faced with a physiological predicament. Requirements are high for both growth and production and one must have occurred at the expense of the other. Verme (1962:21) stated that the physiological stress of the first pregnancy probably was proportionally greater than in pregnancies of older does. Robinette et al. (1973) indicated that fawn losses were heavier for primaparous, as compared with multiparous, mule deer does. Further, they suggested that mule deer females must ordinarily weigh 41 kg (90 lbs), or more, for successful breeding.

A relationship between winter severity and productivity was also suggested. A mild winter occurred in 1976 and an unusually mild winter occurred in 1977. During 1978, the yearling fetal rate was 1.3/doe, as compared with a rate of 1.1/doe for the remaining yearlings in the sample. Similarly, the fetal rate for 2½-years-old and older was 1.8 in 1978, as compared with 1.6 for the remaining animals. Further, net productivity by 2½- and 3½-year-olds, does in their first two breeding cycles, was substantially greater following the 1977 winter (Table 16). Julander et al. (1961) indicated that productivity of the youngest breeding age class reflects range condition more sensitively than that of the older age classes. That the youngest breeding class tends to be the most variable also might be inferred from other studies (Ransom 1967, Verme 1969, Hesselton and Jackson 1974). Verme (1977) indicated that neonatal fawn loss was a function of winter severity. Mackie et al. (1976) indicated that fawn production and survival of mule deer in the Bridger Mountains, Montana, was directly related to the extent to which deer were able to use all portions of the winter range and all forage resources. During the 1977 winter, white-tailed deer were widely dispersed and occupied areas that were peripheral to the usual winter distribution (Mundinger 1977).

The high rate of production recorded for 2½-year-old does during 1979, following the normal winter in 1978, was an apparent inconsistency. However, this cohort was reared by does which had experienced the 1976 winter. Moen (1978) indicated that the effect of an early spring on population dynamics would be most conspicuous when the subsequent fawn crop began to contribute their own fawns to the population. Further, these does were fawns during the 1977 winter. It seemed logical that this cohort experienced unusually good growth in response to the 1976 and 1977 winters. That, in turn, was reflected in the productivity by this cohort during 1978-79.

Alternate year reproductive success was characteristic of the population. Thus, reproductive success by older does was less responsive to the mild winters, however, twinning rates may have been an indicator of range conditions. The highest twinning index was recorded in 1977. Twinning by older does was comparatively high in 1973 (Table 16), though this was not reflected by the twinning index that year because a large number of single fawn litters had been reared by 2½- and 3½-year-old does. The twinning index was lowest in 1979. That year the index reflected a disproportionately large number of single fawn litters produced by 2½-year-olds and a low rate of twinning by old does. The 1976 twinning index was not consistent with observed productibity for old does that year. That may have resulted because the sample of marked does was small in 1976.

It was hypothesized that the observed patterns of reproduction were mechanisms which operated to maintain stable levels of fawn production in the Swan Valley herd. Production operated together with other population phenomena to maintain population stability.

Annual variation in total fawn recruitment was largely a function of the reproductive success rate of young does and the population age structure. With a normal age distribution, yearlings comprised the single largest group of sexually mature females, and that group contributed substantially to the potential annual increment. Data presented by Severinghaus and Cheatum (1956:101) indicated that more than 40% of the anticipated fawn crop in western New York was produced by yearlings. Yet, the ability to conceive fawns did not necessarily indicate an ability to successfully rear them. Reproductive success by 2½-year-old does in the Swan Valley was low and variable. The value of the potential production by that age class varied accordingly.

The rate of reproductive success tended to be fixed for 3+ -year-old does because fluctuations were dampened by alternate year production. Variations in the data were probably artifacts of sample size. Because success rates tended to be fixed, contributions of prime-aged does to the annual increment varied more with the strength of the individual cohorts.

Potential production declined with increasing age because the size of those cohorts declines. The disparity between potential and net production was lowest in the old age classes. Annual variation in the contribution by old does occurred because of fluctuations in the twinning rate, rather than from fluctuations in reproductive success. Moreover, alternate year production was less rigid in the older age classes. Therefore, the contribution by old does to the annual increment was proportionally greater than the number of these animals in the population and may have been essential during poor production years and periods of population decline.

Despite the tendency for population stability, the population retained the potential for rapid growth when young animals were producing. A year which favored recruitment will have its greatest influence on 2½-year-old does. Production by 3½-year-olds will also be favored because most of these animals had failed the previous year. Such was the case during 1977-78, a year which followed an unusually mild winter. During 1978, the reproductive success rates doubled for 2½- and 3½-year-old does (Table 16) and the estimated recruitment rate increased, as compared with 1977 (Table 9).

As the population increased, further increases occurred with greater difficulty. This must have occurred because of increases in the percentages of yearlings, which did not rear young, and 2½-year-olds, which reared young at a reduced rate. Also, success rates of 3½- and 4½-year-old does, which had reared young at an above-average rate the previous year, will decline due to alternate year production. Thus, during 1978-79 success rates declined by 66% and 32%, respectively, for these age-classes (Table 16) and the recruitment rate for the population also decreased (Table 9). Recruitment actually was higher during 1978-79 than previously was anticipated because the high rate of reproductive success by 2½-year-olds was not expected. Mackie (1978) indicated that the rate of increase in two different mule deer populations was progressively damped because the proportion of fawns lost to attrition increased as fawn crops increased.

It was noteworthy that similar recruitment rates were observed in all years except in 1977-78. Verme (1962) indicated that a large residual herd needed very little net population increment to perpetuate itself. Despite a 59% loss of potential production, an average recruitment rate of 29% was recorded. That rate appeared to provide adequate numbers of young to replace annual attrition. The population appeared to be capable of achieving 29% recruitment through a variety of strategies.

Survival of Marked Deer

Four hundred and eleven white-tailed deer have been captured and marked for individual recognition during the four winters of this study. Of those, 129 were known to be alive at the time of spring dispersal in 1979. Numbers of known survivors within the yearly samples are presented, by year, in Table 19.

Sixty marked deer have been known mortalities. They included 24 hunting losses. 19 roadkills, 5 winterkills, and 7 from other causes (Table 20).

Table 19. Number of known survivors within yearly samples of marked deer.

Sample Year	Sample Size	1976	1977	1978	1979
1976	115	85	56	30	16
1977	69		39	22	13
1978	118			92	44
1979	109				56

Table 20. Known mortalities of marked white-tailed deer.

Year	Sample	Hunting	Road-kill	Winter-kill	Coyote-kill	Other
1976	1976	5	1	1	1	1
1977	1976	9	2	2		1
	1977	2	2	1	1	1
1978	1976		3			
	1977	3	3		1	
	1978	5	3		2	2
1979	1976		1			1
	1977		1			
	1978					
	1979		3	1		1
	TOTAL	24	19	5	5	7

The fate of 222 deer had not been determined by spring 1979 (Table 21). The group included animals which had lost collars and undetected mortalities. Certain deer may have been captured while they were occupying transitional range and intensive observations may not have been made within their respective definitive winter home ranges. The sample included 44 deer that were not observed in one or more winters and subsequently were either observed or known mortalities. Two extreme cases were a male fawn and an adult female that were marked in 1976 and first observed in 1979.

Annual survival and mortality rates were determined from numbers of known survivors and known mortalities within individual cohorts (Tables 22 and 23). Those rates suggested that survival varied between individual cohorts within a sex class.

Table 21. Number of marked deer, within yearly samples, for which the fate is unknown.

Sample Year	Sample Size	Year of Last Observation: Never	1976	1977	1978	Total
1976	115	27	19	13	12	71
1977	69	26		11	4	41
1978	118	19			43	62
1979	109	48				48

Table 22. Annual survival and annual mortality rates of marked female cohorts.

Cohort	% Known Survival by Year				% Known Mortality by Year				Age at 1 June 79
	1976	1977	1978	1979	1976	1977	1978	1979	
1974	70	77	70	71	0	15	10	14	6
1975	78	83	50	25	11	8	17	0	5
1976	78	77	59	48	6	0	15	4	4
1977	--	76	71	67	--	0	4	4	3
1978	--	--	78	64	--	--	9	0	2
1979	--	--	--	61	--	--	--	9	1

Table 23. Annual survival and annual mortality rates of marked male cohorts.

Cohort	% Known Survival by Year				% Known Mortality by Year				Age at 1 June 79
	1976	1977	1978	1979	1976	1977	1978	1979	
1975	40	33	80	25	0	33	20	25	5
1976	77	43	50	17	5	19	40	17	4
1977	--	43	57	22	--	0	7	33	3
1978	--	--	86	35	--	--	7	6	2
1979	--	--	--	52	--	--	--	4	1

Average annual survival and mortality rates also were determined by age class (Tables 24, 25, and 26). Samples of marked females were sufficient to determine survival rates through several years. Certain inconsistencies occurred in these data that were artifacts of pooled samples. For example, the data indicated that fewer 2½-year-old females survived through 5 years than the number that survived through 6 years (Table 24). Also, the annual survival rate of 4+-year-old females was 64%. Yet, annual survival rates of 74%, 73%, and 70% may be inferred from the 2, 3, and 4 year survival rates, respectively (Table 26).

Table 24 . Longevity of marked females by age-class.

Age-Class	% known survival to age-class:						% known mortality to age-class:					
	1	2	3	4	5	6	1	2	3	4	5	6
½	73	62	40	17			6	7	14	22		
1½		71	49	16	0			2	12	26	56	
2½			67	33	27	40			8	18	23	10
3½				55	26	32				11	19	26
4½					45						5	
5½						71						14

Table 25. Annual survival and mortality of marked males by age-class.

	Age-Class				
	½	1½	2½	3½	4½
% known survival	67	42	36	45	25
% known mortality	4	10	36	18	25

Table 26. Annual survival and mortality rate for marked 4+-year-old females.

	Years			
	1	2	3	4
% known survival	64	55	39	24
% known mortality	8	14	20	21

A computer similation model of the population (Mooney and Lonner 1978) was developed (Table 27) for comparing simulated with observed survival in the Swan population. The model assumed age-specific recruitment rates (Table 16), and attempted to determine the minimum number of females, their age-structures, and corresponding survival rates of the female segment necessary to generate a stable population.

Table 27. Sex and age structure of a simulated, stable population of 1,000 white-tailed deer.

Age-Class	Females	Survival	Males	Survival
1	148	1.0	132	1.0
2	115	0.78	92	0.70
3	96	0.83	57	0.62
4	77	0.80	36	0.62
5	57	0.75	22	0.62
6	41	0.71	13	0.60
7	28	0.68	8	0.60
8	19	0.68	5	0.60
9	13	0.68	3	0.60
10+	34	0.65	4	0.59

The simulation followed the biological year. The simulated population represented those animals present at the end of the year after all mortality had occurred and immediately prior to births and aging. Within the simulation, recruitment rates were used in place of births. Because recruitment presupposed all fawn mortality, it was necessary to assume 100% survival for this age class.

Since the sex ratio of the adult population in the Swan Valley was unknown, this parameter was not assumed in the simulation. Rather, male survival was adjusted until the adult male population was also stable. The simulation probably overestimated the population of adult males. If that were the case, survival rates of both sexes would be less than those indicated in the simulation.

Preliminary estimates of population life tables were constructed from average annual survival and mortality rates and the simulated population (Fig. 2a and 2c). The estimate derived from simulation for both sexes was artificially high in comparison with the estimates derived from known survival and mortality because no fawn mortality was assumed in the simulation. An additional life table was constructed for females (Fig. 2b). That curve represented the highest possible survival that could be derived for individual age classes from the various observed survival rates (Tables 22, 24, and 26).

Life tables derived from survival and mortality rates should have been similar. That a large disparity between these estimates occurred was the result of unaccounted animals in the sample. The life tables derived from simulation represented a first approximation to the resolution of this disparity.

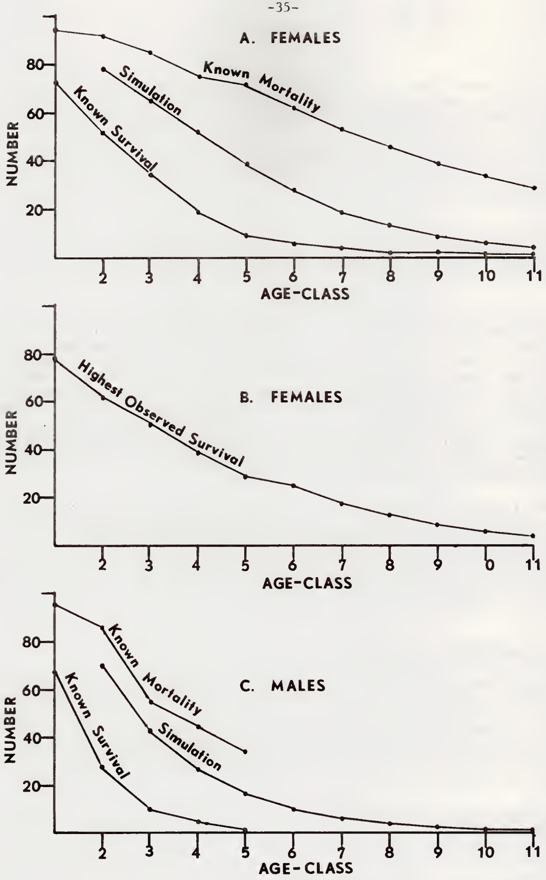

Figure 2. Life tables of the Swan Valley white-tailed deer population.

The life tables indicated that male mortality was higher than that of females. The number of males declined rapidly through the first 4 years and few males older than 5 years remained in this population. Consistent with this conclusion, 4+-year-old males were poorly represented in the hunting season, trapping and roadkill samples (Tables 6, 11 and 12). Mackie, et al. (1978) indicated that male mule deer on the Armstrong range had a life expectancy of 7-8 years and that mortality was relatively high among fawns, light to moderate amont adults, and heavy among old males.

Female mortality rates were lower when compared to males and they were more uniform through all age classes. The mortality pattern for females was also similar to that of mule deer on the Armstrong range (Mackie, et al. 1978).

An important consequence of low and uniform mortality was that 5+-year-old females comprised a substantial proportion of the population, 28% of the females in the simulated population and 31% of those females depicted in Figure 2b. That age-group was well represented in the hunting season, road-kill, and trapping sample (Tables 6, 11 and 12). Distribution of that age group was an important aspect of population dynamics. Old does evidenced a higher recruitment rate than that of younger females (Table 16). Recruitment by old does was less variable, and therefore would be somewhat predictable. Within the simulated population, 54% of the expected recruitment would be produced by old does, while that age-group in simulated population would produce 55% of the expected recruitment.

Mackie (1978) hypothesized in the natural population regulation of mule deer, that high density populations occurred in complex habitats and were characterized by low and stable annual turnover and recruitment. Those relationships also appeared to describe the white-tailed deer population in the Swan Valley. Observed recruitment patterns and the life table estimates there were indicative of a stable population. They were also phenomena which operated to maintain population stability.

Winter Distribution and Range Use

The upper Swan Valley white-tailed deer winter range extends from Goat Creek south approximately 12 miles to Condon Creek, and from the western flood plain of the Swan River east approximately 1.5 miles. From that boundary, narrow extensions occur westerly into Woodward, Cedar, and Cold Creeks, easterly into Squeezer, Lion, Pony, Dog, and Smith Creeks, and southerly to Condon along the river. Isolated wintering areas, associated with either the Swan River or its tributaries, also occur south of Condon.

The winter range is a mature sub-climax forest and six dominant habitat types (H.T.)(Pfister et al. 1977) occur. The *Picea/Clintonia uniflora* H.T. occurs along the bottoms of the Swan River and its tributaries, and adjacent to potholes and marshes. This type is replaced by the *Thuja plicata/Clintonia uniflora* H.T. on certain moist sites, especially in Squeezer Creek. The *Pseudotsuga menziesii/Symphoricarpos albus* and *Pseudotsuga menziesii/Calamagrostis rubescens* H.T.s occur on warm, dry upland sites. The *Abies grandis/Clintonia uniflora* and *Abies lasiocarpa/Clintonia uniflora* H.T.s occur on cool, moist upland sites.

Forested uplands are mixed communities. Douglas fir *(Pseudotsuga menziesii)* in various combinations with western larch *(Larix occidentalis)*, lodgepole pine *(Pinus contorta)*, and ponderosa pine *(Pinus ponderosa)* dominate. These species are important components of seral communities within the major upland habitat types. Grand fir *(Abies grandis)* and sub-alpine fir *(Abies lasiocarpa)* are the indicated climax species on certain upland sites, but they are poorly represented. Spruce *(Picea* spp.) or western red cedar *(Thuja plicata)* dominate mixed communities on mesic sites.

Fire seems to have had an important influence within the entire Swan Valley and on the winter range. Lightening-caused fire is a normal occurence. Evidences of previous fires included even-aged stands of lodgepole pine, dense thickets of Douglas fir, charcoal, and scars on mature trees of several species. Fires probably occurred often and fuels would not have accumulated. Present pure lodgepole pine stands and Douglas fir thickets resulted from small, hot fires. Burns, that presently are occupied by mixed communities, were low-intensity ground fires. Fire seems to have perpetuated the sub-climax condition more so than it initiated secondary succession. Ground fire-suppressed regeneration of all species prevented establishment of fire-sensitive grand fir and sub-alpine fir, and favored fire-resistent Douglas fir, lodgepole pine, ponderosa pine, and western larch. Within the grand fir forests of the Swan Vahley, "A mosaic of various aged, fire induced seral communities is the natural mode of the vegetation" (Antos 1977:203). Singer (1975) reported that most of his study area in the North Fork Flathead River was subjected to repeated fires. In that area, ground fires were characteristic in Douglas fir stands, crown fires were characteristic of other coniferous stands, and fire was largely excluded in wet spruce stands. Arno (1976) indicated that fires frequently occurred on the Bitterroot National Forest and that substantial amounts of forest survived most fires.

The upland topography is an interspersion of ridges, knobs, benches, and draws. Therefore, distinguishable areas of uniform habitat type generally were small. Ecotones, in which more than one climax is indicated in the overstory, understory, or both, frequently occurred. Larger areas of otherwise uniform habitat type contained many small inclusions. Cover type and habitat type boundaries often did not coincide, perhaps as a result of fire. Stands of uniform habitat type often included more than one cover type. More frequently, stands of uniform cover type included two or more habitat types.

The winter range contained central mesic areas: the adjacent riparian zone was ecotonal and the associated upland was a timbered mosaic. This was a diverse habitat. Interspersion characterized the riparian and upland communities and the relationship between these communities.

Distinct deer concentrations occurred in proximity to mesic areas. This was evidenced by frequent observations of deer in riparian habitat. Heavily used trails occurred in such areas and these trails followed obvious topographic features. For example, two major trails were parallel to and east of the Swan River through the length of the winter range. They occurred in the floodplain near the river and at the edge between riparian and upland habitats. Frequent bed sites, normally in the snow-wells of large trees, were encountered near these trails. Ozoga (1968) reported that, in the Petral Grade deeryard in northern Michigan, deer activity was closely associated with the mature swamp conifers. That stand provided a uniform microclimate and the most effective protection against body heat loss. Cedar swamps also were important components of wintering areas in east central Minnesota (Rongstad and Tester, 1969). Kearney and Gilbert (1976) indicated that the winter distribution of white-tailed deer on the Himsworth Game Preserve, Ontario, was related to shelter factors and that the mixed and coniferous habitat types supported the highest deer densities.

Deer consistently used the timbered uplands in the Swan Valley but that use was dispersed. Frequent secondary trails occurred, they originated from major trails in riparian areas. Minor trails and tracks of individuals radiated from the secondary trails.

Coniferous cover was an integral component of upland habitat. Similarly, Singer (1975) indicated that white-tailed deer used areas that were stable or intermediate with respect to fire. They used habitats modified by ground fire in which a conifer canopy remained and small seral habitats resulting from crown fire.

Use of clearcuts and natural openings was minor in all winters except 1977. During that mild winter, deer used clearcuts peripheral to the normal winter distribution (Mundinger 1977). In other winters, use of large openings was restricted either to the margins or to a single trail with no radiating trails or tracks, that crossed the opening.

The winter range was occupied yearlong by some deer, but their summer and winter ranges probably did not coincide. Two radio-collared does summered within the winter range at locations other than their respective wintering areas. Other deer move to the winter range during late November - mid-January.

Two types of movements were observed. Radio-collared does either moved directly to their respective wintering areas or they moved to an intermediate area within or peripheral to the winter range, and from thence to their respective wintering areas. Additional movements within wintering areas also were observed. Those appeared to be gradual reductions in the individual's cruising radius, such that individuals occupied definitive home ranges or areas of most confinement only in late winter-early spring.

Five radio-collared does were followed during three consecutive winters. Two of those, #27-76 and #36-76 (Fig. 3), occupied intermediate areas within the winter range throughout the 1976 and 1977 winters. In 1978 they both occupied respective intermediate ranges during early winter, moved to definitive home ranges in midwinter, and returned to the intermediate ranges prior to departing for the summer.

Deer #60-76 (Fig. 4) used an intermediate range, peripheral to the winter range, in late fall-early winter and again each spring. She occupied the same winter area each year. In 1977 whe used the entire 280 acres. When confined, she used 148 acres of that area in 1976, and 119 acres in 1978.

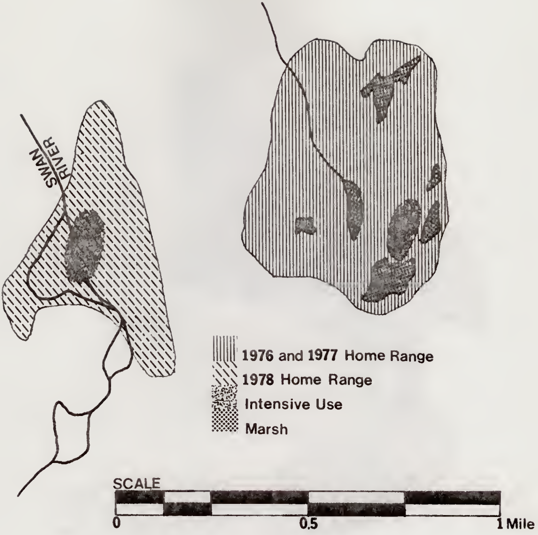

Figure 3. Winter home range of deer 36-76.

Deer #4-76 (Fig. 5) did not use an intermediate range and occupied the same winter area each year. She used the entire 230 acres in 1977. That area included two different confinement areas, 156 and 47 acres, which were used in 1976 and 1978, respectively.

Deer #25-77 (Fig. 6) occupied a 115-acre winter home range during 1977. Subsequently, that area was not used in any season. In 1978 and 1979 she occupied a 95-acre area that was near, but distinct from her 1977 winter home range. Her summer range was less than 2 miles downriver from her difinitive winter range. In 1978 and 1979 her return movements were gradual.

Ten radio-collared does were followed during two consecutive winters. Deer #4-77 was a 1976-77 fawn of #4-76. Her 1978 and 1979 home ranges were similar to the 1978 and 1976 home ranges, respectively, of deer #4-76 (Fig. 5).

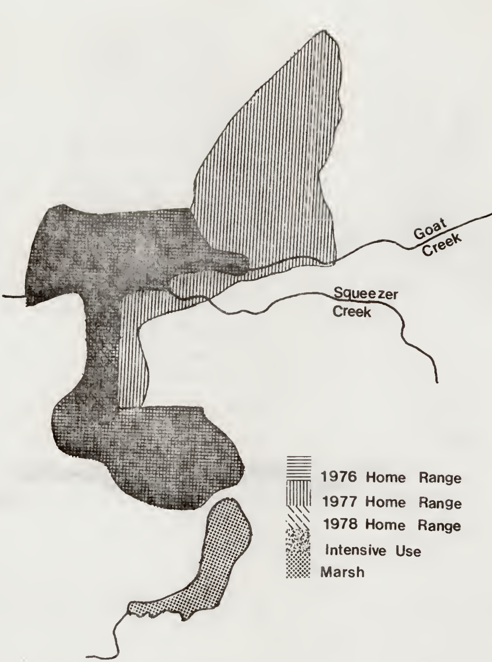

Figure 4. Winter home range of deer 60-76.

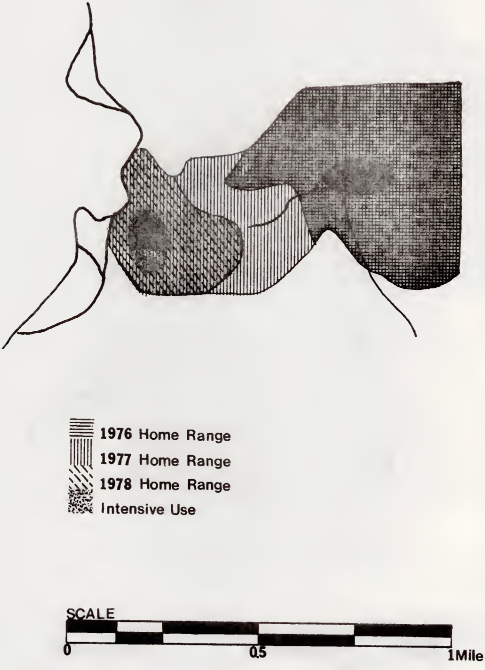

Figure 5. Winter home range of deer 4-76.

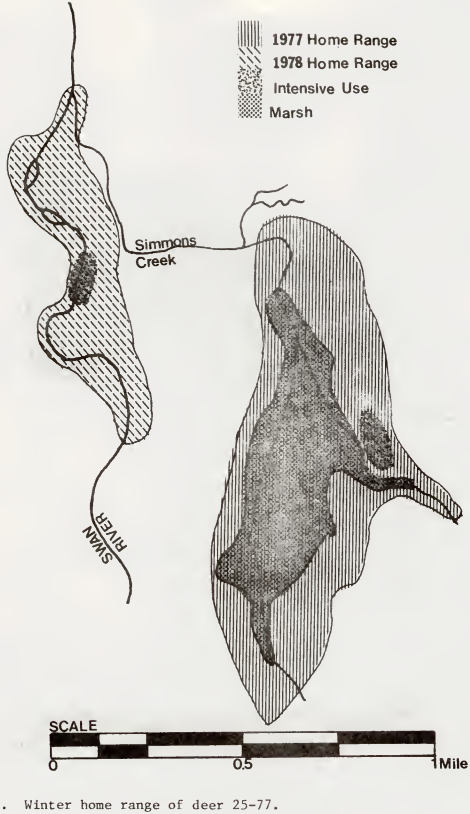

Figure 6. Winter home range of deer 25-77.

Deer #50-75 wintered near Goat Creek and was monitored in 1976 and 1977. Those years her winter ranges were similar to those of deer #60-76 (Fig. 4).

Deer #23-77 wintered along Pony Creek. She used similar areas, approximately 128 acres, in 1977 and 1978.

Deer #56-77 wintered along Alder Creek in 1977 and near Squeezer Creek in 1978. The Alder Creek location was peripheral to the winter range. She used this as an intermediate range in spring and fall 1977 and spring 1978.

Deer #39-78 wintered near Cedar Creek in 1978. In spring 1978 she used an intermediate range near Simmons Meadow. She returned to Simmons Meadow in fall 1978 and remained there for the 1979 winter.

Deer #41-78 wintered near the confluence of Goat and Squeezer Creeks in 1978 and 1979. She used an intermediate area along Goat Creek in Spring 1978 and 1979. In fall 1978 she first returned to that intermediate range, then gradually moved down Goat Creek and occupied her definitive winter range by mid-February.

Deer #48-78 (Fig. 7) apparently used two winter home ranges in 1978 and 1979. Through February in both years, whe was found either near the confluence of Goat Creek with the Swan River or near a large pothole that flowed into Simmons Creek. She used the pothole area more consistently in late winter through early spring.

Deer #56-78 (Fig. 8) wintered along Dog Creek in 1978 and 1979. Her 1979 winter home range overlapped only a portion of that area used in 1978. She used an active timber sale in 1978. That area attracted an unusual concentration of deer in 1978, compared with deer use in 1976 and 1977, while few deer used that area in 1979.

Deer #26-78 used similar winter home ranges in Cedar Creek in 1978 and 1979. Deer #63-78 also used similar winter home ranges along Pony Creek in both years.

A consistent range use pattern was apparent for all radio-collard does. Definitive winter home ranges were less than 160 acres. Each deer used an activity center(s) within riparian habitat. The activity center was a comparatively small portion of the home range, yet each deer spent most of its time there. Gladfelter (1978) reported that white-tailed deer in Iowa used winter home ranges of 100-370 acres and that activity centers comprised less than 15% of the home range. Rongstad and Tester (1969) reported winter home ranges of 400-1,200 acres and indicated that deer concentrated their use in a small portion of their home range.

Each deer also used additional riparian habitat and a comparatively large area of upland habitat accessible from the riparian area. Riparian areas were used for resting and security; uplands were used for foraging. As winter progressed, the cruising radius of each deer gradually was reduced, that occurred as a reduction in the amount of upland area used. This phenomenon was not observed during the mild 1977 winter. Rongstad and Tester

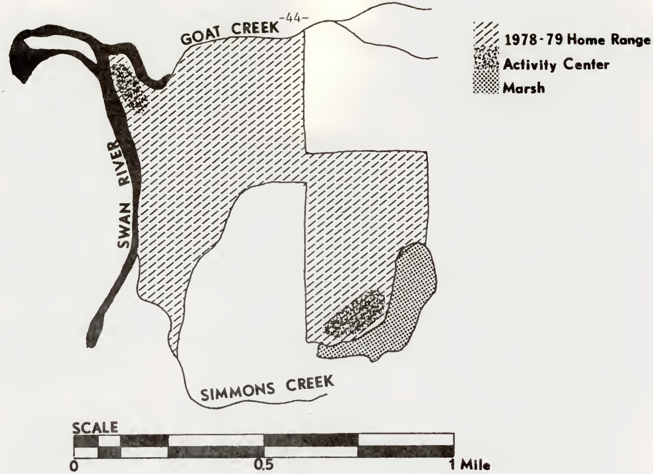

Figure 7. Winter home range of deer 48-78.

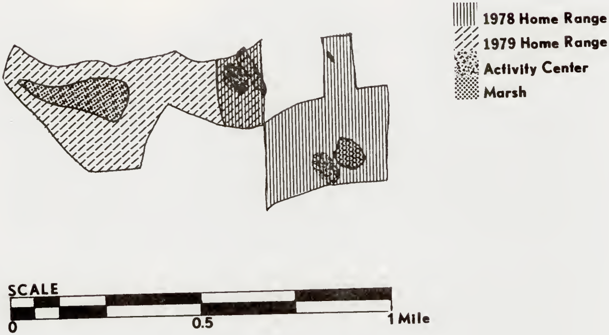

Figure 8. Winter home range of deer 56-78.

(1969) reported that with increased snow depths, deer remained in the cedar swamps, upland foraging stopped, and home ranges decreased. Drolet (1976) reported an inverse relationship between home range size and snow depth.

Loveless (1967) suggested that mule deer move about within their winter habitat to seek the most comfortable temperature zones. Ozoga (1968) demonstrated microclimatic variation within the Petral Grade deeryard. In that area, mature swamp conifers provided the warmest average temperatures, the most stable microclimate, and snow conditions were the most amenable to travel. Moen (1968) demonstrated that under clear night skies, deer experienced greater radiant heat loss in an open field than under a cedar canopy. Drolet (1976) indicated that a dense forest of conifers and mixed woods provided more protection against adverse weather than open mixed and hardwood forest. Presumably, timbered riparian areas in the Swan Valley provided the most comfortable microclimate.

Animals which wintered in the upper Swan Valley and at Salmon Lake were different herd units within the same overall population. Apparently deer in this population were capable of seeking out ameliorating microclimates in physiographically dissimilar situations. The Salmon Lake winter range has greater topographic relief than the Swan Valley and is typified by open canopy forest habitat types within the *Pinus ponderosa* and *Pseudotsuga menziesii* series. High deer use occurred on ridges and slopes that were first to be free of snow. Those areas also provided sites for sunning (Janke 1977).

Food Habits

White-tailed deer food habits were determined by rumen analysis. Analysis of fall and winter samples, 1976-78 was presented previously (Mundinger 1978). Analysis of the 1979 sample has not been completed.

Deciduous browse was the predominant item in fall rumen samples. Oregon grape *(Berberis repens)* was the single most important species. Serviceberry *(Amelanchier alnifolia)* and snowberry *(Symphoricapos albus)* were also important. Use of conifer browse was minor in fall. Greater use of forbs occurred in fall as compared with winter and spring samples. Bunchberry dogwood *(Cornus canadensis)* and twin-flower *(Linnaea boralis)* were important forbs.

Deciduous browse was the predominant item during winter 1976 and 1977, Oregon grape was the major species. A variety of species, notably serviceberry, kinikinnik *(Arctostaphylos uva-usi)*, evergreen ceanothus *(Ceanothus oclutinus)*, and willow *(Salix* spp.), received minor use. Use of conifers, particularly Douglas fir and common juniper *(Juniperis communis)*, increased relative to fall use. Conifers predominated in the winter 1978 diet. Douglas fir was the most important species. Common juniper, spruce and lodgepole pine were used consistently that winter. Tree-moss *(Allectoria* spp.) probably was important every winter, but its importance was difficult to determine by rumen analysis.

Deciduous browse again predominated in the spring diet. The greatest use of Oregon grape occurred in that season. Other important deciduous species included serviceberry, kinikinnik, and Myrtle pachistima *(Pachistima myrsinites)*. Common juniper and Douglas fir were important conifers, but the use of conifers decreased in the spring diet, as compared to use during winter. The use of forbs increased, relative to the winter diet, but forbs were less important than in the fall. Twin-flower and bear grass *(Xerophyllum tenax)* were the prominant species.

Winter food habits during 1976-78 generally were consistent with those reported for 1957 (Weckwerth 1958) and 1970 (Hildebrand 1971). Species composition in the diet was similar, except for thelact of snowbrush ceanothus in the 1957 samples. A greater percentage of Oregon grape occurred in the 1976 and 1977 samples than in those from 1957 and 1970. Bergeson (1943) indicated that the majority of food consumed was Douglas fir and tree-moss. Use of willow, mountain maple *(Acer glabrum)*, serviceberry, ceanothus (*Ceanothus* sp.), and common juniper was also indicated. Oregon grape, huckleberry *(Vaccinium* spp.), and kinikinnik also were used furing periods of reduced snow cover. Present data were consistent with these observations.

White-tailed deer winter food habits generally were similar to those reported for the Fisher River-Wolf Creek winter range (Firebaugh 1970; Flath 1971, 1972). In both areas, Oregon grape and Douglas fir were prominant items and the use of Douglas fir increased with decreasing availability (due to snow) of Oregon grape. A variety of deciduous species was used as minor items.

Grasses were the predominant item in the winter diet of white-tailed deer at Salmon Lake (Janke 1977). Oregon grape and Douglas fir were consistently used, but in lesser quantities than in either the Swan or the Fisher River-Wolf Creek areas. Serviceberry was used to a greater extent at Salmon Lake.

Movements

Nine radio-equipped deer were followed in 1976. Nine deer, four of which were included in the 1976 sample, were followed in 1977. The 1978 sample included 19 deer, of which four were in the 1976 sample and three were in the 1977 sample. During 1979, 17 deer were followed. This was comprised of 1 deer from the 1977 sample, 7 from the 1978 sample, and 9 deer which were collared in 1979. Distributional histories of deer radioed in 1976, 1977 and 1978 were described by Mundinger (1978). Movements through the summer of 1979 are summarized in Figures 9-15.

Among deer equipped with transmitters in 1979, deer #93-78 (deer a in Fig. 16) was captured, as a fawn, in Dog Creek in February 1978. She was recaptured and equipped with a radio in February 1979. She remained in Dog Creek through early April. Thereafter, she occupied her summer range near the Swan River, approximately 11 miles south of Dog Creek.

Deer #37-79 (deer b in Fig. 16), a 2½-year-old female, was captured in Dog Creek in early February 1979. She remained in Dog Creek through early April, had moved to McKay Creek by late April and to Lindbergh Lake by late May. She then summered at Lindbergh Lake approximately 15 miles south of her wintering area.

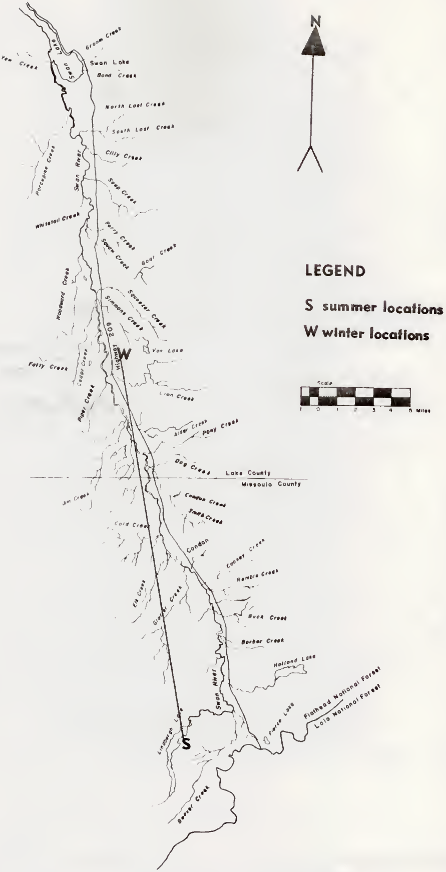

Figure 9. Movements of deer 4-76, as determined from 1976, 1977 and 1978 relocations.

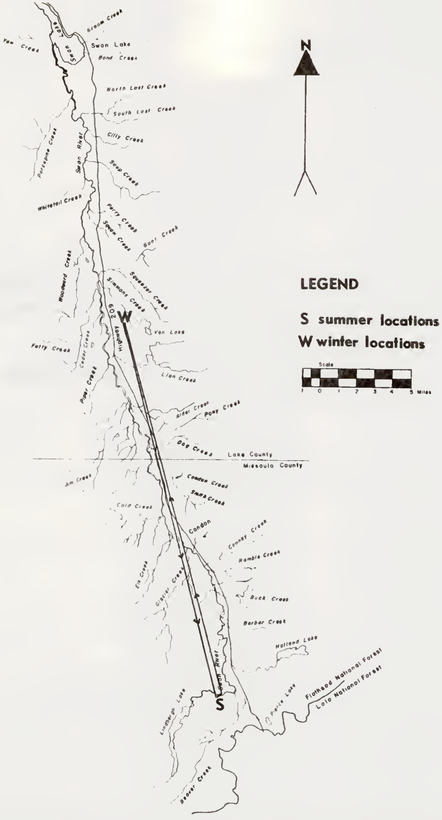

Figure 10. Movements of deer 27-76, as determined from 1976, 1977, and 1978 relocations.

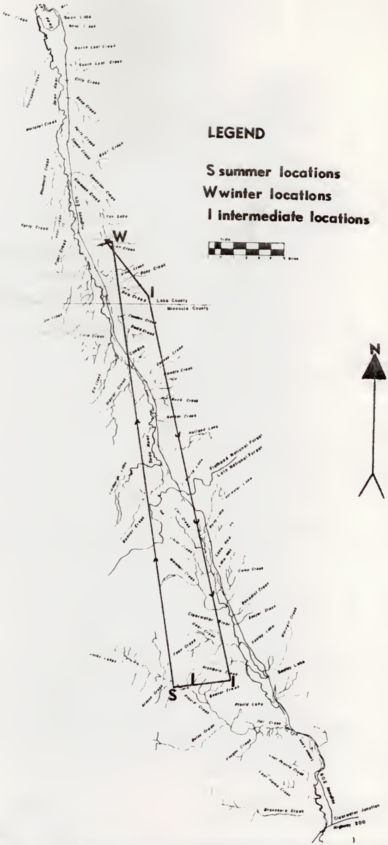

Figure 11. Movements of deer 36-76, as determined from 1976, 1977, and 1978 relocations.

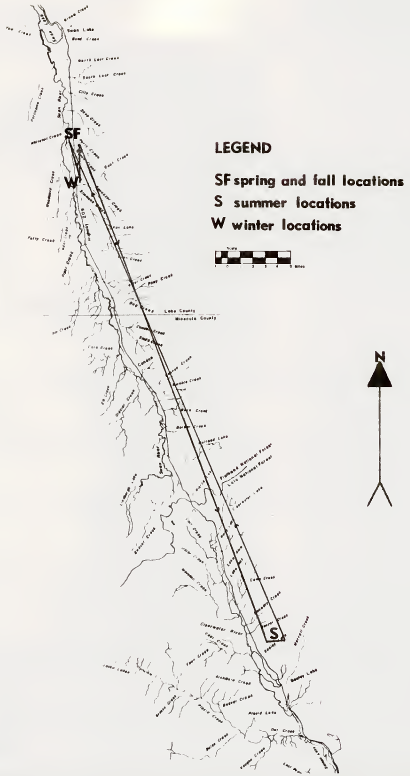

Figure 12. Movements of deer 60-76, as determined from 1976 and 1977 relocations.

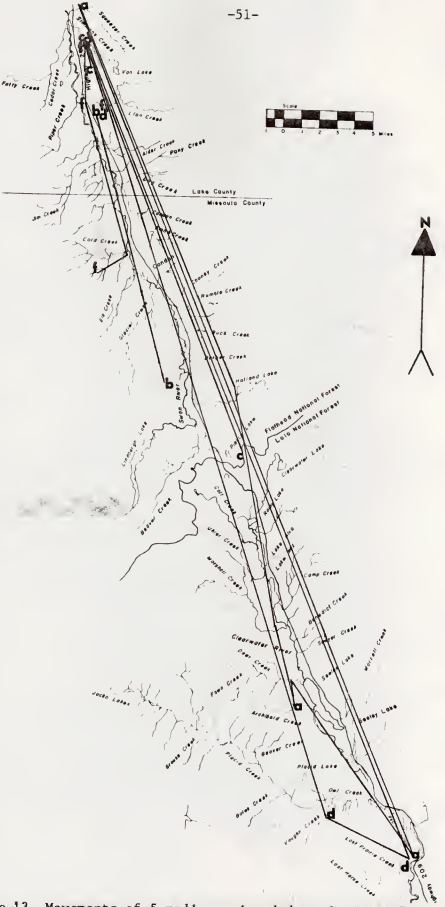

Figure 13. Movements of 5 radio-equipped deer during 1976.

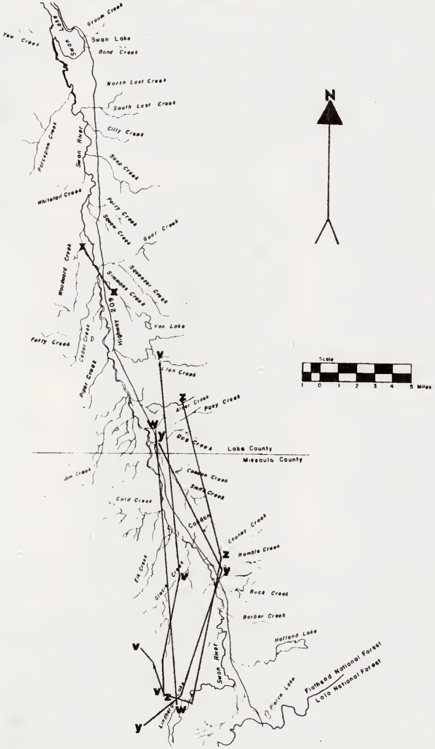

Figure 14. Movements of 5 radio-equipped deer during 1977.

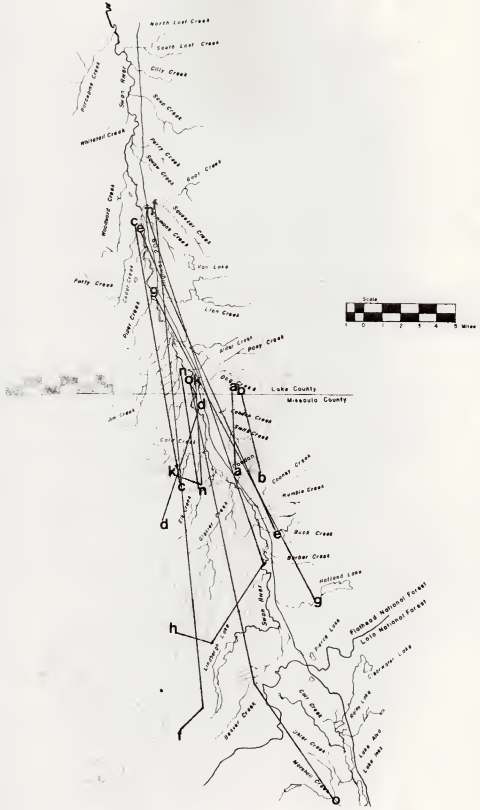

Figure 15. Movements of 11 radio-equipped deer during 1978.

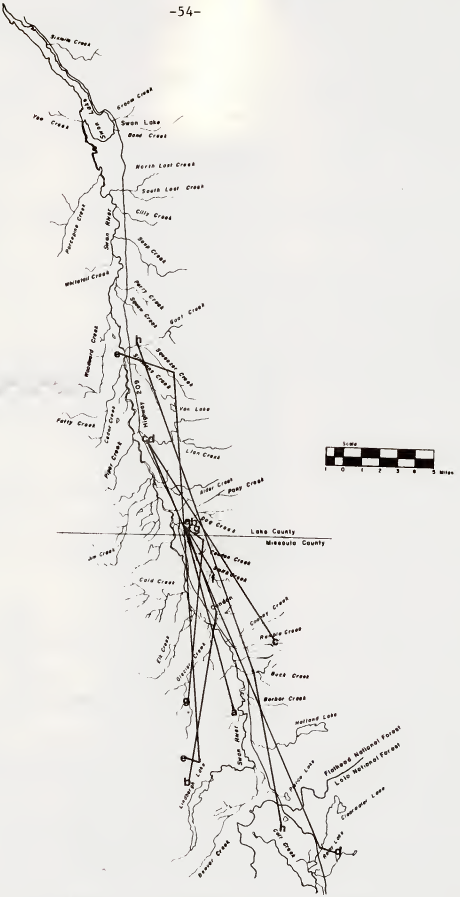

Figure 16. Movements of 8 radio-equipped deer during 1979.

Deer #55-79, (deer c in Fig. 16), a 3½-year-old female, was captured in Lion Creek in mid-February. She remained in the vicinity of her wintering area through mid-April. She occupied her summer range, in the North Fork of Rumble Creek by late April. Fourteen miles separated her winter and summer ranges.

Deer #74-79 (deer d in Fig. 16), a 3½-year-old female, was captured in Lion Creek in late February. She remained in Lion Creek through mid-April, moved to Rainy Lake in late April, and occupied her summer range in Richmond Creek by early May. She moved approximately 25 miles.

Deer #79-79 (deer e in Fig. 16), a 2½-year-old female, was captured in Cedar Creek in late February. She remained in Cedar Creek through March, then occupied an intermediate range approximately 3 miles east in Squeezer Creek. She occupied her summering area, approximately 23 miles south of Cedar Creek, by mid-May. She apparently used two summer activity centers. One was north of Lindbergh Lake and the other in Glacier Sloughs, 1.5 miles northwest of the first.

Deer #87-79 (deer f in Fig. 16), a yearling female, was captured in Dog Creek in late February. She remained there through early April and then moved three miles south to Smith Creek for the summer.

Deer #91-79 (deer g in Fig. 16), a 3½-year-old female, was captured in Dog Creek in early March. During March and April, she was found either near the trap site or in Condon Creek, 1.5 miles southeast. Sheleft the winter range in late April and occupied her summer range in Kraft Creek in early May. Eleven miles separated her winter and summer areas. During May-mid-June, she cruised between Kraft, Hemlock and Windfall Creeks, an area larger than one square mile. By late June, she was settled in Kraft Creek.

Deer #103-79 (deer h in Fig. 16), a 2½-year-old female, was captured in Goat Creek in early March. She remained in Goat Creek through early May. In mid-May, she was found once in Buck Creek. Thereafter, she occupied her summer range near Summit Lake, approximately 28 miles south of Goat Creek.

Deer #102-79, a 2½-year-old female, was captured in Lion Creek in early March. She remained there through April. An indefinite location in lower Glacier Creek was obtained in early May. Thereafter, the transmitter failed.

Each radio-collared deer used recognizable summer and winter ranges, and each was faithful to those areas. Certain deer also occupied distinguishable intermediate ranges during spring, and in several instances, the intermediate ranges were occupied again in the fall. Other deer apparently were able to satisfy their spring and fall range requirements within their winter and summer home ranges. Deer moved directly between seasonal ranges or between seasonal and intermediate ranges. Rongstad and Tester (1969) also observed direct movements from winter to summer ranges.

The average straight-line distance between winter and summer home ranges was 19 miles (s.e.=.32), and ranged from 3-44 miles. Gladfelter (1978) reported average movements of 14 miles and a range of 0-44 miles.

Mass migration did not occur. Rather, white-tailed deer behaved as individuals in their movements. Deer which wintered in close proximity often summered in distinctly different areas, and the converse also was true. The timing of movements occurred as individual events, such that certain deer left the winter range at the onset of spring, while others remained longer. Deer also were consistent in this behavior. Mackie and Knowles (1977) indicated that mule deer in the Bridger Mountains moved as individuals between seasonal ranges.

Summer Distribution and Range Use

White-tailed deer summered throughout the Swan Valley at low to mid-elevations. The majority of deer that wintered in the upper Swan summered between Condon and the Swan-Clearwater divide, south of the winter range. Movements of marked deer indicated that lesser numbers summered in the Clearwater River drainage. Summer distribution overlaped that of deer which disperse from the Salmon Lake Winter Range (Janke 1977).

Deer also summered north of the winter range, between Goat Creek and Swan Lake. A few summer observations of collared deer have been reported in that area, but specific collars were not identified. Presumably, the Goat Creek-Swan Lake summer population included a few deer that wintered in the upper Swan and the majority wintered in the lower Swan. The population appeared to be contiguous from Salmon Lake to Echo Lake, with three or more recognizable sub-populations. This hypothesis should be tested with additional marked animals from the three winter ranges.

Similarities were evident in the summer range-use patterns of radio-equipped deer. Summer home ranges occurred in closed-canopy forest. A variety of habitat types, within the *Pseudotsuga menziesii*, *Abies grandis*, and *Abies lasiocarpa* series, occurred. They were represented either by mixed, seral communities or dense stands of lodgepole pine. Habitat and cover types were not consistent between home ranges. Those paramenters probably were less important than mere presence of dense coniferous cover in seral communities.

Each radio-collared deer used a small activity center that was near a mesic sit. The sites occurred as creek bottoms, marshy creek bottoms, potholes, marshes, and meadows. Habitat types, within the *Picea* series, often occurred in the mesic margins and spruce, in combination with other conifers, dominated.

Certain summer home ranges also included recent clearcuts. The heaviest use apparently was confined to the edges, as few tracks or pellets were encountered elsewhere in clearcuts. Natural openings and wet sites, which had been isolated by logging, were not used.

Evidences of fire were frequently enountered. Fire seems to have had an influence similar to that described for the winter range. However, hot fires may have been more extensive. Stands of dense lodgepole pine, particularly along Glacier Creek, presently occupy these sites.

Habitat diversity also characterized summer home ranges. Mesic sites were intersperced with uplands. Uplands were mosaics of habitat and cover types. The mosaics resulted from topographic variations and previous influences of fire. Only major trails were recognizable on summer range. They always followed edges.

The distribution of radio-collared deer and hunter tag returns (Figs. 17, 18 and 19) suggested the occurrence of three important summering areas. Densest summer concentrations apparently occurred in the southwest quadrant of the valley, from Glacier Creek south to the Swan-Clearwater divide and from the Swan River west to the base of the Mission Mountains. The area included the summer home ranges of 15 of 34 radio-collared deer. Seven of 24 hunter-returned collars were recovered in that area. A disproportionate percentage of the deer harvest, relative to hunting pressure, occurred south of Elk Creek (Table 2). The southwestern portion of the Swan Valley was typified by 1) a high density of small meadows and potholes, 2) numerous small creeks, 3) topographic variation and 4) extensive, mature forest. Several extensive fires probably occurred in this area during the past century.

Another important summer concentration apparently occurred immediately north of Glacier Creek, between Elk and Jim Creeks. The area included summering areas of 5 radio-collared deer and 4 tag-returns. It is physiographically similar to Glacier Creek although recent logging has been extensive. The radio-collared deer were associated with remaining stands of mature timber. The Elk-Jim Creek area could probably support more summering deer, but adequate cover is lacking.

Four tag returns and two radio-collared deer were associated with the southeastern quadrant of the valley, between Barber and Owl Creeks. That area is drier than the western half of the drainage. Large clearcuts occur in portions of it, but fewer mesic areas have been isolated by logging, in comparison with Elk-Jim Creek.

Timber Management

Timber production is the dominant land use in the Swan Valley. The influence of timber management on white-tailed deer may be inferred from the previous discussions of deer distribution and habitat relationships. Deer occupy small seasonal home ranges, which are mosaics of essential habitat components, mesic sites and mature, subclimax forest.

Fire suppression, one aspect of timber management, has had a subtle influence on white-tailed deer habitat. Fire seems to have had a stabilizing influence on plant succession, especially on winter range. The result was a subclimax condition and a predictable combination of forage and cover. In the absence of fire, plant succession has progressed and the forage resource probably has decreased.

Previous timber harvests have reduced the total area of white-tailed deer habitat. This has occurred because cover was removed, habitat integrity and diversity were disrupted, and logging units werelarge in comparison with average home range size. Specific examples of detrimental practices included: (1) logging units defined by property lines rather than ecological boundaries, such that a uniform prescription included a diversity of

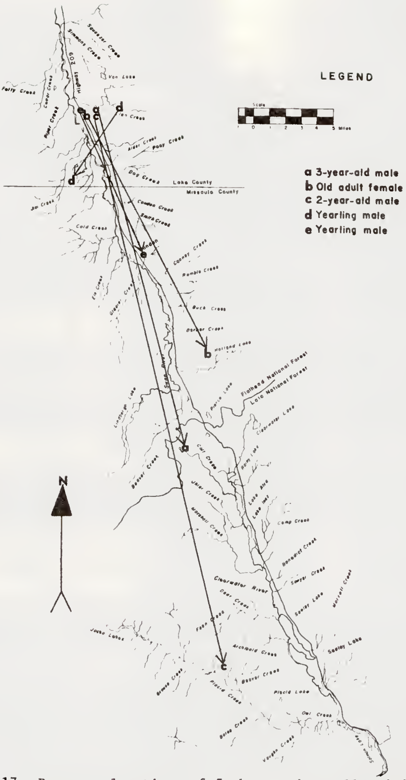

Figure 17. Recovery locations of 5 observation-collared deer during the 1976 hunting season.

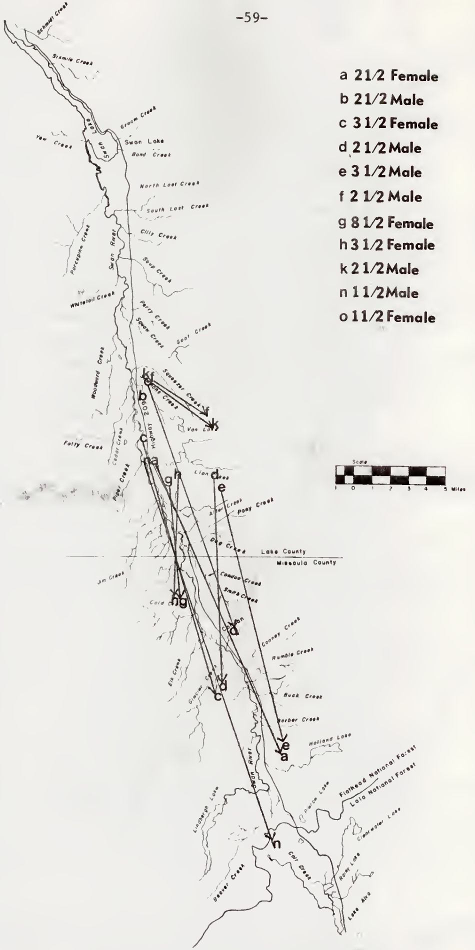

Figure 18. Recovery locations of 11 observation-collared deer during the 1977 hunting season.

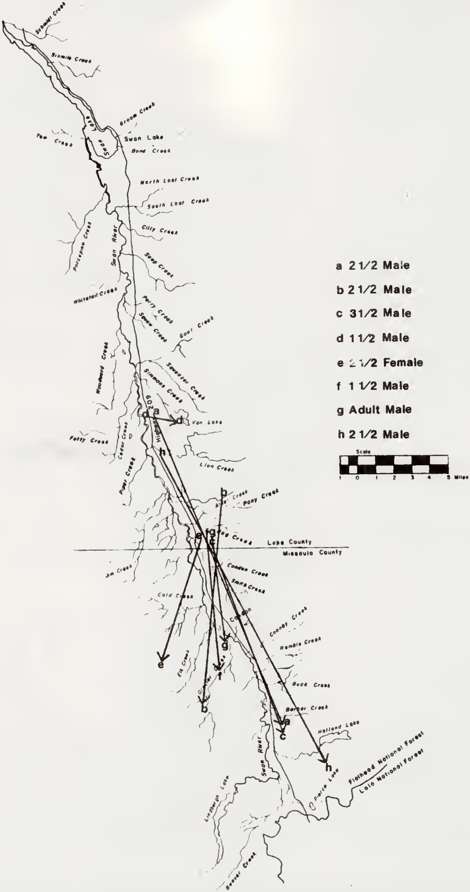

Figure 19. Recovery locations of 8 observation-collared deer during the 1978 hunting season.

of habitat/cover types; (2) logging units which isolated important topographic features, eg. mesic sites, ridge and draw complexes; and (3) large clearcuts on winter range.

Logging has impacted extensive areas in the Swan Valley. Benefits which may have resulted from that logging will not appear for deer until cover develops. Regeneration is proceeding slowly. It is doubtful that logging can be used effectively to improve white-tailed deer habitat until recent cuts are reoccupied by deer. Rather, logging in the next 20-50 years should be designed to minimize detrimental influences within presently occupied deer range.

The integrity of mesic sites with associated cover must be maintained on summer range. Mesic sites must also be contiguous with larger units of cover. Withdrawel from treatment is preferred. Logging in riparian areas may be acceptable if it is restricted to a very light selection for sanitation/salvage.

A variety of logging techniques may be appropriate on summer range uplands. The primary considerations are that unit boundaries should follow ecological boundaries and clearcuts should be less than 20 acres.

The integrity of both riparian areas and upland foraging areas is essential to the winter range. Riparian areas should be withdrawn from treatment, although very light selection may be tolerable.

Winter range uplands should be managed to encourage communities with mixed species in multiple age classes. Logging should employ selection/group selection within units of less than 20 acres or clearcuts of less than 5 acres. Units should be contained within a natural boundary. Selection should not reduce the overstory below 70% crown closure.

On all seasonal ranges, sale proposals should be evaluated on an individual basis. Additional modifications may be necessary to accommodate previous logging.

Logging constraints for white-tail deer should be compatable with the habitat requirements of elk. The reverse may not be true. Therefore, considerations for deer should have precedence where the species are sympatric.

These recommendations are extrapolations from observed deer range use patterns. Field tests should be conducted prior to broad application. During the interim, the recommendations are a reasonable alternative to obviously detrimental practices.

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Submitted by: John G. Mundinger

JOB TITLE: White-tailed deer movements, survival and population characteristics in the Clearwater River drainage, Montana.

ABSTRACT: A study of white-tailed deer, initiated in the Clearwater River drainage during 1975, was continued during winter-summer 1978 and 1979. Findings are being prepared in the final report.

OBJECTIVES:

To determine and describe:

1. Summer distribution of white-tailed deer which winter in the Salmon Lake area of the Clearwater drainage.

2. The status, i.e., numbers and trend, fawn production and survival, and mortality factors affecting this deer population.

3. Seasonal food habits.

4. Winter range condition.

5. The potential effects of logging on deer habitats and population in the Clearwater River drainage.

FINDINGS:

Field work continued through the winter-summer 1979 and data have been compiled. Data analyses and the final job report will be completed in December 1980.

Submitted by: Barbara Slott

Job Title Population ecology and habitat ralationships of mule deer in the Bridger Mountains, Montana.

ABSTRACT

This report describes studies on the population ecology and habitat relationships of mule deer in the Bridger Mountains, Montana, with emphasis on population studies of mule deer associated within the Armstrong winter range from 1971-72 through 1979. Winter distributions were generally similar to previous years although significantly higher concentrations of deer used the West Slope-South Unit in the mouth of Bridger Canyon; and significantly fewer numbers used the Blacktail Mountain Winter Range. Distributional data on 30 deer radio-collared during 1975-79 on the Armstrong winter range indicated that 50% summered in Bill Smith and North Cottonwood Canyon, 23% in the Frazier, Carol and Flathead drainages east of the Bridger Divide, 20% in Mill, Johnson and Pass Creeks and 7% in Tom Reese Creek. Generalized dispersal patterns of marked deer off the Armstrong, Schafer and Brackett Creek winter ranges suggested that mule deer associated with individual winter ranges may comprise population units that occupy rather distinct yearlong herd ranges. Individual marked deer that use particular portions of the Armstrong winter range were shown to be at least generally associated with particular portions of the summer herd range. Population data for the Armstrong winter range indicated that about 234 mule deer were present in early winter; the number decreasing to about 140 animals in early spring. Overwinter mortality, during the severe winter, resulted in an estimated loss of 80% of the fawns, 24% of adult males, and 5% of adult females present in early winter. The sex ratio of 14 marked fawns that survived the winter was 180 males:100 females. Fawn mortality was unevenly distributed on the winter range with 79% and 44% apparently dying on the north and central winter range subunits, respectively. The observed fawn:female ratio in early winter was 93:100, the highest recorded since the study began in 1971-72. However, by May the ratio decreased to an estimated 18 fawn:100 does, which was lower than previous years except 1975 and 1976. The proportion of adult males in the Armstrong population increased slightly since spring 1978 as a result of some improvement in yearling recruitment. Approximately 83% of 17 marked does were 2½ years of age or less. Proportions of adult females declined in 1978-79 after remaining relatively stable from 1975-78. Approximately 68% of 82 marked females were 6½ years or older, while only 4% were yearlings. Totals of 4,854 and 4,594 mule deer were counted on winter ranges, including the North 16-Mile area, during early and late winter, respectively. Calculations based on numbers observed within the Bridger complex and helicopter sampling efficiencies of 40% for west slope ranges and 48% for east slope and the South 16-Mile area suggested that as many as 7,800 mule deer may have been present in early winter (December 1978). The estimate for mid-March, based on sampling efficiencies of 64-65%, was approximately 5,500 mule deer. Total mortality for the late-December mid-March period was indicated at about 29%, including 10-12% of the adults and 56-58% of all fawns. These rates as well as the late winter population estimate did not include additional mortality which accrued in late March and April on many, if not most Bridger Mountain winter ranges.

Job Title Population ecology and habitat relationships of mule deer in the Bridger Mountains, Montana.

Job Objective To determine the environmental requirements of mule deer and factors regulating mule deer populations in mountain-foothill habitats of southwestern Montana.

To determine the effects of various potentially competing land use and management practices upon mule deer in southwestern Montana.

To develop new and improved guidelines for management of southwestern Montana mule deer populations and their habitats.

INTRODUCTION

This report describes and summarizes findings of studies on the population ecology and habitat relationships of mule deer in the Bridger Mountains, Montana, for the period 1 July 1978 through 30 July 1979. These studies were initiated and have been conducted continuously since the winter of 1971-72 following two, broadly different approaches: (1) Intensive studies of the distribution, movements, range use and population characteristics of mule deer associated with specific winter ranges and (2) Extensive studies of the seasonal distribution, habitat relations and population characteristics of mule deer generally throughout the Bridger Mountain complex. The history and general nature of both efforts were described by Mackie et al. (1978).

In this report, emphasis is given to information obtained for mule deer associated with the primary study area, the Armstrong range; though data obtained generally and for other populations are included or presented comparatively where appropriate. Findings from several special, intensive studies on local areas are or will be reported separately as progress reports (Rosgaard 1979) or supplementary final thesis reports (Steerey 1979, Youmans 1979, Nyberg in prep.)

ACKNOWLEDGEMENTS

Studies of mule deer in the Bridger Mountains have been conducted with the cooperation and assistance of the Montana Department of Fish and Game, Region 3, and the U. S. Forest Service, Gallatin National Forest and Bozeman Ranger District. The willingness of numerous private landowners throughout the Bridger Range to allow access to their lands and in many cases their direct assistance in various aspects of the studies has been a major factor both in enabling the work to be done and in results achieved. Murray Duffy, Central Helicopters, Bozeman, and James Stradley, Gallatin Flying Service, Belgrade, both contributed extensively through their flying and observational skills in helicopter and fixed wing aerial surveys, respectively. Much credit is also due to all of the many individual Montana Department of Fish and Game personnel and Montana State University graduate and undergraduate students who have participated in one way or another in the studies, and without whose help much of the work could never have been accomplished.

THE STUDY AREA

The Bridger Mountain Range (Fig. 1) is located in northeastern Gallatin and northwestern Park Counties, Montana. The total study area, encompassing the Bridger Range complex and adjacent foothills, prairie and agricultural lands used by or available to deer, includes a land area of approximately 800 square miles. It is bounded on the west by the East Gallatin River, Dry Creek and the Dry Creek-Maudlow road; on the north by 16-Mile Creek, its Middle Fork, and Cottonwood Creek; on the east by U. S. Highway 89 and the Shields River; and on the south by the Yellowstone River and Interstate Highway 90 between Livingston and Bozeman. A portion of the 16-Mile Creek winter range extends north of this boundary to the Gallatin-Meagher County line. Whether deer associated with that north portion of the 16-Mile winter range move south from the Big Belt Mountains or include some animals from the Bridger complex is not known at this time.

The Bridger Mountain complex includes the main Bridger Range which extends north and west in a gently curving arc from Bridger Canyon to Blacktail Mountain, a distance of about 23 miles (McMannis 1955). It also includes Elkhorn Ridge, which extends northeast off the northern portion of the main range, and Battle and Bangtail Ridges, which extend northeast and southeast, respectively, from about the center of the range. Topographic and geological features of the Bridger Range have been described by McMannis (1955). Elevations on the study area range from about 4,600 ft. along 16-Mile Creek in the northwestern corner of the area to 9,665 ft. Highest elevation and the most severe and complex topography occur along the main Bridger Range; while easterly extending ridges and drainages are of lower (less than 7,600 ft.) and less severe relief.

Seven, generally distinct, major mule deer winter ranges occur around the perimeter of the Bridger Range (Fig. 1). Collectively, these occupy an area of about 90,000 acres (140 mi^2) or slightly less than 20% of the total area available to deer within the Bridger complex.

Three of the major winter ranges occur on the west slope along a narrow band of steep, south and west facing slopes which extend in elevation from 5,200-5,600 ft at their lower limit up to 6,800-7,200 ft. The South unit, which includes the Schafer Creek winter range as a sub-unit, extends from the mouth of Bridger Canyon north to Ross Creek and encompasses a total maximum area of about 9 mi^2. The North unit, including the very intensively studied Armstrong winter range as a subunit, spans a maximum area of approximately 5 mi^2 from Ross Creek north to Pass Creek. The Blacktail Mountain winter range, from Pass Creek north to Blacktail Creek, comprises about 3.6 mi^2.

The South 16-Mile winter range is located at the extreme north end of the main Bridger Range and comprises all of the area south of 16-Mile Creek and its Middle Fork, including Table Mountain, the lower South Fork and the south to westerly facing slopes of Hatfield Mountain. It includes a total area of approximately 37.8 mi^2 within an elevational range of from 4,600 ft along 16-Mile Creek to about 6,000 ft. The terrain is generally of the "Breaks" type of slight to moderate gradient.

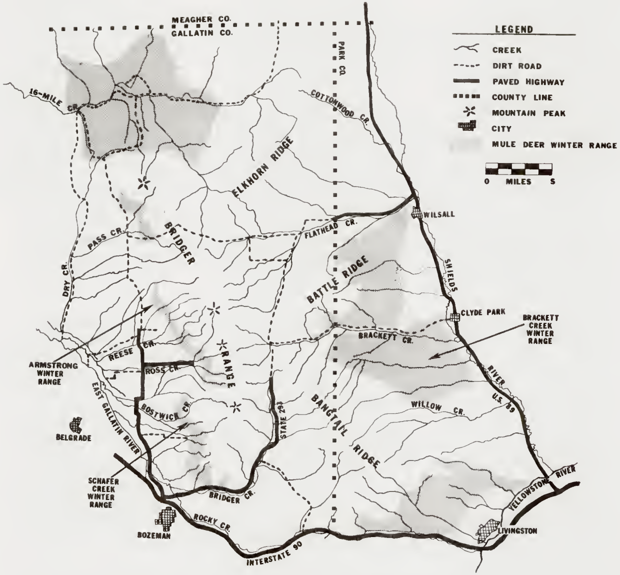


Figure 1. Map of the Bridger Range showing major features and the location of primary study areas.

The three major winter ranges which occur along the east side of the Bridger Range are broad, open ridge and bench lands which extend from the lower slopes of Battle and Bangtail Ridges to the Shields and/or Yellowstone Rivers. Elevations range from 4,800-5,200 ft. at the lower limits of mule deer distribution to 6,000-6,200 at the upper limit for most years. The Battle Ridge winter range includes about 27.5 mi^2, the east-central portion of which, between Antelope and Fox Creeks, receives only light usage by mule deer. Because of this, future studies may determine that two separate winter ranges should be recognized; one extending from Horse Creek to Fox Creek, the other from approximately the Looking Glass-Antelope Creek divide north to Flathead Creek. The Brackett Creek winter range encompasses about 38.5 mi^2, including the Brackett Creek drainage below Miles Creek and all but the upper reaches of Canyon Creek and Bangtail Creek. The Livingston area includes about 28.9 mi^2 extending from the north rim of Ferry Cr. south and west to Billman and Flynn Creeks.

The major winter ranges differ broadly in vegetal, climatic and land use characteristics as well as in their topo-physiographic attributes. In general, the east side ranges are characterized by relatively open vegetation consisting of sagebrush-grassland with scattered clumps or individual plants of Rocky Mountain juniper *(Juniperus scopulorum)*. Agricultural croplands are interspersed, especially at lower limits, while timber cover occurs mainly along a few drainages and at the upper margins. The 16-Mile basin area is characterized by extensive stands of shrubby and shrub-grass vegetation interspersed by open to moderately dense stands of Douglas fir *(Pseudotsuga menziesii)*, limber pine *(Pinus flexilis)*, and Rocky Mountain juniper along slopes of all drainageways. West slope ranges are generally characterized by steep open slopes dominated by grass-forb or grass-shrub vegetation. Moderate to dense stands of timber, primarily Douglas fir, are interspersed; extending upward along north slopes of canyons and draws from the lower limits of the winter range. Open stands of timber and Rocky Mountain juniper usually extend onto south and westerly exposures at higher elevations. Major differences between west slope ranges appear to be in the relative representation of various habitat and cover types and in the occurrence of some individual plant species of importance to deer. For example, antelope bitterbrush *(Purshia tridentata)* is well represented in shrub-grass vegetation on the Armstrong range but absent on the Schafer Creek area (Steerey 1977).

To date, our studies have centered on the Armstrong winter range and adjacent spring-summer-fall ranges used by deer associated with that area, which includes primarily that portion of the main Bridger Range extending from Flathead Pass south to Ross Pass. Vegetational and other "habitat" and environmental characteristics of much of this area have been described in detail by Bucsis (1974) and Pac (1976). Steerey (1979) has described vegatational attributes of yearlong ranges used by mule deer associated with the Schafer Creek winter range, located along the west slope from approximately Ross Creek south to Middle Cottonwood Creek. Studies to provide similar information for portions of the Bridger Mountain complex used by deer associated with the Brackett Creek winter range, located along the east slope from approximately Brackett Creek south to Bangtail Creek, are being completed by Nyberg (in prep.) and Rosgaard (1979). Results of current studies to generally define vegetational and other environmental characteristics of the Bridger Range as a whole are presented elsewhere in this report.

METHODS

Habitat Studies

Habitat parameters measured and/or monitored and general methodology employed were described by Mackie et al. (1978:91-93); though some modifications were necessary. Nutritional analysis of forage plant samples collected during the summer of 1978 included only crude protein and moisture contents. Small samples and high analytical cost precluded determination of total energy content. Because of cost considerations, it now seems unlikely that complete nutritional characterization of the forage base in various vegetation types can be achieved. Also, it may not be possible to complete measurements of dry matter forage production in the major habitat types due to the lack of manpower and funding necessary to carry out the large amount of work involved. One additional modification, also due to reduced funding, was the establishment of only one, rather than two weather stations on the Armstrong winter range.

During 1978-79, emphasis was placed on (1) obtaining basic weather data for five of the major mule deer winter ranges to: (a) document prevailing conditions and (b) to compare conditions between winter ranges and between representative winter ranges and the nearest office of U.S. Weather Service Stations; (2) continuing vegatation cover and habitat type delineations and mapping of major mule deer summer ranges; and (3) collection and analysis of nutritional values of forage plant samples from various habitat types and elevations within the range of the Armstrong deer herd.

Population Studies

Mule deer winter distributions and population and range use characteristics were determined primarily through aerial surveys during early and late winter. For the Armstrong range, population data were also obtained through ground observations associated with deer trapping and other studies throughout the winter as well as specific observations of marked and unmarked deer on the area during late winter and early spring.

The intensive helicopter surveys, employing a Bell 47G 3B-2 helicopter with the same pilot and observer as previous years, were completed December 26-31, 1978 and March 12-14, 1979. All major mule deer wintering areas in the Bridger complex were covered during both early and late winter surveys. Locations, numbers, sex (in early winter) and age (adult or fawn) were recorded. In addition, elevations and habitat types used, as well as numbers, locations and identifying markings of collared deer were noted. Similar records for all deer observed during fixed wing aerial surveys to relocate "radio"-collared deer at approximately weekly intervals throughout the year provided supplementary population data.

Ground observations to develop late winter population estimates were recorded during a total of 12 days in April. All mule deer observed were recorded as to number, age (adult and fawn), whether marked, specific markings, activity, location, habitat types, elevation, slope gradient and exposure. Groups were recorded collectively, with locations marked precisely on aerial photograph-habitat type maps.

Additional marked deer in the Armstrong population were obtained by trapping between 7 January and 6 March. Trapping methods included a corral type bait trap and cannon net as described by Mackie et al. (1975) plus portable bait traps (Clover 1954). A total of 250 mule deer (109 different animals) was trapped, including 141 recaptures of 37 previously marked animals and 71 new (Table 1). General markers were four-inch wide collars or neckbands of Armor-tite fabric, color coded using Tuff-flex marking paint, and fastened with blind rivets. Radio-transmitter collars were fastened to five new deer, two males and three females (Appendix Table 20). Three other females, two wearing non-functioning transmitters and the other a neckband, were recaptured and equipped with new transmitter collars. At the conclusion of the 1979 trapping period, a total of 15 deer held functional transmitters. In April, a transmitter in operation since January 1978 failed. In May, an adult male, 8+-years of age, wearing a transmitter collar attached in February, was found dead. A third transmitter, in operation on a doe since January 1978, apparently failed in August. A summary of all mule deer tagged on the area from 1972 through 1979 and their status as of June 1979 is given in Tables 1, 2 and 3.

Table 1. Summary of mule deer trapping effort and success on the Armstrong winter range, winter of 1978-79 (January 7, 1979 - March 6, 1979).

Trap No.	No. Trap Nights	No. Deer Caught	No. Deer/ 100 Nights	No. New Deer Tagged
1[1]	17	18	105.9	3
2	18	18	100.0	5
3	18	12	66.7	3
4	6	0	0	0
5	21	14	66.7	3
6	22	17	77.3	6
7	18	17	94.4	2
8	17	13	76.5	5
9	17	18	105.8	3
10	17	14	76.5	1
11	13	8	61.5	1
12	12	13	108.3	7
13	6	4	66.7	1
14	6	3	50.0	2
15	6	8	133.3	3
16[2]	21	55	261.9	9
TOTAL	235	232	98.7	54[3]

[1]Trap numbers 1-15 were Clover traps.
[2]Corral trap.
[3]Eighteen additional new deer were marked using the cannon net.

Table 2. Summary of mule deer trapped on the Armstrong winter range from 1972 through 1979 and their status as of June 1, 1979.

Year	Total No. Marked	No. OK 6/79[1]	No. Dead	Unknown[2]
1972	5	0	4(3)[3]	1
1973	16	2	9(1)	5
1974	39	9	13(2)	17
1975	36	10	21(8)	5
1976	9	4	3(1)	2
1977	16	11	4(2)	1
1978	42	25	9(2)	8
1979	72	44	28 [4]	-

[1] Number alive and accounted for on Armstrong winter range during spring 1979.
[2] Includes four deer known to have left AWR in past years and wintered elsewhere but were not observed in 1978-79.
[3] Number shot by hunters in parentheses.
[4] Includes 13 fawns and 1 yearling male that have not been observed since early March and are believed dead.

Table 3. Year of last observation for marked mule deer of unknown status.

Year Tagged	1972	1973	1974	1975	1976	1977	1978	Total
1972	0	1						1
1973		1	1			3		5
1974			2	4	5	4	2	17
1975				1	4			5
1976					1	1		2
1977						1		1
1978							8	8
TOTAL	0	2	3	5	10	9	10	39

Trapping was conducted on the Brackett Creek and Battle Ridge winter ranges during mid-March and on a portion of the West Slope South Unit, near the mouth of Bridger Canyon in mid-April. These operations employed a helicopter drive net. Within a 2½-day trapping period, 81 new mule deer were captured at Brackett Creek and 23 on Battle Ridge. Six of those trapped on Brackett Creek were equipped with transmitter collars; the remainder were neck-banded. Five mule deer were captured at the Bridger Canyon site, of which two were radio-collared and three were neck-banded.

Following trapping, and as deer left the winter range, radio-collared deer were relocated approximately weekly using receiving equipment from a fixed-wing Piper Supercub aircraft. When or where possible, supplementary relocations were obtained by ground tracking from a vehicle or on foot. As in previous years, an effort was made to visually relocate all transmitter equipped females to determine reproductive success and survival of fawns during the summer.

Mortality records were obtained for the Armstrong area through field and other contacts with hunters and landowners providing access, returns of marked animals and, during winter, by general observations in the course of trapping and other studies on the winter range. As in previous years, (Mackie et al. 1976), a systematic "dead deer survey" of the winter range between North Cottonwood and Bill Smith Creeks was conducted in mid-May.

RESULTS AND DISCUSSION

Habitat Studies

Weather Conditions on Major Mule Deer Winter Ranges

Weather stations were established in late fall 1978 on the Armstrong, Schafer Creek and Blacktail Mountain winter ranges along the west slope of the Bridger Mountains and on the Livingston and Brackett Creek winter ranges on the east slope. Two complete stations were maintained on Brackett Creek. Comparative data were obtained from official U.S. Weather Service Stations at Bozeman (MSU) for the west slope and Livingston (Airport) for the east slope.

Trends in mean maximum and mean minimum temperatures averaged for east and west side stations are shown in Figure 2. Maximum daily temperatures varied only slightly between winter ranges on the east and west slopes; while daily minimums on the east slope averaged approximately 5^{o}F lower during most of the winter and early spring.

Mean monthly temperatures for the Schafer Creek and Livingston winter ranges are compared with monthly means and 30-year "norms" at Bozeman and Livingston, respectively, in Table 4. The monthly means were generally similar for all stations, except during January, and showed similar trends from month to month and in relation to long-term norms. They also show the record lows which occurred from November through January on both the east and west slopes of the Bridger Range. Temperatures moderated somewhat in February and were near normal through April.

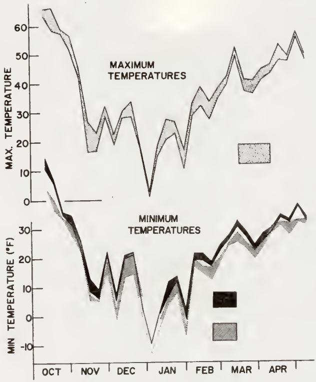


Figure 2. Trends in daily maximum and minimum temperatures on mule deer winter ranges in the Bridger Mountains, October 1978-May 1979.

Table 4. Mean monthly temperatures (^{o}F) recorded on the Schafer Creek and Livingston winter ranges compared with monthly means and 30-year averages for U. S. Weather Service stations in Bozeman (MSU) and Livingston (airport).

		Nov.	Dec.	Jan.	Feb.	Mar.	Apr.
MSU	30 yr. ave.	32.3	25.1	20.8	26.2	29.9	41.9
	1978-79	24.5	16.8	4.7	24.9	33.0	42.1
Schafer Cr. Winter Rge.	1978-79	26.8	17.4	11.2	26.9	34.5	40.3
Livingston Airport	30 yr. ave.	35.2	28.9	24.8	28.6	31.4	43.2
	1978-79	27.3	17.4	*	27.3	*	*
Livingston Winter Rge.	1978-79	25.0	17.1	9.3	23.2	32.2	39.8

*Not available

Table 5 compares monthly (November-May) climatological data for the Bozeman (MSU) weather station for the years 1971-72 through 1978-79. The severity indicies (Picton and Knight 1969) indicate the 1978-79 winter was more severe than any previous winter since the study began. Monthly severity indicies for November, December and January also were the highest recorded, while that for February was the second highest on record. Indicies for March and April were about average for those months. Overall, the winter was characterized by below average temperatures and slightly above normal precipitation.

Mean monthly wind speeds, computed from total miles of wind recorded over weekly or occasionally longer periods, for the five major winter ranges are presented in Table 6. These data indicate that east slope ranges were much windier than west slope ranges. Higher average wind speeds, together with similar or slightly lower average temperatures on the east slope could be expected to result in a higher overall average wind-chill factor for winter ranges along the east side as compared with those on the west slope. On the other hand, generally higher winds combined with less total snowfall might also be expected to result in lower total snow depths, especially on exposed ridges and slopes, on the east as compared with west side ranges.

Table 7 shows snow depths and percentages of ground surface covered by snow in the vicinity of weather stations on the five major winter ranges from late December or early January through mid-April. Measurements were generally made at weekly intervals, except at the lower Brackett Creek (Peckenpaugh) site where only one measurement was made in January and February and at one site on the Blacktail Mountain winter range (Felix Canyon No. 2) where measurements were made only during March and April. These data, combined with general observations made earlier, indicate that west slope winter ranges were completely snow covered from 9 November 1978 through the first week of March, 1979, when the snow cover began to rapidly disappear from steep south and southwest facing slopes. Snow depths were greatest on the Blacktail Mountain winter range, where the Felix Canyon snow course showed depths ranging from 4.5 to 6 dm ($1\frac{1}{2}$-2 ft.) from December to mid-March. This area was also the last to lose its snow cover, with substantial accumulations persisting into April. The period of total snow coverage was less prolonged on east slope winter ranges, especially on the Livingston area where less total snowfall occurred and higher winds reduced snow depths and frequently cleared exposed slopes and ridges. Observations indicated that snow crusting occurred on west slope ranges between the 10th of February and early March; but this condition may not have been as severe as in some previous years due to the lack of mid-winter thawing and high winds. Crusting appeared more prevalent on east slope winter ranges, but may have been less important because of the generally lower snow depths and less complete coverage.

Because the timing of "green-up" and the subsequent rate of phenological development of plants has been considered important in the recovery of mule deer from nutritional stresses of winter as well as in reproduction, phenology and growth rates of some common plant species were measured on each of the major winter ranges (Table 8). These data indicate that some green-up and new growth of grasses was under way on the Armstrong and Schafer Creek ranges on the west slope and on the Livingston range on the ease side by the last week of March. The relatively slow development of plants on the Blacktail Mountain area probably was due to the late snowmelt, since other factors

Table 5 . Climatological data, MSU Weather Station, Bozeman, and severity indices, November through May, 1971-1979.

		Ave. Temp. (°F)	Ppt. (in.)	Total Snowfall (in.)	Max. Snow Depth (in.)	No. Days Snow on Ground	Severity Index[1]
November	1971	33.7	0.77	11.2	5	17	- 297
	1972	32.8	0.63	3.0	4	8	- 250
	1973	30.4	1.27	15.8	11	25	+ 104
	1974	35.1	0.67	4.7	2	10	- 377
	1975	30.5	1.33	20.5	12	15	+ 491
	1976	35.5	.20	3.9	4	4	- 415
	1977	31.7	1.19	12.0	8	11	+ 260
	1978	24.6	1.87	17.0	9	26	+ 955
December	1971	20.8	0.56	11.1	10	31	+ 1161
	1972	18.6	0.49	12.2	4	23	+ 1047
	1973	29.5	1.29	20.5	13	16	+ 234
	1974	25.5	1.02	13.2	6	31	+ 284
	1975	30.0	1.10	15.8	6	22	+ 84
	1976	30.3	.22	3.3	3	8	- 232
	1977	25.2	1.19	12.7	8	22	+ 315
	1978	16.8	.72	13.9	10	31	+ 1954
January	1972	19.1	0.86	13.8	10	31	+ 1068
	1973	19.2	1.10	16.6	9	31	+ 1837
	1974	21.3	0.42	5.8	14	25	+ 3743
	1975	22.8	1.58	22.9	14	31	+ 1369
	1976	26.6	0.60	8.7	9	28	+ 360
	1977	30.3	.60	13.5	9	31	+ 583
	1978	22.2	1.03	13.7	12	31	+ 842
	1979	6.9	1.03	15.5	16	31	+ 5597
February	1972	31.0	0.66	10.2	6	27	- 75
	1973	24.4	0.04	1.8	8	28	+ 483
	1974	32.0	0.43	7.8	4	21	- 206
	1975	21.3	1.11	19.5	17	28	+ 1659
	1976	30.4	0.52	9.8	4	5	- 187

Table 5. (Continued).

		Ave. Temp. (°F)	Ppt. (in.)	Total Snowfall (in.)	Max. Snow Depth (in.)	No. Days Snow on Ground	Severity[1] Index
	1977	33.8	.06	1.0	3	17	- 322
	1978	26.3	.87	15.1	11	28	+ 892
	1979	25.0	.75	11.5	18	28	+ 1354
March	1972	41.0	1.24	13.6	8	8	- 586
	1973	33.9	1.89	23.0	11	31	- 303
	1974	32.6	1.71	24.7	7	26	- 206
	1975	29.1	1.08	20.7	9	31	+ 295
	1976	28.7	1.03	18.5	6	12	+ 262
	1977	30.9	2.39	27.0	8	23	- 184
	1978	37.2	.74	4.6	10	19	+ 59
	1979	33.0	.77	10.1	14	31	- 125
April	1972	41.3	1.91	21.9	4	5	- 652
	1973	38.9	2.84	34.7	14	14	- 520
	1974	45.8	1.87	3.2	0	0	- 764
	1975	32.9	1.77	16.1	8	24	- 141
	1976	43.4	3.35	21.9	4	4	- 663
	1977	48.1	.57	5.7	8	4	- 875
	1978	44.9	.93	1.4	trace	0	- 692
	1979	42.1	1.93	18.1	1	9	- 623
May	1972	50.7	1.73	trace	1	0	- 958
	1973	51.4	1.44	1.3	trace	0	- 989
	1974	48.3	3.00	12.1	3	3	- 880
	1975	46.9	4.88	21.5	9	6	- 803
	1976	55.5	1.95	trace	0	0	- 1157
	1977	50.3	3.84	3.4	0	1	- 946
	1978	49.7	4.04	1.0	0	0	- 886
	1979	60.7	3.66	1.3	0	3	- 1269

Table 5. (Continued).

		Ave. Temp. (°F)	Ppt. (in.)	Total Snowfall (in.)	Max. Snow Depth (in.)	No. Days Snow on Ground	Severity Index
Nov. - May	1971-72	33.9	7.7	81.8	10	119	- 329
	1972-73	31.3	8.4	92.6	14	135	+ 1335
	1973-74	34.3	10.0	89.9	14	116	+ 2025
	1974-75	30.5	12.1	118.6	17	161	+ 2286
	1975-76	35.2	9.9	95.2	12	86	- 810
	1976-77	37.4	7.9	57.8	9	88	- 2391
	1977-78	33.9	10.0	60.5	12	111	+ 790
	1978-79	29.9	10.7	87.4	18	159	+ 7843
20 Year Ave.		32.4	9.5				

[1] + Values indicate greater severity.

Table 6. Mean monthly wind speeds (MPH) recorded on five mule deer winter ranges in the Bridger Mountains.

	PERIOD				
Station	Dec. 15- Jan. 5	Jan. 6- Feb. 2	Feb. 3- Mar. 2	Mar. 3- Mar. 30	Mar. 31- May 4
Schafer Creek Winter Range	2.19	0.84	1.58	1.51[1]	1.85
Armstrong Winter Range	3.19	1.56	2.89	2.23	2.73
Blacktail Mt. Winter Range (Felix Canyon)	3.42	2.06	2.52	2.50	2.80
Brackett Cr. Winter Range (Leffingwell)	6.53	3.85	5.41	3.94	3.97
Brackett Cr. Winter Range (Peckenpaugh)	8.54	4.27	6.76	5.14	6.82
Livingston Winter Range	8.38	5.55	7.55	5.59	6.55

[1]From three weeks data.

Table 7. Snow depths and coverages recorded on five mule deer winter ranges, 1978-79. Depths are in decimeters, coverage is in percent of ground covered.

		Dec.	January				February				March					April	
		28	5	12	19	26	2	9	16	23	2	9	16	22	30	6	13
Schafer Cr. W.R.	D[1]	2.2	2.8	3.1	3.3	3.5	3.8	3.6	2.4	2.2	2.7	.7	0	0	0	0	
	C[2]	100	100	100	100	100	100	100	100	100	100	68	0[3]				
Armstrong W.R.	D	2.4	2.8	M	3.5	3.4	3.9	3.5	2.4	2.4	3.1	1.4	0.1	0	0	0	
	C	100	100	100	100	100	100	100	100	100	100	92	1[4]				
Blacktail Mt. W.R. (Felix Canyon #1)	D	4.5	M	M	5.2	5.1	5.3	4.6	4.8	5.2	5.8	4.4	2.9	2.1	1.5	1.0	0.1
	C	100	100	100	100	100	100	100	100	100	100	100	95	81	69	57	8
Brackett Cr. W.R. (Leffingwell)	D		2.7	4.2	3.2	3.6	3.7	2.7	3.2	2.8	5.1	2.0	*[4]	0	0	0	0
	C		100	100	98	100	100	100	100	92	100	48					
Bracket Cr. W.R. (Peckenpaugh)	D			2.8							2.6	0.7	*	0	0	0	0
	C			100							100	25					
Livingston W.R.	D		1.0	1.3	0.9	0.8	0.7	*	*	*	3.5	*	*	0			
	C		98	100	88	100	98				100						
Blacktail Mt. W.R. (Felix Canyon #2)[5]	D										4.4	3.6	1.8	1.5	1.0	1.0	0.7
	C										100	100	79	61	40	37	36

[1]Snow depth (Decimeters)
[2]Snow coverage (Percent)
[3]Snow was gone from the snow course but was still 1-2 dm deep on the flats below.
[4]Only scattered drifts left
[5]Second Felix Canyon snow course, established 3/2/79
M - Data missing

Table 8. Spring phenology on five winter ranges in the Bridger Mountains March 29-May 11, 1979.

	Schafer Creek and Armstrong W.R.							Blacktail Mt. W.R. (Felix Canyon)						
	Date							Date						
Species	3/29	4/6	4/13	4/20	5/1	5/4	5/11	3/29	4/6	4/13	4/20	5/1	5/4	5/11
AGSP[1]	2(2)[2]	2(2)	2(3)	2(3)	3(5)	3(5)	3(7)	9	2(1)	2(1)	2(1)	2(2)	2(2)	2(2)
FEID	2(2)	2(2)	2(3)	2(4)	3(6)	3(6)	3(6)	9	1	1	2(1)	2(2)	2(3)	2(3-4)
KOMA														3(2-3)
CHVI	2	2	2	2	2	2	3							
BASA	9	9	9	9	1	1	2-4	9	9	9	9	9	1	1
	Bracket Creek W.R. (Leffingwell)							Bracket Cr. W.R. (Peckenpaugh)						
AGSP		2(2-3)	3(3)	3(3)	3(4)	3(5)	3(6)		2(1)	2(2)	2(2)	3(3)	3(4)	3(5)
FEID		2(1-2)	2(2)	2(2)	2(2)	2(3)	3(3)							
KOMA									2(1)	2(1)	2(1-2)	3(2)	3(2)	3(2)
CHVI									2	2	2	2	2	2
BASA														
	Livingston W.R. north-facing slopes							Livingston W.R. south-facing slopes						
AGSP	9	9	2(1)	2(1)	2(1-2)	2(2)	2(3)	2(1)	2(2)	2(2)	2(3)	3(6)	3(6)	3(6)
FEID	2(½)	2(1)	2(1)	2(1)	2(1)	2(1)	2(2)	2(2)	2(3)	2(3)	2(3)	3(6)	3(6)	3(6)
KOMA								2(1)	2(1)	2(1)	3(2)	3(2)	3(2)	3(2)
CHVI								9	2	2	2	2	2	3

[1]AGSP=*Agropyron spicatum*, FEID=*Festuca idahoensis*, KOMA=*Koeleria macrantha*, CHVI=*Chrysopsis villosa*, BASA=*Balsamorhiza sagittata*.

[2]Phenological state. Phenological stages are: 1) Recent emergence or leaf bud, 2) Early leaf, 3) Full leaf, 4) Early flower (bud), 5) Full flower, 6) Early fruit, 7) Mature fruit, 8) Post seed drop, 9) Dead or dormant.

In parenthesis -height in inches given for grasses only.

influencing plant growth and development were essentially the same as on other west slope ranges. The relatively slow development of bluebunch wheatgrass (AGSP) on the Brackett Creek (Peckinpaugh) range might be explained by the location of the phenology transect on a flat, level hilltop rather than a warmer, south-facing slope like other sites.

Generally, the onset of spring green-up and rate of early phenological development appears later or slower than normal. However, phenological data for lilacs in Bozeman (D.K. Scharff, pers. comm.), listed in Table 9, indicate that early bud development occurred very close to the ave-age date while full bloom occurred nearly a week earlier than normal. This might indicate about average early growth and development of plants in the area and somewhat faster development later in the spring.

Table 9. Phenology of lilac development and growth in Bozeman. Data provided by Donald K. Scharff, Professor, Biology Dept., Montana State University, Ret.

Year	Early Bud Stage[1]	Lush Full Bloom[2]	Remarks
$\bar{X}$ 1955-1970	12 May	8 June	
1971	11 May	10 June	
1972	3 May	31 May	
1973	16 May	11 June	
1974	3 May	13 June	
1975	18 May	24 June	Latest recorded for both
1976	-	2 June	
1977	25 April	28 May	2nd earliest recorded for both
1978	20 May	28 May	Earliest recorded for both
1979	13 May	2 June	

[1]Early bud stage = first sight of flower buds, leaf buds will be open and new growth will be about 1" long.

[2]Peak of bloom

Vegetation Classification and Mapping

Detailed vegetation classification for the Bridger Range was initiated in 1972 with studies by Buscis (1974) on the Armstrong Winter Range. This effort was continued and expanded to other areas by Pac (1976), Jorgensen (1977), Steerey (1979), and Nyberg (1978, In Prep.). Through these efforts of workers, ground truth reconnaissance of varying intensity has been accomplished for the Livingston and Brackett Creek winter ranges, Bangtail Ridge, the north end of the Bridger Range from Flathead Pass to Tom Reese Creek (including the Armstrong winter range) and the southern part of the Bridger Range along the west slope from Mizer Canyon to Middle Cottonwood Canyon. Preliminary vegetation mapping was accomplished for seasonal ranges occupied by the Armstrong and Schafer Creek herds. Intensive mapping has been completed for the northern and western portions of Bangtail Ridge, including parts of the Bridger and Brackett Creek drainages.

At present, 87 different vegetation entities have been recognized within the Bridger complex. These range from the vegetation on heavily disturbed sites, such as grain fields, to virtually climax stands of forest. Many of these types are, in realty, seral stages of, and may be grouped together under, a smaller number of habitat types (vegetal-geological-climatic entities in near climax condition). The habitat type classification employed for forested areas of the Bridger Range follows that of Pfister, et al. (1977). Since the ecology and successional relationships of the nonforested areas is not well understood, vegetational entities associated with these areas will be delineated only as cover types at the present time. If and when successional relationships are established, nonforested cover types will also be grouped into habitat types.

Data collection and analyses are not sufficiently complete to facilitate a detailed discussion of the ecology and spatial distribution of all the cover and habitat types within the Bridger Range; though fairly detailed descriptions of some habitat types were presented by Buscis (1974), Pac (1976), and Steerey (1979). Table 10 lists the occurrence and some ecological characteristics of various habitat and cover types presently recognized in various study areas in the Bridger Mountain complex. Future analyses will be directed to possible relationships between the occurrence and other attributes of various types within range areas occupied by the Armstrong, Schafer Creek and Brackett Creek deer populations and the distribution, density and dynamics of mule deer associated with these ranges.

Nutritional Analysis of Forage Plants

Previous analysis of crude protein in plants collected from the Armstrong summer range were reported by Pac (1976) and analysis for protein plus certain mineral elements in plants on the Armstrong winter range were reported by Morton (1976). During 1978-79, additional data were obtained concerning 1) changes in crude protein content of some major forage plants through the summer, 2) the relationship between percent protein on a wet weight basis and dry weight basis, 3) the effects of site differences (mainly altitude) on protein content of plants of the same species, 4) the differences or similarities in protein content between forbs and shrubs, and 5) the relationship between phenological stages and protein content.

The results showed steady declines in percent protein on a dry weight basis as the growing season progressed. (Table 11, Figures 3 and 4). These findings are in agreement with results from similar studies (Dietz, et al. 1958, Wallmo, et al. 1977, Urness, et al. 1975, Williams 1953, Payne 1955 and others). When protein percentages were plotted on the basis of phenological stages rather than calendar dates (Figures 3 and 4) it became evident that the curves showing the decline in protein as development progressed were quite similar for the same plant species whether it was collected at a high or low elevation site. This suggests that at least part of the difference in protein content within the same species collected on the same date but at different elevation sites (Table 11) was due to the different stages of phenological development at the different sites. Only one species, *Vaccinium scoparium*, exhibited lower protein content at the very early leaf stage than at a later phenological stage; however, not all species were collected in the early leaf stage.

Table 10. Ecological characteristics and distribution of habitat and cover types on various study areas in the Bridger Mountain complex.

Forested Habitat Types	Bucsis North Bridger Winter Ranges	Pac North Bridger Summer and Transitional Ranges	Steerey South Bridger Summer and Winter Ranges	Nyberg Bangtail Summer Range	Nyberg Brackett Creek Winter Range	Jorgensen Livingston Winter Range	Elev.	Restricted to Limestone	Restricted to Igneous
PSME[1] Series									
PSME/AGSP		+[2]	+				low		
PSME/FEID	+		+	+			low		
PSME/CAGE	+	+	+	+			mid		
PSME/SYAL	+								
SYAL phase		+		+			low		
CARU phase*			+	+			low-mid		
AGSP phase			+	+		+	low		
PSME/PHME				+					
CARU phase*			+				low		
PSME/CARU									
CARU phase*		+	+	+			mid		
PSME/PRVI	+						low		
PSME/VAGL									
VAGL phase*		+	+	+			mid		
ABLA Series									
ABLA/CAGE									
CAGE phase*				+			high		
PSME phase*			+	+			mid		
ABLA/CARU*			+	+			mid		
ABLA/VAGL*		+	+	+			mid		
ABLA/CLPS		+	+				high	+	
ABLA/ARCO*		+	+				mid		
ABLA/VASC									
VASC phase		+		+			high		+
THOC phase		+					high		+
CARU phase*				+			mid		+
ABLA/ALSI									
SALIX phase				+			mid		

Table 10. (continued).

Forested Habitat Types	Bucsis North Bridger Winter Ranges	Pac North Bridger Summer and Transitional Ranges	Steerey South Bridger Summer and Winter Ranges	Nyberg Bangtail Summer Range	Nyberg Brackett Creek Winter Range	Jorgensen Livingston Winter Range	Elev.	Restricted to Limestone	Restricted to Igneous
PINUS Series									
PIFL/JUSC						+	low		
PIFL/JUCO		+	+				high	+	
PIAL/VASC		+					high		+
PIAL/CAGE		+					high		+
Other									
PICEA/PHMA				+			low		
PICEA/GATR				+			mid		
POTREM/SALIX				+			low		
POTRICH/PRVI	+						low		
JUSC/PRVI				+			low		
Nonforested Habitat Types									
AGSP/ORHY					+	+	low		
AGSP/FEID					+	+	low		
AGSP/ARTR									
PUTR phase					+		low		
AGSP/AGSM	+						low		
AGSP/PSME					+		low		
RHTR/AGSP									
PIFL phase					+		low		
FEID/AGSP	+		+		+	+	low		
FEID/AGSM			+			+	low		
FEID/CAHO				+			mid		
FEID/ARLU				+			mid		
FEID/BRCA		+		+			mid		
FEID/ANRO				+			mid		
ARTR/FEID	+		+			+			
AGSP phase					+		low		
POPR phase					+		low		

Table 10. (continued).

Nonforested Habitat Types	Bucsis North Bridger Winter Ranges	Pac North Bridger Summer and Transitional Ranges	Steerey South Bridger Summer and Winter Ranges	Nyberg Bangtail Summer Range	Nyberg Brackett Creek Winter Range	Jorgensen Livingston Winter Range	Elev.	Restricted to Limestone	Restricted to Igneous
ARTR/AGSP			+						
AGDA phase					+		low		
POPR/ARTR					+	+	low		
POPR/FEID					+		low		
POPR/PHPR					+		low		
POPR/SYAL					+	+	low		
PUTR/AGSP	+						low		
PUTR/ARTR	+						low		
JUSC/PUTR									
ARTR phase	+						low		
AGSP phase	+						low		
FEID phase	+						low		
TRHA/LOCO		+					v.high	+	
ABLA/RIBES		+					v.high	+	
CRSU/AMAL					+		low		
SALIX/ALSI					+		low		
ACGL/PHLE	+						low		
Hayfields		+			+		low		
Grain Fields		+			+		low		

[1]Species abbreviations used in names of types:

PSME - Pseudotsuga menziessii (Douglas fir)
AGSP - Agropyron spicatum (bluebunch wheatgrass)
FEID - Festuca idahoensis (Idaho fescue)
CAGE - Carex geyeri (elk sedge)
SYAL - Symphoricarpus albus (snowberry)
CARU - Calamagrostis rubescens (pinegrass)
PHMA - Physocarpus malvaceus (ninebark)
PRVI - Prunus virginiana (chokecherry)
VAGL - Vaccinium globulare (huckleberry)
ABLA - Abies lasiocarpa (subalpine fir)
CLPS - Clematis pseudoalpina (clematis)
ARCO - Arnica cordifolia (heartleaf arnica)
VASC - Vaccinium scoparium (grouse whortleberry)
THOC - Thalictrum occidentale (western meadow rue)
ALSI - Alnus sinuata (thinleaf alder)
SALIX - Salix sp. (willow)
PINUS - Pinus sp. (pine)
PIFL - Pinus flexilis (limber pine)
PIAL - Pinus albicaulis (whitebark pine
JUCO - Juniperus communis (common juniper)
JUSC - J. scopulorum (Rocky Mountain juniper)
PICEA - Picea sp. (spruce)
POTREM - Populus tremuloides (quaking aspen)
POTRICH - P. trichocarpa (black cottonwood)

[2]"+" means yes, blank space means no.

*Indicates those habitat types of phases in which the dominant climax tree may be replaced by Pinus contorta (lodgepole pine) following disturbance.

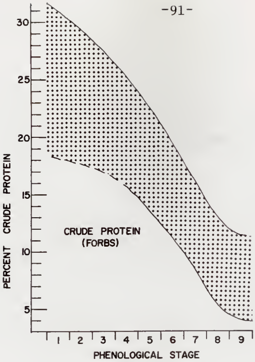
Table 11. Percent crude protein of important mule deer forage plants collected within the Armstrong herd range in 1978 - wet[1] and dry basis.

Species	Site Elev.	Wet or Dry	June 13	June 22	June 26	July 4	July 12	July 24	July 27	August 7	August 9	August 17	September 1	September 3	October 2	October 18
Thalictrum venulosum	8200	D			30.9	25.0	25.2	18.7			15.3	17.5	10.6			12.8
		W			4.8	4.4	4.9				4.0	?[2]	2.9			8.4
	7200	D	29.2	27.2			17.2			9.4		10.6		6.6	7.2	
		W	5.2	8.5			4.3			2.9		?		2.2	3.9	
	6200	D	20.1	19.1						12.2				6.8	4.7	
		W	4.0	4.2						3.4				2.9	3.0	
Geranium viscossissimum	8200	D			22.5	22.3	19.9	16.2			13.3	12.9				4.7
		W			3.8	4.5	4.3	3.5			3.1	?				3.0
	7200	D	23.2	22.7			16.8			12.5						
		W	4.4	3.8			3.3			3.0						
	6200	D	15.8	13.5			11.6			8.5						
		W	3.2	3.1			2.7			2.8						
Balsamorhiza sagittata	7680	D	23.2	24.4			20.1		15.2			12.6		5.3	9.2	
		W	4.3	4.9			4.4		4.7			?		1.7	8.3	
	6000	D	21.5	17.7			13.3			6.5			4.5		5.4	
		W	4.4	4.6			3.8			2.6			4.3		4.6	
Trifolium haydenii	8300	D				28.4	29.5	21.4			17.0		13.3			14.0
		W				4.5	5.6	4.8			4.8		4.6			7.2
Vaccinium globulare	7680	D	24.7	21.6			11.4							8.9	7.7	
		W	5.8	4.7			3.3							3.4	3.0	
	6800	D	19.5	14.2			11.4			8.7				6.4	6.0	
		W	4.6	3.8			3.8			2.9				2.6	2.4	
	6200	D	14.7	13.7			11.4		8.5					7.8	5.3	
		W	3.6	3.9			3.9		2.5					3.0	2.0	
Symphoricarpus albus	6880	D	20.6	17.3			13.3			10.4		10.2			6.0	
		W	5.2	5.1			4.4			7.0		?			2.3	
	6200	D	14.4	12.4			11.5		10.6	10.9			8.0		6.3	
		W	3.7	3.6			3.8		3.7	3.7			3.0		2.2	
Vaccinium scoparium	7680	D	8.6	11.2			9.6					8.3		6.9	6.9	
		W	3.5	3.8			3.4					?		2.9	3.1	

[1]Percent nitrogen on a wet wt. basis calculated as follows: $\%N_W = \frac{(\%N_D)(\text{dry wt of sample})}{\text{wet wt of sample}}$

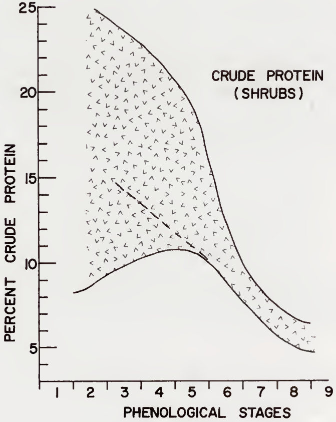
where $\%N_D$ = percent nitrogen on oven dry basis.

[2]The wet weight data for some of the samples were lost, making it impossible to calculate the %N on a wet weight basis.



[1]For description of phenological stages see Table 8, p. 84.

Figure 3. Seasonal trend in percent protein, dry weight basis, forbs, 1978.



[1]For description of phenological states see Table 8, p. 84.

Figure 4. Seasonal trend in percent protein on a dry weight basis, shrubs, 1978.

Dry weight protein contents of most shrubs collected in early phenological stages ranged from 14 to 25%. However, by the end of the growing season, the range in protein content for all the shrubs was much narrower and was very close to the minimum percentage considered necessary for mule deer maintenance.

The protein content of forbs on a dry weight basis ranged somewhat higher than for shrubs in early stages of phenology, but declined during autumn to levels near the minimum percentage for deer maintenance. However, the range of values at this time was greater than for shrubs (Figs. 3 and 4). Protein content of forb species collected at high and low elevation sites were similar during most of the development period. At the stage of dormancy, however, plants at high elevation sites maintained greater percentages of crude protein. One explanation for this may be that those plants collected at higher elevations, although dormant, had not progressed as far into dormancy, and lost less protein from the leaves than plants collected at lower elevations.

The data were also analyzed on the basis of percent protein per unit of forage wet weight since high water content of forage during spring and early summer could dilute protein levels to the extent that deer may have difficulty obtaining adequate amounts. Results showed rather convincingly (Figs. 5 and 6) that in spite of the high water content early in the season, the percent protein on a wet weight basis for shrubs was still slightly higher in spring than fall and remained about the same for forbs at moderate elevations. At high elevations in the fall, the percent protein on a wet weight basis increased sharply for all the forbs tested as a consequence of having a relatively high protein content, coupled with a very low moisture content. One may conclude that high water content of forage species in spring and early summer probably do not effect the ability of deer to obtain protein at that time. The availability of protein at high elevations in the fall (i.e. 8000-8500 feet as investigated here) may be greater than at any other locations at any other time.

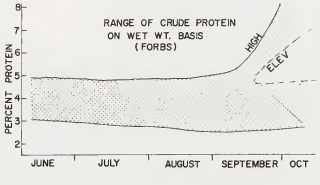


Figure 5. Seasonal trend in percent crude protein on a wet weight basis, forbs, 1978.

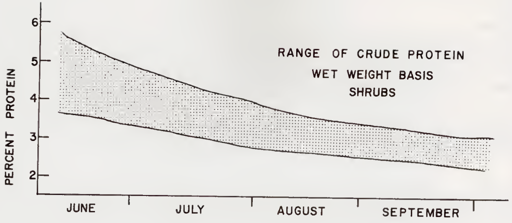


Figure 6. Seasonal trend in percent crude protein on a wet weight basis, shrubs, 1978.

Distribution, Movements and Habitat Use

Winter

General distributional characteristics of mule deer in the Bridger Range during winter were described by Mackie et al. (1978). Overall distributions recorded in early and late winter aerial surveys during 1978-79 were generally similar to previous years. The only differences observed were in local distributions within major winter range boundaries during late winter. Notable in this respect were: 1) an extreme concentration of deer on that portion of the West Slope-South Unit which lies within the mouth of Bridger Canyon and 2) the apparent movement or shift of large numbers of mule deer, possibly 200-300 from the Blacktail Winter Range north to the 16-Mile Creek area. Also, the Hatfield Mountain-South Fork portion of the South 16-Mile Winter Range held very few deer in both early and late winter. Other differences were even more local and expected from previous observations under the severe weather and snow conditions which prevailed throughout the winter. The fact that no mule deer have been marked in any of the areas on which significant distributional changes occurred precludes further analysis of the movements at this time. Observations on the intensively studied Armstrong, Schafer Creek and Brackett Creek winter ranges throughout the winter indicated that by mid-winter most animals were confined to primary or critical range areas within the total winter ranges. These concentrations began to break up on the Brackett Creek area in late February (Nyberg In Prep.), but persisted into mid-March on west slope winter ranges.

The recently completed, intensive studies of winter habitat use of radio-collared deer on the Armstrong study area (Youmans 1979, see abstract in this report) have contributed significantly to our understanding of winter distribution and habitat use on that area. Especially notable was documentation of three subunits, comprising the north, central and south portions of the Armstrong winter range. These were relatively discrete, with only slight overlap between north and central and central and south units. The distribution and movements of individual marked does were almost totally restricted to the individual subunits on which they were marked. Some apparent relationships between this pattern of winter distribution and other seasonal distribution as well as implications in the dynamics of mule deer on the Armstrong area will be discussed later. The findings of this study also indicated that usage of various habitat and cover types varies between deer associated with each of the subunits and that previous analysis of habitat usage based on general observations probably have greatly underestimated the use and importance of timbered types. They further suggested that habitat usage reflected a strategy of energy conservation rather than forage gathering.

Summer

Substantial data on spring-summer-fall distribution, movements and habitat usage of deer in the Bridger Range have been obtained for animals associated with the Armstrong, Schafer Creek and Brackett Creek winter ranges. Some limited data on seasonal movements have also been obtained for deer wintering near the mouth of Bridger Canyon. Findings for the Armstrong population have been reported and discussed by Schwarzkoph (1973), Hamlin (1974, Pac (1976), Mackie et al. (1976), Mackie and Knowles (1977) and Mackie et al. (1978). Data for the Schafer Creek population were discussed by Steerey (1979), while Nyberg (in prep.) presents findings for deer associated with the Brackett Creek winter range.

As reported by Mackie et al. (1978), all 800 square miles included in the study area may be used by mule deer during spring, summer and fall. Most summer-fall activity and use by mule deer occurs within the Bridger Range at elevations above about 5,600 feet or within an area encompassing approximately 434 square miles. Notable exceptions occur where deer continue to use winter ranges and agricultural crop and rangelands below 5,600 feet.

Spring dispersal and summer distribution and movements of deer associated with the Armstrong winter range were discussed by Mackie and Knowles (1977) and Mackie et al. (1978). Additional data obtained during 1979 showed generally similar dispersal and summer movements and supported earlier conclusions. Four deer first equipped with transmitters in late winter 1979, moved off the winter range in a northerly direction. One spent the summer at low to moderate elevations in the North Cottonwood drainage, the second utilized foothill slopes south of Mill Creek, the third moved to an upper tributary of Mill Creek, and the fourth summered at the head of Johnson Canyon. One of the two deer radio-collared on winter range in lower Tom Reese Creek spent the summer just east of the winter range, while the other crossed the Bridger Divide and summered along the South Fork of Carrol Creek.

Generalized summer home range polygons for all radio-collared deer for which movements off the Armstrong range have been monitored since 1975 are shown in Figure 7. The drainages most frequently used by Armstrong deer were Bill Smith and North Cottonwood Creeks, where 15 of 30 (50%) radio-collared deer spent the summer. Six of the 30 (20%) had summer home ranges in the Mill, Johnson, and Pass Creek drainages. The east slope of the Bridger Range was utilized by 7 of 30 (23%) individuals with most summering in Frazier Creek and Carrol Creek. The remaining two (7%) had summer home ranges in Tom Reese Creek. These data, together with similar findings for deer marked on the Schafer Creek and Brackett Creek winter ranges, support the suggestion (Mackie et al. 1978) that deer associated with the various winter ranges in the Bridger Mountains comprise population units which occupy fairly distinct and definable herd ranges.

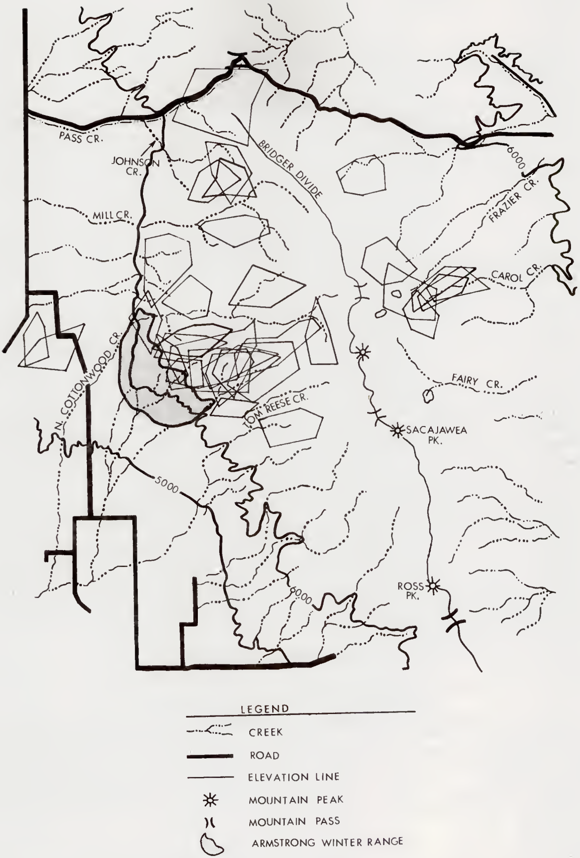


Figure 7. Generalized summer home range polygons for 30 mule deer radio-marked on the Armstrong winter range 1975-79.

Generalized summer dispersal patterns of marked deer off various winter ranges in the Bridger Mountains are shown in Figure 8. These data also illustrate the general location and the relationships between individual herd ranges. The Armstrong herd range appears to be bounded on the north by Pass Creek and Flathead Creek, on the east by State Highway 293, on the south by North Fork of Brackett Creek and Tom Reese Creek, and on the west by Foster Creek. The Schafer Creek herd range extends north to Jones Creek, east to Bangtail Ridge and as far south as Beasley Creek. The Brackett Creek herd range is bounded on the north by Battle Ridge, on the east by Shields River, on the south by Interstate 90 and on the west by State Highway 293, although a few deer move as far as the Bridger Divide. Data for deer wintering near the mouth of Bridger Canyon are limited. Relations of two deer, radio-collared in April 1979, showed that one spent most of the summer on and adjacent to the winter range; the other moved north to summer in Pine Creek.

Overlap occurs between individual herd ranges and seems to be more prevalent in particular areas. The east and west slopes of Bridger Canyon is one portion of the Bridger Range where deer from the four winter ranges may "mix" somewhat during summer and fall.

Yearlong movements of radio-collared and neck-banded deer associated with the Armstrong range have shown that individuals using subunits or particular portions of the winter range (Youman's 1979) may be at least generally associated with particular portions of the summer herd range (Figure 9). Deer that use the northern portion of the winter range and belong to subunit 1 tend to distribute themselves in the northern part of the herd range. Individuals belonging to subunit 2 on the winter range generally spend the summer in the central and southern parts of the herd range while the greater percentage of subunit 3 deer spend the summer on the east slope of the Bridgers. There are numerous exceptions with considerable overlap occuring between individuals from the three subunits. In general, males appear less consistent in their distribution patterns than females and some may change either their summer or winter home ranges between years. Also, movements of some adult males during the breeding season have been erratic and involved temporary movements outside the normal herd range. Several young males have been known to emigrate and become "residents" of other herd ranges. We have no positive record of any marked female of any age dispersing from the Armstrong herd range or changing a seasonal home range between years. However, an adult female marked on Brackett Creek in March 1978 spent the following winter 7 miles to the north on the Battle Ridge winter range.

Population Characteristics

Trend and Dynamics of the Armstrong Deer Population

Trends in estimated mule deer numbers and the sex and age composition of late winter-spring population on the Armstrong winter range from 1973 through 1978 were discussed in detail by Mackie et al. (1978). Population estimates for mule deer using the Armstrong winter range during 1977-79 are presented in Tables 12 and 13. These were developed as Lincoln (Overton and Davis 1969) and Schnabel indicies for observations of marked and unmarked animals during early and late winter.

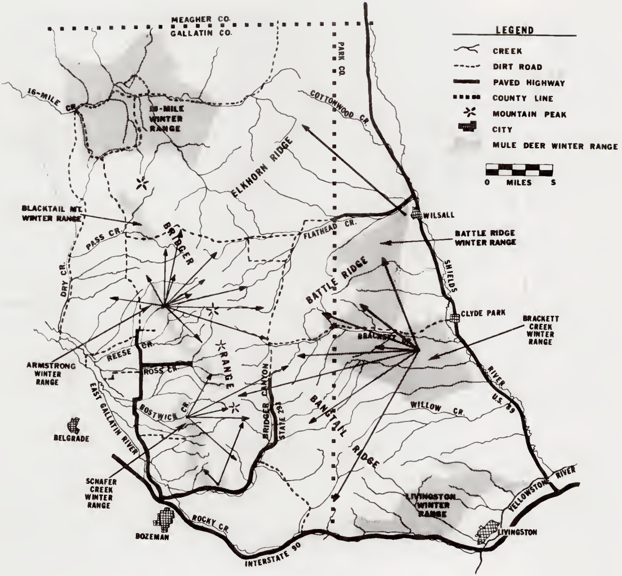


Figure 8. Generalized dispersal patterns of mule deer associated with various winter ranges in the Bridger Mountains.

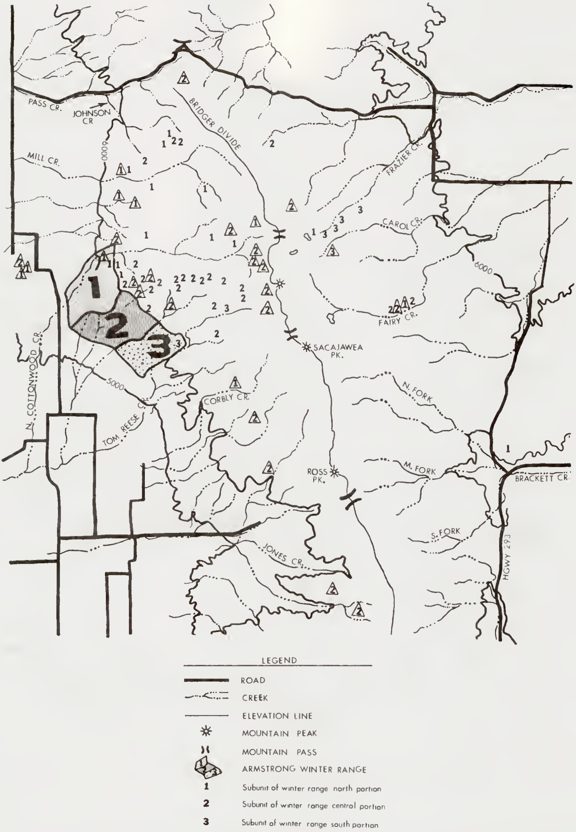


Figure 9. Relationship between winter and summer distributions among mule deer marked on the Armstrong winter range, 1972 - 1979. Small numerals indicate summer locations of deer associated with correspondingly numbered subunits of the winter range. Triangles around numerals indicate males.

Cumulative ground, aerial and trapping records provided knowledge of the numbers of marked deer on the area throughout the winter. At the end of April, approximately 105 animals wearing recognizable collars were on the winter range. It is possible that even more marked animals could have been present since 13 fawns and 1 yearling male marked during 1979 and 39 adults tagged in previous years but not observed during the 1978-79 winter were not included in the spring total. All marked adults observed in early winter 1979 were accounted for in spring. Because of this, the 13 missing fawns, last seen prior to early March, were believed to have died. The yearling male was last seen in early March in very poor physical condition. Ten of the 39 adults of unknown status were last seen during the spring of 1978, while the remainder have not been observed since the spring of 1976 or earlier (Table 3).

The mean percentage of collared deer in April observations made between Bill Smith and North Cottonwood Creeks was 69.2 percent, ranging from 59.3 to 75.0 percent in daily observations. Between 25 and 45 percent of all deer on the Armstrong range were marked at various times during the previous five winters.

For spring 1979, a population of 140 animals is believed to represent the best estimate of mule deer numbers on the Armstrong winter range. The mean Lincoln index for 12 ground surveys in April, was 140 mule deer (Table 12). The Schnabel index was similar at 139 deer. A point estimate of 140 deer is also obtained assuming a total collared deer population of 98 animals to represent 70 percent of all deer using the area between Bill Smith Creek and North Cottonwood Creek. Lincoln and Schnabel indicies indicate that approximately 50-60 deer used the area between Bill Smith and Tom Reese Creek just south of the Armstrong winter range. Interchange of individuals between this group and deer wintering on the southern portion of the Armstrong range apparently occur during some winters, and may be more frequent following spring green-up.

Estimates of mule deer numbers on the Armstrong range during early winter (Figure 10) generally are more difficult to obtain than those for late winter, when the population is much more concentrated, the deer use open habitat types, and maximum numbers of marked deer occur. Using over-winter mortality rates of marked adults and fawn:doe ratios observed during classification flights in December, an early winter population numbering about 234 deer was expected. This would have included about 110 adult females, 6 adult males, 15 yearling males, and 102 fawns.

The estimated 140 deer on the Armstrong range in early spring 1979 included approximately 104 adult females, 6 adult males, 11 yearling males, and 19 fawns (Table 13). These data compared with estimates for early winter indicated substantial over-winter mortality. Approximately 94 animals died, or 40 percent of the early winter population.

Known deaths included 36 deer found dead during the winter or during a systematic search for carcasses in late April (Table 14). Mortality was severe among fawns, the total possibly reaching 81 percent of early winter numbers. Among 37 fawns marked between early January and early March, 30 percent were found dead while an additional 32 percent were unaccounted for in the spring and believed dead. Other losses, not documented in losses of marked fawns, probably occurred as a result of severe early winter weather before and during the trapping period.

Table 12. Late winter estimates of numbers of mule deer on the Armstrong winter range, April, 1979.

Estimated Numbers Total	S	Remarks
140	11.06	$\overline{X}$ Lincoln Index for 12 ground surveys (47-123 deer obs/survey) and 95-98 collars in population.
139		Schnabel Index for 12 ground surveys (47-123 deer obs/survey) and 95-98 collars in population.

Table 13. Estimated late winter-spring mule deer populations on the Armstrong winter range, 1973-1979.

Year	Total Number	No. Adult Females	No. Males		No. Fawns
			Adult	Yearling	
1973	230	123	31	27	49
1974[1]	220	130	27	23	40
1975	140	92	35	8	5
1976	170	118	37	3	12
1977	200	120	24	6	50
1978	160	116	6	6	32
1979	140	104	6	11	19

[1]No population estimate calculated. A spring population slightly lower than that of 1973 is assumed consistent with fawn production and survival for 1973 and 1974 and an early winter estimate of 210 mule deer on the range in January 1975 (Mackie et al. 1976).

Table 14. Number and age classes of winter-killed mule deer found on the Armstrong winter range, 1971-1979.

Year	Total	Fawns	Yearling	Prime	Old	Unknown
1971-1972	19	9	-	-	10	-
1972-1973	18	12	-	1	5	-
1973-1974	12	10	-	-	2	-
1974-1975	42	16	2	10	14	-
1975-1976	2	2	-	-	-	-
1976-1977	2	-	-	1	1	-
1977-1978	25	11	-	-	7	7
1978-1979	36	26	2	1	6	1
TOTAL	156	86(55.1%)	4(2.6%)	13(8.3%)	45(28.8%)	8(5.1%)

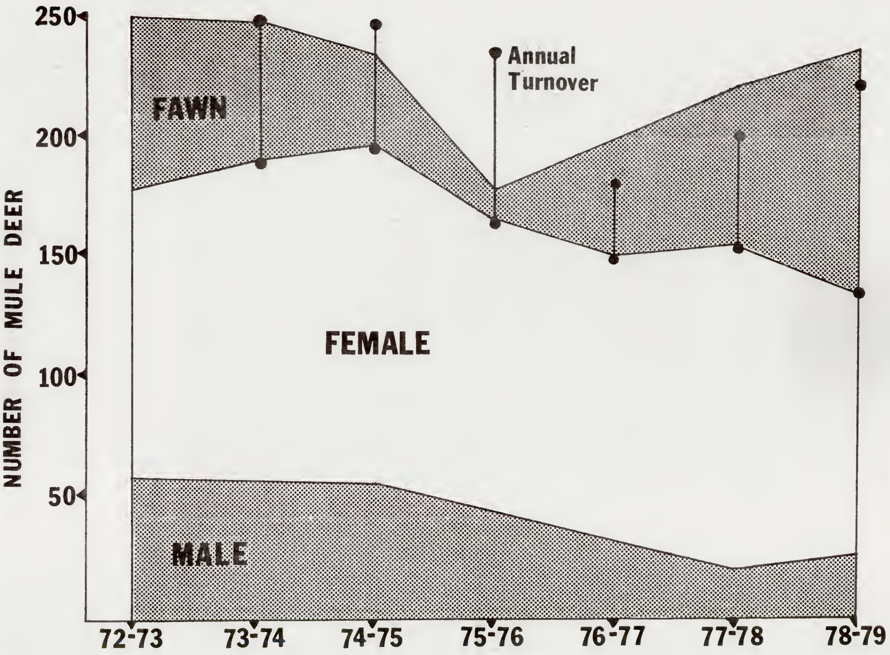


Figure 10. Early winter population trend of mule deer on the Armstrong winter range, Bridger Mountains, 1972-79.

The time of mortality among marked fawns apparently varied by sex. Mortality of female fawns was most prevalent in January and February while male fawns succumbed in late March and early April. The latter occurred after the March 12 aerial classification of the Armstrong range (Table 15). The sex ratio of fawns that survived was 180♂♂/100♀♀. Mortality records also indicated that fawn losses were not evenly distributed across the Armstrong winter range. Approximately 79 percent of all fawns marked on the northern portion of the area died or apparently died while only 44 percent of those marked on the central portion were not accounted for in spring.

Adult losses were comparatively light and totaled approximately 8 percent. Mortality of females and males was estimated at 5 percent and 24 percent, respectively, among marked adults.

Data obtained through trapping and marking together with intensive aerial and ground observations have provided basis for annual estimates of the size and sex-age composition of the Armstrong mule deer population during late spring, 1973-1979 (Table 13). To further evaluate trends and year-to-year dynamics, annually obtained data were used to develop a mathematical model of the Armstrong population using a computor population simulation program (POSIM Mooney and Lonner 1978).

A brief summary of POSIM data analysis and output are shown in Table 16. For data in some years, discrepancies occurred between mortality and for recruitment rates derived from POSIM and those implied by our data. In 1976-77, for example, a population of 40 adult males and 6 yearling males was estimated through POSIM to be present on July 1, 1976. Our data indicated very low hunter harvest and over-winter mortality of males during 1976-77. To arrive at our spring population estimate of 24 adult males and 6 yearling males we had to eliminate 16 individuals for which we had only limited data to support mortality. This led us to believe that innaccurate data on population size and composition for 1972 may have been used to initialize the POSIM program. Other possible explanations include poor documentation and lack of understanding of male harvest rates; or inaccurate estimates of numbers of yearling and adult males on the area in spring.

In May 1977, our data indicated a spring recruitment of 50 animals (presumably 25 females and 25 males). This would have resulted in a population of 144 adult females and 55 adult males on July 1, 1977. To arrive at a population of 116 adult females and 12 adult males estimated by our spring population data, mortality rates would have had to occur that were significantly higher than we documented. This indicated that either we over-estimated actual recruitment in spring 1977 or under-estimated mortality during 1977-78. The former, in our judgment, probably represents the best explanation for this discrepancy. In this manner, POSIM was used to uncover weaknesses in our understanding of certain aspects of Armstrong population dynamics.

Hunting mortality appeared to be lower in 1978 than the previous year (Table 17). In 1977, 60 percent of the marked bucks from the Armstrong range were shot. Tag returns during the 1978 hunting season showed that 4 of 11 (36%) marked males were killed. These included one 2½-year-old which died in mid-November, evidently as a crippling loss. Three of the 11 (27%) marked males which left the winter range in May 1978 and presumed to be alive during fall were not accounted for during the winter. These may represent undocumented mortality, or they may have spent the winter undetected on another winter range. All three were young males. Thirty-six percent of the marked male sample was known to be alive at the close of the hunting season. Seven other

Table 15. Aerial classifications of mule deer on the Armstrong winter range, January 1972 through March 1979.[1]

			NUMBERS							RATIOS			PERCENTAGES		
			Total Count	Total Class.	Adults	Males	Females	Fawn	Uncl.	F:100 Females	F:100 A	Males:100 Females	% Fawn	% Ylg Males	% Spike Ylg Male
Reese Creek -	1971-72	Jan. 3	173	173	119	39	80	54	-	68	45	49	31	56	26
N. Cottonwood		Mar. 28	92	83	68	-	-	15	9	-	22	-	18	-	-
	1972-73	Feb. 7	188	188	143	-	-	55	-	-	31	-	24	-	-
	1973-74	Dec. 27	131	131	100	28	72	31	-	43	31	39	24	46	62
		Apr. 1	188	188	154	-	-	34	-	-	22	-	18	-	-
	1974-75	Jan. 5	140	140	116	37	79	24	-	30	21	47	17	19	17
		Mar. 23	227	227	214	-	-	13	-	-	6	-	6	-	-
		Apr. 20	99	99	96	-	-	3	-	-	3	-	3	-	-
	1975-76	Jan. 2	121	121	113	29	84	8	-	10	7	35	7	7	100
		Mar. 15	102	102	90	-	-	12	-	-	13	-	12	-	-
	1976-77	Jan. 5-9	90	90	70	14	56	20	-	36	29	25	22	21	100
		Mar. 10-11	116	116	87	-	-	29	-	-	33	-	25	-	-
	1977-78	Dec. 19	133	133	94	11	83	39	-	47	42	13	29	46	40
		Apr. 2	126	126	101	-	-	25	-	-	25	-	20	-	-
	1978-79	Dec. 26	118	118	68	14	54	50	-	93	74	26	42	43	29
		Mar. 12	98	98	68	-	-	30	-	-	44	-	31	-	-

[1] Includes some animals ranging between Bill Smith and Reese Creeks not included in the Armstrong winter range population.

Table 16. Seasonal and annual trends in the Armstrong mule deer population 1972-1979.

	Fawns	Ad.♀♀	Ad.♂♂	Yearling♂♂
1972-73				
July 1, 1972	184	150	60	30
	(-106)[1]	(-12)	(-23)	(-2)
Jan. 1, 1973	78	138	37	28
	(-29)	(-15)	(-6)	(-1)
May 1, 1973	49	123	31	27
1973-74				
May 1, 1973	193	147	58	25
	(-134)	(-11)	(-27)	(-1)
Jan. 1, 1974	59	136	31	24
	(-19)	(-6)	(-4)	(-1)
May 1, 1974	40	130	27	23
1974-75				
July 1, 1974	206	150	50	20
	(-163)	(-7)	(-8)	(-5)
Jan. 1, 1975	43	143	42	15
	(-37)	(-30)	(-7)	(-7)
May 1, 1975	6	113 [2]	35	8
1975-76				
July 1, 1975	186	120	43	3
	(-172)	(-2)	(-4)	(-0)
Jan. 1, 1976	14	118	39	3
	(-2)	(-0)	(-2)	(-0)
May 1, 1976	12	118	37	3
1976-77				
July 1, 1976	190	124	40	6
	(-140)	(-0)	(-16)	(-0)
Jan. 1, 1977	50	124	24	6
	(-0)	(-4)	(-0)	(-0)
May 1, 1977	50	120	24	6
1977-78				
July 1, 1977	184	145	30	25
	(-124)	(-2)	(-19)	(-19)
Jan. 1, 1978	60	143	11	6
	(-28)	(-27)	(-5)	(-0)
May 1, 1978	32	116	6	6
1978-79				
July 1, 1978	190	132	12	16
	(-88)	(-2)	(-0)	(-2)
Jan. 1, 1979	102	130	12	14
	(-83)	(-26)	(-6)	(-3)
May 1, 1979	19	104	6	11

[1] Losses between time periods in parentheses.

[2] Approximately 21 adult females that apparently wintered off the area in 1974-75 were included in the spring estimate.

Table 17. Known hunting mortality of mule deer marked on the Armstrong winter range, 1972-78.

Year Marked	No. Marked	Year Killed 1972	1973	1974	1975	1976	1977	1978	Total
1972	5	1(1½M)	1(2½M)	0	0	1(5½M)	0	0	3
1973	16	-	0	1(7½M)	0	0	0	0	1
1974	39	-	-	1(1½M)	0	0	2(4½M) (10+M)	0	3
1975	36	-	-	-	2(4½M) (6½F)	1(3½M)	4(5½M) (7½M) (4½M) (7½M)	1(7½M)	8
1976	9	-	-	-	-	0	1(Ad.M)	0	1
1977	16	-	-	-	-	-	2(2½M) (8½M)	0	2
1978	42	-	-	-	-	-	-	2(2½M)[1/] (2½M)	2
TOTALS	163	1	1	2	2	2	9	3	20
No. Marked in Pop.[2/]		5	20	56/58	67/69	64/78	66/87	72/109	
% Shot		20.0	5.0	3.5	2.9	2.8	12.8	3.3	

[1]An additional 2½ year-old male marked in 1978 was a probable cripple loss during the 1978 hunting season.

[2]1974-1978 - Known no. marked/total possible marked deer that could have been present.

unmarked bucks were known to have been shot in the vicinity of the Armstrong winter range during fall 1978. As in 1976-77, hunting was for males only, except for 100 either-sex permits issued for National Forest lands within Hunting District 312 which includes the Bridger Range.

The proportion of adult males in the Armstrong population has declined progressively from early winter 1974-75 to spring 1978 (Figure 10, Table 13). Although numbers of males were still low in spring 1979, some improvement in yearling recruitment seemed evident. The four year trend has been influenced greatly by low yearling recruitment, periodic over-winter mortality of old adult males, and hunting losses of prime-aged adults throughout the period, but especially in 1977. As shown in Figure 10, early winter numbers of adult females also declined in 1978-79 after remaining relatively stable from 1975-76 to 1977-78. This may be attributed to poor recruitment of females during spring 1978, which failed to compensate for higher mortality rates experienced by a predominantly old-age structured female segment. If female recruitment fails to increase substantially in the next 2 years a promounced decline in numbers of adult females can be expected.

Table 18 lists the distribution by age class of mule deer trapped on the Armstrong range each year since 1972. Ages were assigned to the nearest year when possible or to an age category on the basis of tooth replacement and wear (Robinette et al. 1957). Mackie et al. 1978 indicated that life expectancy of male mule deer in the Bridger Mountains appear to be only about two-thirds as long as that of females (7-8 years vs. 10-12 years). The effects on population trends and dynamics of variability in annual recruitment, as well as differences in mortality rates and patterns was also discussed.

Age structural data for the 1979 winter-spring population (Table 18) indicate that the young animals greatly predominated among males while old and very old animals predominated in the female segment. Approximately 83 percent of the adult males were 2½ years of age or less. In contrast, 68 percent of the adult females were older than 6½ years and only 4 percent were aged as yearlings.

Fawn Production and Survival

Aerial classification of deer on the Armstrong range during helicopter surveys in late December 1978 and mid-March 1979 are listed in Table 15 together with comparable data for previous years. The 93 fawns: 100 females and 74 fawns: 100 adults were the highest early winter ratios recorded since the study began in January 1972. The 44 fawns: 100 adults observed in March 1979 was also higher than any late winter ratio recorded in previous years. However, as noted earlier, significant mortality of fawns occurred after mid-March. Much less favorable results are obtained when the adjusted ratios are converted to late spring fawns: female ratios and compared with previous years. Spring population estimates show 40 fawns: 100 females in the spring of 1973, 31:100 in 1974, 5:100 in 1975, 10:100 in 1976, 42:100 in 1977, 27:100 in 1978, and 18:100 in 1979. In this light, survival to spring was lower than all other years except 1975 and 1976.

Over-winter mortality of fawns during 1978-79 approached 80 percent. Mortality during previous winters has ranged from little or none (1977) to 85-90 percent (1975). The severe winter combined with a late spring green-up may have precipitated high total fawn loss. Aerial observations of radio-collared females through August 1979 show a fawn: female ratio of 54:100 as compared to 113:100 for summer 1978. Then data may indicate lower fawn production and/or postpartum survival during the current year.

Table 18. Mule deer population age structure on the Armstrong winter range as determined from deer trapping samples, 1972-1979.

Year	Sex	Total No.	Numbers of deer by age category						
			½	1	2-5	6-7	8-10	10+	Uncl. Ad.
1972	M	4	4						
	F	1			1				
1973	M	6	1	1	4				
	F	12		1	9		2		
1974	M	12	4	2	3	1			2
	F	36	1	5	21	2	4	2	1
1975	M	21	2	2	15		2		
	F	29	2		17	4	3	3	
1976	M	15			10	2	1		2
	F	8		1	4	2	1		
1977	M	13		1	4	7	1		
	F	20	1		12	5	2		
1978	M	18	10	4	2	1	1		
	F	53	6	4	17	14	11	1	
1979*	M	39	22	11	3	1	1	0	1
	F	97	15	3	16	30	24	2	7

*Includes observations that verify presence of deer aged in 1978.

In utero production for 23 female mule deer collected in the Bridger Mountains between 1973 and 1979 has averaged 139 fetuses per 100 females 2.5-years of age and older, and 100:100 for yearling females. Reproductive data for individual females examined are listed in Appendix Table 21. Although sample sizes are rather limited, these data suggest an overall fetal rate somewhat lower than reported for mule deer on most other ranges in Montana and elsewhere (Knowles 1977). When the potential for the Bridger Range is compared with realized reproduction to early winter on the Armstrong range from 1971-72 through 1978-79, substantial mortality between parturition and early winter is evident and may be characteristic of this range and population. Data on fawns in the population during summer and fall are limited or lacking for most years. Pac (1976) found considerable fawn mortality to occur in late fall during 1975.

During early winter 1978-79, 6 (43%) of 14 males observed during aerial classifications were yearlings (Table 15). This compared with 5 (46%) of 11 males observed in late December 1979. While higher recruitment and survival of yearlings through their first fall is indicated for the past two years, yearling recruitment to and through the 1978-79 winter was relatively low compared to 1973 and 1974. Fifteen yearling males were believed to occur in the Armstrong population in early winter and 11 survived to April.

General Population Characteristics of Bridger Mountain Mule Deer, 1978-79.

Totals of 4,854 and 4,594 mule deer were classified throughout the Bridger Range including the North 16-Mile area in early and late winter, respectively (Table 19). These were the highest counts recorded for both periods since the surveys were initiated in 1974-75. Early winter (December) counts were up substantially from the same period in 1977 on the east side (Battle Ridge, Brackett Creek and Livingston) winter ranges as well as in the 16-Mile basin, while counts were generally down on west slope ranges. Compared with counts for previous years, these data suggested generally increasing populations on the east side and in the 16-Mile basin, while west slope numbers have remained stable or declined since 1974-75.

The aerial counts underestimate actual numbers of deer present on winter range, more so in early than in late winter (Mackie et al. 1978). In 1977-78, data for the intensively studies Armstrong area indicated sampling efficiencies of about 47% and 59% for early and late winter. We believed that these rates applied about equally to other west slope ranges, while the efficiency of sampling on more open east side and 16-Mile ranges probably was higher; perhaps 75%. On this basis, a total mule deer population of 4,500-5,000 was estimated for the entire Bridger Complex in early winter 1977-78. Data obtained in 1978-79 suggested that this estimate may have been too low.

For 1978-79, calculated sampling efficiencies for the Armstrong Range were approximately 40% in early winter and 64% in late winter. For the same time periods, Nyberg (In Prep.) estimated sampling efficiencies for the Brackett Creek winter range as about 48% and 65%, respectively. Using Armstrong data for the west slope and Brackett Creek data for the east slope provides 1978-79 total population estimates of about 7,800 mule deer

Table 19. Numbers and sex and age ratios of mule deer classified by aerial (helicopter) survey on various winter ranges in the Bridger Mountain complex during early and late winter, 1971-72 through 1978-79.

		1971-72		1972-73		1973-74		1974-75		1975-76		1976-77		1977-78		1978-79	
		Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late	Early	Late
NO. END WEST SLOPE	No. Classif.	204	352	523		367	356*	412	600	288	266	236	281	325	315	302	252
	♂♂:100 ♀	39.6	–	–		39.8	–	31.1	–	29.9	–	24.7	–	19.7	–	16.7	–
	FF:100 ♀	62.3	–	–		38.3	–	34.8	–	9.2	–	37.0	–	48.7	–	84.7	–
	FF:100 AD	44.6	29.9	32.7		27.4	19.0	26.5	9.4	7.1	6.1	29.6	34.4	40.7	30.3	72.5	39.9
SO. END WEST SLOPE	No. Classif.	470	332	271		174	162	459	448	335	307	335	365	336	121	277	473
	♂♂:100 ♀♀	39.1	–	–		39.6	–	22.8	–	28.6	–	27.2	–	25.0	–	11.2	–
	FF:100 ♀♀	45.4	–	–		32.6	–	51.1	–	25.8	–	46.1	–	53.7	–	61.2	–
	FF:100 AD	32.6	26.7	38.1		23.4	14.8	41.6	31.7	20.0	12.0	36.2	30.8	42.9	31.2	55.0	39.9
BLACKTAIL MOUNTAIN	No. Classif.	–	–	–		–	–	79	–	174	–	69	133	221	93	172	92
	♂♂:100 ♀♀	–	–	–		–	–	48.6	–	33.3	–	24.3	–	19.2	–	11.9	–
	FF:100 ♀♀	–	–	–		–	–	64.8	–	27.7	–	62.1	–	50.7	–	90.4	–
	FF:100 AD	–	–	–		–	–	43.6	–	20.8	–	50.0	37.1	42.5	40.9	80.8	27.8
SOUTH 16-MILE	No. Classif.	–	–	–		–	–	378	–	290	–	307	–	543	–	601	726
	♂♂:100 ♀♀	–	–	–		–	–	6.2	–	16.2	–	5.0	–	7.5	–	14.0	–
	FF:100 ♀♀	–	–	–		–	–	24.5	–	22.4	–	49.2	–	68.2	–	67.7	–
	FF:100 AD	–	–	–		–	–	23.1	–	19.3	–	46.8	–	63.4	–	59.4	46.8
NORTH 16-MILE	No. Classif.	–	–	–		–	–	665	483+	766	725	814	831	910	1050	1267	1041
	♂♂:100 ♀♀	–	–	–		–	–	6.6	–	15.9	–	8.0	–	9.5	–	14.9	–
	FF:100 ♀♀	–	–	–		–	–	35.4	–	25.6	–	43.3	–	67.8	–	77.5	–
	FF:100 AD	–	–	–		–	–	33.2	32.7	22.1	10.0	40.0	25.9	61.9	39.3	67.6	47.6
BATTLE RIDGE	No. Classif.	–	–	–		–	–	–	–	148	–	81	–	388	–	629	515
	♂♂:100 ♀♀	–	–	–		–	–	–	–	5.3	–	24.5	–	22.8	–	24.6	–
	FF:100 ♀♀	–	–	–		–	–	–	–	25.6	–	54.1	–	78.2	–	96.1	–
	FF:100 AD	–	–	–		–	–	–	–	24.3	–	47.2	–	63.7	–	77.1	42.7
BRACKETT CREEK	No. Classif.	–	–	–		–	–	299	–	560	–	–	–	978	509	1120	1057
	♂♂:100 ♀♀	–	–	–		–	–	11.3	–	5.0	–	–	–	12.2	–	13.1	–
	FF:100 ♀♀	–	–	–		–	–	49.4	–	32.5	–	–	–	74.1	–	77.2	–
	FF:100 AD	–	–	–		–	–	44.4	–	31.0	–	–	–	66.0	51.2	68.1	31.1
LIVINGSTON-BILLMAN CR.	No. Classif.	–	–	–		–	–	300	–	223	–	–	–	266	–	460	436
	♂♂:100 ♀♀	–	–	–		–	–	12.8	–	10.7	–	–	–	18.9	–	24.1	–
	FF:100 ♀♀	–	–	–		–	–	41.0	–	26.1	–	–	–	67.1	–	74.4	–
	FF:100 AD	–	–	–		–	–	36.3	–	23.6	–	–	–	56.4	–	57.6	28.2
OTHER MISCELLANEOUS AREAS	No. Classif.	–	–	–		–	–	–	–	–	–	–	–	28		26	
	♂♂:100 ♀♀	–	–	–		–	–	–	–	–	–	–	–	7.1	–	11.1	
	FF:100 ♀♀	–	–	–		–	–	–	–	–	–	–	–	92.9	–	100.0	–
	FF:100 AD	–	–	–		–	–	–	–	–	–	–	–	86.6	–	90.0	–
BRIDGER RANGE TOTALS	No. Classif.	674	684	794		541	518	2592	1531	2784	1298	1842	1610	4060	2088	4854	4594
	♂♂:100 ♀♀	39.3	–	–		39.7	–	14.8	–	16.5	–	13.5	–	14.6	–	16.0	–
	FF:100 ♀♀	50.3	–	–		36.4	–	38.7	–	25.1	–	45.0	–	66.4	–	77.7	–
	FF:100 AD	36.1	28.3	34.4		26.1	18.5	33.7	22.3	21.5	9.7	39.6	29.3	58.0	39.9	66.9	43.9

*Not including 100+ unclassified
+Northwest of 16-Mile Creek only

for early winter and 5,500 for late winter. These estimates excluded the North 16-Mile area, which is not considered part of the Bridger Complex.

These data indicate an approximate late December-mid March loss of about 29%, including 10-12% of all adults and 56-58% of all fawns present in early winter. As indicated earlier, an estimated 40% of all deer present on the Armstrong Range in early winter died, including about 8% of the adults and up to 81% of the fawns. The Armstrong data, however, included additional losses which occurred in late March and April. Nyberg (in prep.) estimated total losses on the Brackett Creek winter range at approximately 10% of all adults and 58% of all fawns for the December-March survey period, but also noted additional losses of deer in late March and April. Because of this, the estimate of 5,500 deer probably overestimates the number alive in spring, and the 10-12% and 56-58% mortality rate for adults and fawns, respectively, would also be minimal for the total Bridger Mountain mule deer population. However, at this time we have no basis for believing that very high total mortality rates experienced on the Armstrong area also applied on other winter ranges, especially on the east slope and in the 16-Mile basin.

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Submitted by: Richard J. Mackie

David F. Pac

Henry E. Jorgensen

Appendix Table 20. List and current status of radio-collared deer on the Armstrong range.

Radio No.	Animal No.	Sex	Age[1]	Date Collared	Collar Type	Trans. Freq.[2]	Remarks/Status
1	14-73	F	3½+	2/10/73	Belt	M-4 AVM 1-8	Failed immediately Recollared 1/21/79
2	7-74	F	Mat	4/16/74	Tygon	M-4	Failed? Never relocated
3	8-74	F	Mat	4/16/74	Tygon	M-8	Failed - May 1974
4	3-72	F	6½+	3/6/75	Tygon	AVM 3	Failed - June 1978 Died Feb. 1979
5	34-74	F	Mat	3/29/75	Tygon	AVM 6	Winterkill - May 31, 1975
6	41-74	F	Mat	3/29/75	Tygon	AVM 1	Winterkill - May 2, 1975
7	16-75	F	2½+	4/9/75	Tygon	AVM 8 AVM 2-3	Failed late July 1976 Recollared 1/29/78
8	17-75	F	3½+	4/10/75	Tygon	AVM 2	Failed mid-Aug. 1976
9	20-75	F	5½+	4/13/75	Tygon	AVM 11	Shot by hunter 10/29/75
10	27-75	F	3½+	4/24/75	Tygon	AVM 12	Winterkill - May 13, 1975
11	9-73	F	7½+	5/8/75	Tygon	AVM 6	Died Dec. 1977
12	1-76	M	5½+	2/22/76	Tygon	AVM 6	Died March 1978
13	2-76	M	6½+	2/22/76	Tygon	AVM 1	Failed late June 1976
14	2-72	M	4½	2/25/76	Tygon	AVM 4	Shot by hunter 10/30/76
15	6/75	M	5½	2/27/76	2" PVC	AVM 2-8	Died Dec. 1977
16	1-75	F	1½	3/3/76	Tygon	AVM 11 AVM 1-2 AVM 2-9	OK when recollared on 1/24/78 Failed Jan. 1979 Recollared 2/27/79
17	1-73	F	4½	3/16/76	Tygon	AVM 5 AVM 1-7	Failed Dec. 1977 Recollared 1/10/78 Died March 1978
18	11-73	F	6½+	3/16/76	Tygon	AVM 10	Failed Dec. 1977 Died late March 1979
19	2-74	M	Mat	3/25/76	Tygon	AVM 7	Failed Nov. 1976 Shot by hunter 10/30/77
20	7-76	F	Mat	3/27/76	Tygon	AVM 9 AVM 1-4	Failed Jan. 1977 Recollared 1/23/78 Failed April 1979
21	1-77	F	Mat	1/31/77	1½" PVC	AVM 3	Failed June 1978
22	8-75	M	Mat	3/3/77	Tygon	AVM 8	Shot by hunter 11/26/77
23	19-74	F	Mat	3/5/77	2" PVC	AVM 1	OK through summer 1979
24	12-73	M	6½	3/20/77	Tygon	AVM 7	Died March 1978

Appendix Table 20. (continued).

Radio No.	Animal No.	Sex	Age[1]	Date Collared	Collar Type	Trans. Freq.[2]	Remarks/Status
25	4-77	F	8½+	3/22/77	1½" PVC	AVM 2-5	Died April 1978
26	35-75	M	6½+	4/2/77	Tygon	AVM 5	Died April/May 1977
27	1-78	F	6½+	1/21/78	1½" PVC	AVM 1-12	Failed August 1979
28	7-78	M	1½	1/25/78	1½" PVC	AVM 1-1	Died Nov. 1979
29	13-78	F	5½	3/17/78	1½" PVC	AVM 2-1	OK through summer 1979
30	20-78	F	5½+	2/4/78	1½" PVC	AVM 2-4	OK through summer 1979
31	40-78	F	½	4/24/78	1½" PVC	AVM 1-7	OK through summer 1979
32	41-78	F	6½+	4/24/78	1½" PVC	AVM 2-5	OK through summer 1979
33	42-78	F	6½+	4/24/78	1½" PVC	AVM 1-11	Failed June 1978
34	31-75	F	7½	1/18/79	1½" PVC	AVM 1-6	OK through summer 1979
35	51-79	M	2½	2/22/79	1½" PVC	AVM 3-2	OK through summer 1979
36	55-79	M	8-9	2/24/79	Belt	Tel. 1-9	Died May 1979
37	56-79	F	Mat	2/24/79	1½" PVC	AVM 1-10	OK through summer 1979
38	69-79	F	7½	3/1/79	1½" PVC	AVM 2-8	OK through summer 1979
39	70-79	F	7½	3/2/79	1½" PVC	AVM 2-10	OK through summer 1979

[1]Estimated or known age when radio collar attached, several were radio-equipped as recaptures of earlier collared deer; e.g., No.'s 14-73, 3-72, etc.

[2]M = Markusen Electronics; AVM = AVM Electronics. AVM channels 1-12 as designated for single band receiver. Other AVM channel designations are from four band receiver.

Appendix Table 21. Reproductive status of 30 mule deer females from the Bridger Mountains.

Collection Date	Location	Age of Female	Number of Fetuses	Sex of Fetuses	No. Corpora Lutea of Pregnancy	Fetus Crown-Rump Measurement (cms)	Fetus Weight (gms)	Estimated Date of Conception
4-16-73	Armstrong Winter Range	8-12	1	M	1	26.8	589	Dec. 1
4-22-73	Armstrong Winter Range	8-12	1	F	1	31.5	941	Nov. 28
3-18-75	Armstrong Winter Range	12	1	F	2	23.0	336	Nov. 18
3-29-75	Armstrong Winter Range	4½	2	M	2	23.5	399	Nov. 28
				F		23.0	424	Nov. 28
4-14-75*	Armstrong Winter Range	14	1	M	1	21.0	239	Dec. 22
5-3-75**	Armstrong Winter Range	12	0	-	2	-	-	-
5-12-75	Armstrong Winter Range	12	2	F	2	30.0	796	Dec. 20
				F		29.0	731	Dec. 20
5-12-75	Armstrong Winter Range	5	2	M	2	37.0	1,450	Dec. 1
				M		37.0	1,591	Dec. 1
5-14-75	Armstrong Winter Range	6	2	M	2	34.0	975	Dec. 10
				F		34.0	791	Dec. 10
3-21-77	Schafer Cr. Winter Range	8-10	2	F	2	25.0	368	Nov. 14
				F		24.5	395	Nov. 14
3-23-77	Schafer Cr. Winter Range	5½	2	F	2	28.0	649	Nov. 17
				F		28.0	638	Nov. 17
June/1977	Schafer Cr. Winter Range	8+	2	-	-	-	-	-
1-30-79	Armstrong Winter Range	1½	1	M	1	5.3	-	Dec. 6

Appendix Table 21. (continued).

Collection Date	Location	Age of Female	Number of Fetuses	Sex of Fetuses	No. Corpora Lutea of Pregnancy	Fetus Crown-Rump Measurement (cms)	Fetus Weight (gms)	Estimated Date of Conception
1-31-78	Armstrong Winter Range	5½	1	M	2	11.5	-	Nov. 18
2-5-78	Armstrong Winter Range	1½	1	M	1	4.0	-	Nov. 17
3-7-78	Armstrong Winter Range	8½	1	F	2	22.0	-	Nov. 17
3-15-78	Mouth of Bridger Canyon	4½	2	M	-	20.0	-	Dec. 7
				F		-		-
3-16-78	Bear Canyon	8	2	F	2	21.3	252	Nov. 30
				F		21.4	278	Nov. 30
3-31-78	Brackett Cr. Winter Range	1½	2	M	2	22.0	-	Dec. 11
				F		22.8	-	Dec. 11
4-10-78	Brackett Cr. Winter Range	5½	1	F	2	29.4	-	Nov. 27
4-20-78	Armstrong Winter Range	8½	1	F	1	20.5	-	Jan. 7
4-24-78	Armstrong Winter Range	1½	1	M	1	31.3	-	Dec. 8
2-13-79	Brackett Cr. Winter Range	10-12	1	F	2	10.2	30	Dec. 18
3-3-79	Brackett Cr. Winter Range	7½	1	F	3	15.5	101	Dec. 3
3-9-79	Battle Ridge Winter Range	1½	-	-	-	-	-	-
3-9-79	Brackett Cr. Winter Range	1½	1	M	2	15.0	83	Dec. 16
4-4-79	South 16-Mile Winter Range	3½	1	M	-	27.7	748	Dec. 1
4-4-79	"M" Winter Range	2½	1	M	1	23.5	410	Dec. 5
4-4-79	Jackson Creek	3½	2	F	3	25.5	-	Nov. 27
4-25-79	Brackett Cr. Winter Range			F		24.5	-	Nov. 27
		1½	1	F	-	27.0	431	Dec. 25

*Evidence of absorption of 1 fawn, 1 ovary atrophied.
**This doe had apparently aborted or resorbed its fetus.

JOB TITLE: Habitat use by mule deer of the Armstrong winter range, Bridger Mountains, Montana.

OBJECTIVES:

To determine the extent to which individual deer vary in their use of winter habitats; and to evaluate the reliability of observational data in indicating relative use and importance of various habitat types by mule deer during winter.

FINDINGS:

Field work was completed during the spring of 1978 and the final thesis report was submitted as a separate supplement to the 1977-78 Deer Studies Report for investigation of radio-marked mule deer on the Armstrong winter range. An abstract of the thesis by Heidi B. B. Youmans is presented below.

ABSTRACT:

A study of winter habitat usage by mule deer was conducted on the Armstrong winter range in the Bridger Mountains of southwestern Montana during the winters of 1976-77 and 1977-78. Objectives were to ascertain the extent of individual variability in habitat use and to evaluate the reliability of conventional estimates of winter range use. A total of 19 deer wearing radio transmitter collars were monitored from the ground, and from the air during weekly surveys in a Supercub aircraft. Conventional ground observations were obtained of neckbanded and unmarked deer. The number of marked deer on the winter range totaled 58 and 76 for the 1976-77 and 1977-78 winters, respectively. Relocations of instrumented and neckbanded individuals indicated the existence of three major winter range units. Instrumented animals exhibited larger home ranges during the first, mild winter than during the second, more severe winter, and north unit deer were characterized by more extensive movements than middle unit deer both winters. A substantial bias toward open habitats in observations of neckbanded and unmarked deer favored the use of instrumented deer for habitat use assessment. During the 1976-77 winter, deer use was concentrated on the forested upper portion of the winter range with only 19% of the total use by instrumented deer occurring in shrub/grass types. Percent total use of shrub/grass and forest types by instrumented deer during the 1977-78 winter was 39% and 54%, respectively. Core home range preference ratios for individual habitat types and for shrub/grass and forest habitat categories varied widely among individuals. But preference ratios less than 1 for total shrub/grass types and greater than 1 for total forested types were common to all instrumented individuals of the north and middle range units, indicating a common preference for forested types. Habitat types most selected were the JUSC-PUTR/FEID and PSME/FEID types of the north unit and the PSME/SYAL and PSME/PRVI types of the middle unit. Temporal variation in habitat usage and home range size during the 1977-78 winter reflected snow depth and crust conditions. Snow depths of 36-48 cm with a nonsupportive surface crust prompted deer congregation in forested habitats offering less severe snow conditions. Habitat use patterns observed on the winter range suggested a strategy of energy conservation rather than forage gathering. Daytime deer activity reached a peak the first half of March, at the start of accelerated snowmelt. Largest group size and greatest number of individuals sighted per observation period were recorded at that time.

JOB TITLE: Factors affecting deer populations in mountain-foothill habitats of central and southwestern Montana (distribution, range use and population characteristics of mule deer associated with the Schafer Creek winter range, Bridger Mountains, Montana).

OBJECTIVES:

To determine and describe seasonal habitats and habitat use of mule deer associated with the Schafer Creek winter range; and to compare habitats, habitat usage, and habitat relationships of mule deer on the Schafer Creek Range with those of mule deer on the Armstrong Range.

FINDINGS:

Field work was completed during the spring of 1978 and the final thesis report was submitted as a separate supplement to the 1977-78 Deer Studies Report for investigation on the population ecology and habitat relationships of mule deer in the Schafer Creek winter range, Bridger Mountains, Montana. An abstract of the thesis by William F. Steerey is presented below.

ABSTRACT:

A study was conducted in the Bridger Mountains of southwestern Montana from June 1976 through April 1978. Objectives were (1) to obtain data on yearlong distribution, range use and population characteristics of mule deer associated with the Schafer Creek winter range and (2) to compare findings with those of earlier studies of deer associated with the nearby Armstrong winter range. Vegetation of the Schafer Creek study area was described as consisting of 5 habitat series, comprising 18 distinct habitat types. Series were: Idaho fescue with 2 habitat types covering 1.7% of the area; big sagebrush with 2 habitat types cov- 2.6% of the area; Douglas fir with 7 habitat types covering 61.9% of the area; subalpine fir with 5 habitat types covering 30.7% of the area and; limber pine with 1 habitat type covering 2.9% of the area. Nine adult females and 3 adult males were radio-collared and monitored from the ground and 53 fixed-wing flights. An additional 17 mule deer were neck-banded. Movement from the winter range by marked animals ranged from 0 to 29 km and averaged 4.8 km. Three holding areas were delineated on two major travel corridors which were used by deer arriving on and departing from the winter range. Associations among adult females appeared to affect summer, fall and winter distributions. Home range size of radio-collared deer was: 111 ha for females and 387 ha for males during the mild winter of 1976-77; 178 ha for females and 152 ha for males summer-early fall and; 58 ha for females during the more severe winter of 1977-78. Three radioed deer summering in heavily forested habitats had significantly smaller home ranges than 8 others of broken timber habitats. Deer appeared to habitually use the same winter and summering areas. Douglas fir habitats were the most important in winter, spring and fall, and ranked second to subalpine fir in summer. Douglas fir/Idaho fescue was the most used habitat type in winter while subalpine fir/virgin's bower appeared to be the most important summer type. Closed canopy habitats were important during spring and fall migrations. Females with fawns occurred with greater than expected frequencies in cer-

tain habitat types (PIFL/JUCO and PSME/FEID) during summer-early fall but not during the 1977-78 winter. Forbs and browse were the most important summer forage classes used while browse, grass and forbs, respectively, were the most important winter forage classes. There was an apparent 10-20% increase in population and an increase in fawn production from the 1976-77 winter to 1977-78. Winter mortality was approximately 17-19% in 1976-77, consisting primarily of fawns, and was estimated at a minimum of 15%, including 34% of all fawns in 1977-78. Noted differences between the Schafer and Armstrong areas were: more Douglas fir and subalpine fir habitats with shrub understories on the Schafer summer area; no bitterbrush and much more Douglas fir/snowberry habitats on the Schafer Creek winter range and; smaller home ranges and generally higher winter survival on the Schafer Creek winter range.

JOB TITLE: Distribution, movements and habitat use of mule deer associated with the Brackett Creek winter range, Bridger Mountains, Montana.

ABSTRACT: A study was initiated in January 1978 to determine the movements, distribution and habitat use of mule deer associated with the Brackett Creek winter range on the east side of the Bridger Mountains. Findings are being prepared in the final report.

OBJECTIVES:

To determine the movements, distribution and habitat use of mule deer associated with the Brackett Creek winter range and compare the results of this study with similar studies conducted on the Armstrong and Schafer Creek winter ranges on the west slope of the Bridger Mountains and elsewhere.

To prepare cover type and habitat type maps of the vegetation of the study area.

To determine population characteristics of the Brackett Creek deer herd in comparison with those of other mule deer populations in the Bridger Mountains and elsewhere.

FINDINGS:

Field work continued through summer 1979 and winter-spring 1979. Data have been compiled and analyzed, and the final job report will be completed in November 1980.

Submitted by: Harvey E. Nyberg

Job Title: Habitat relations of mule deer associated with the Brackett Creek winter range.

Job Objectives:

1. To determine movements, distribution and habitat use of the mule deer associated with the Brackett Creek winter range and to compare results of this study with results of similar studies conducted on the west slope of the Bridger Mountains.

2. To quantify the vegetation of various habitat types on the Brackett Creek winter range and compare these data with results from studies on the west slope of the Bridgers to determine whether a vegetation factor is responsible for population density and home range size differences between the two areas.

3. To determine public and hunter access and land use practices on the Brackett Creek herd range in relation to habitat use by mule deer.

INTRODUCTION

This study continues investigations initiated by Nyberg (1978, *In prep.*) during the summer of 1978. This report summarizes the methods employed and describes some results obtained from field studies during the summer of 1979.

STUDY AREA

The Brackett Creek study area, located in the east-central portion of the Bridger Mountain Range complex, has been described previously by Nyberg (1978, *In prep.*). It consists of the northern half of Bangtail Ridge, Brackett, Canyon and Bangtail Creek drainage to the Shields River. These boundaries may be subject to some modification through further studies and relocations of additional radio-collared and neckbanded deer.

METHODS

The distribution, movements and habitat use of mule deer associated with the Brackett Creek winter range are being determined by relocation and general observations of radio-collared, neckbanded and unmarked animals. Relocation flights, using a fixed-wing aircraft, were conducted weekly during June and July and biweekly in August and September 1979. Ground observations, made in the course of vegetational studies on the winter range or during specific observation trips through the entire study area, provided additional data.

Habitat and vegetative cover types on the Brackett Creek winter range were delineated and mapped by Jorgenson (1977) and Nyberg (*In prep.*). During the present study, vegetational characteristics of the various types will be quantified using the point centered-quarter technique (Cottam and Curtis 1956) to determine tree-shrub densities and the canopy coverage method (Daubenmire 1959) to estimate coverage of low shrub and herbaceous plants.

Information on hunting access, land ownership and land use practices will be obtained from Park and Gallatin County and Gallatin National Forest records and by interviewing landowners within and adjacent to the study area. Data on hunter numbers, distribution and success and the harvest of mule deer from the Brackett Creek population will be obtained using hunter questionnaires, field surveys and bag checks during the hunting season, and returns of tagged animals.

RESULTS

Field studies were initiated in mid-June, 1979. Emphasis was placed on weekly and biweekly aerial relocations of radio-collared deer and on vegetational analyses. The relocations involved nine deer radio-collared in 1978 and six equipped with transmitters in late winter 1979 (Table 1). In general, the former exhibited the same dispersal pattern as observed during 1978 (Nyberg 1978). One adult doe (Ch. 4/7.5), which could not be relocated during the summer of 1978, was relocated in June 1979 and subsequently spent the summer on Elkhorn Ridge, in the extreme northeast corner of the Bridger Mountains, approximately 17 mi north of the study area. However, the animal is no longer associated with the Brackett Creek population, as it also spent the 1978-79 winter on the Battle Ridge winter range, about 9 mi north of where it was originally trapped. All but one of the 1979 radio-collared deer dispersed and established summer home ranges within the general area used by deer in 1978. The exception, a young adult male, moved approximately 5 mi north to the Antelope Creek drainage along Battle Ridge, where it was later found dead. One other instance of dispersal from the primary study area was recorded in the recovery of a 2-year-old, neckbanded doe killed on Interstate Highway 90, 1 mi east of Bozeman and approximately 25 airline mi southeast of the Brackett Creek winter range.

Field measurements associated with vegetational analyses on the winter range were completed by mid-September. Data will be compiled and analyzed during the 1979-80 winter and summarized in the 1980 progress report.

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Submitted by: Al Rosgaard

Table 1. Description of radio-collared deer on the Brackett Creek range.

Channel	Sex	Age at Trapping	Trap Site	Location of Summer Range
1978 Trapping				
2/3.10	F	3½	Site E	Miles Creek
2/6.35	F	5½	Site C	White Creek
2/9.35	F	4½	Site D	Bangtail Creek
2/11.35	F	Adult	Site C	Ward Ranch
4/7.5	F	4½	Site A	(Relocated) Elkhorn Ridge
4/8.30	F	3½	Site E	Miles Creek
4/9.10	F	3½	Site B	Pehenpaugh Ranch (winter range)
4/10.10	F	6½	Site B	Stone Creek
4/12.15	F	6½	Site D	Miles Creek
1979 Trapping				
3/11.25	M	1½	Site G	Canyon-Bangtail Cr. Divide S. of Gobblers Knob
3/12.25	F	3½	Site H	Miles Creek
4/2.20	M	3½	Site I	Antelope Creek (dead)
4/4.20	F	6½	Site F	Miles Creek
4/5.20	F	3½	Site I	White Creek
4/6.20	F	4½	Site I	Bangtail Creek

JOB TITLE Mule deer population ecology and habitat relationship in the Missouri River Breaks, Montana.

ABSTRACT

An extremely severe winter in 1978-79 followed the almost equally severe winter of 1977-78. Although some winter mortality of mule deer fawns occurred, it was substantially less than that which occurred during the relatively mild winter of 1975-76. Fawn production following both the 1977-78 and 1978-79 winters was excellent. As a result of this, the mule deer population increased by almost 100% during 1978. Estimates of initial fawn production in 1979 was 1.76 fawns/producing female, again, near species potential. A sample of marked female mule deer indicated that their initial fawn production was at least as high as that of the population as a whole, indicating no ill effects of the capture and marking procedure. To date, a minimum of 73% of the known causes of summer mortality of fawns was attributable to coyote predation. Percentage of fall-winter deer mortality attributable to coyote predation has not been reliably documented, however coyote predation was the major source of documented mortality of females and fawns. During the last four years, hunting mortality has been limited to adult males. Estimates of small mammal population levels for 1976 through summer 1979 are presented. These estimates indicate increasing small mammal populations through the period, with the peak in rodent populations apparently occurring from fall 1978 through early summer 1979. Mule deer fawn survival to December has been positively associated with small mammal population levels, but apparently not with coyote density. Baseline forage abundance data for five habitat types during May, July and September are presented. Documentation of the levels of sweetclover abundance during the last three years is presented. A brief description of the movements and habitat use of the deer during the two past severe winters is presented. Some preliminary observations of home range establishment and social behavior of yearling mule deer are presented. Information to date suggests that a poor forage production year in 1971 followed by a severe winter in 1971-72 reduced mule deer populations to a low level with no biological surplus. Subsequent poor fawn survival and heavy either-sex hunting pressure further aggravated this situation. As a result of low numbers of breeding female mule deer and low small mammal populations during 1975-77, existing levels of coyote predation appeared to be sufficient to impede recovery of the mule deer population.

Job Title — Mule deer population ecology, habitat relationships, and relations to livestock grazing management and elk in the Missouri River Breaks, Montana.

Job Objective — To further determine the environmental requirements of mule deer and factors regulating mule deer populations in the "breaks" type of eastern Montana.

To further determine the direct and indirect effects of livestock grazing management under rest-rotational and continuous grazing systems upon deer populations and habitat relationships and upon deer-elk interrelationship in the "breaks" type.

To develop new and improved guidelines for management of mule deer populations and their habitats in the "breaks" type of eastern Montana and for consideration of deer habitat requirements in elk, livestock, and range management programs in this type.

INTRODUCTION

In 1960, an intensive study of mule deer and their relationship to elk *(Cervus canadensis)* and domestic livestock was established on a representative 75,000 acre area in the Missouri River Breaks approximately 25 miles northeast of Roy, Montana. Habitat use and population studies were conducted from June 1960 through September 1963 and intermittently from October 1963 through May 1964 (Mackie 1970). From the summer of 1964 through spring 1975, less intensive studies were continued on the area primarily to obtain population data for mule deer (Mackie 1976). Mackie (1970) presented historical information on mule deer in the "Breaks", discussed development of the existing population from the late 1930's through the early 1950's, and described trends in numbers, sex and age composition and harvest from 1960 through winter-spring 1964. Subsequent reports (Mackie 1966, 1973 and 1976) extended these data through early winter 1975-76. In July 1975, intensive studies resumed under the statewide deer research program to further evaluate factors regulating mule deer populations in the breaks type habitat of eastern Montana.

A mule deer population decline on the study area, which started in winter 1971-72, continued to 1976-77 (Mackie 1976, Hamlin 1977). Population declines have occurred on this area in the past, but recovery has generally started within a year or two of the decline. Low fawn production and/or survival and ultimately low fawn recruitment was apparently the problem involved in the continuing population decline of the mule deer herd in recent years (Mackie 1976, Hamlin 1977). Low fawn ratios in some prior years were associated with severe environmental conditions such as drought in 1961-62 and severe winters in 1964-65 and 1971-72. However, severe environmental conditions apparently cannot be implicated in the relatively low fawn production and/or survival during the years 1973-76. From 1972 to 1976 normal precipitation during the growing season and mild, open winters have been the general rule (Mackie 1976).

A preliminary report by Knowles (1976) indicated that coyote predation may have been an important cause of mortality of mule deer, at least during winter 1975-76. A graduate research project investigating mortality of mule deer fawns from birth to September was initiated in June 1976. Dood (1978) indicated that coyote predation was implicated in at least some summer mortality of mule deer fawns on the south side Missouri River Breaks study area.

Present work on the project emphasizes determination of fawn production and survival, population dynamics of the herd and causes and timing of mule deer mortality. Time constraints have precluded the analysis of much of the data on basic deer biology that does not have apparent direct population consequence. This information will be included in future reports.

ACKNOWLEDGEMENTS

The quantity and quality of data collected on this project has been greatly enhanced by the superior flying and observational skills of Supercub pilot Larry L. Schweitzer of Denton and helicopter pilot Murray Duffy of Bozeman. Duane Pyrah has provided assistance and advice in all phases of the project. Dick Mackie has provided assistance and advice in all phases of the project and has provided unpublished data from the study area for 1960-1975. Shawn Riley has provided invaluable assistance during three summers. Dr. Robert Moore, Montana State University, is gratefully acknowledged for making Sherman livetraps available during the summer. Many other Department or former Department employees have provided valuable field assistance. The study is being conducted in part on lands comprising the Charles M. Russell Wildlife Range, administered by the U. S. Fish and Wildlife Service and in part on lands administered by the Bureau of Land Management and the East Indian Buttes Grazing District. The cooperation and assistance of these agencies in some aspects of the study, including some financial support of aerial surveys, is gratefully acknowledged, as is the assistance of many individual personnel. Numerous private landowners and ranchers on the study area have also cooperated to assist the study effort through the years.

STUDY AREA

The south study area encompasses all of the timbered "breaks" portion of the area described by Mackie (1970) as extending approximately 20 miles on a 4 to 7 mile wide belt adjacent to the Missouri River in Fergus County, Montana (Fig. 1). It comprised approximately 100 square miles between U.S. Highway 191 on the west, the Skyline Trail on the east, the Missouri River on the north and the Musselshell Trail on the south. Physiography, climate, land use and vegetation of this area were described in detail by Mackie (1970). Some of the work described in this report was conducted on the adjacent Missouri River Bottomlands described by Allen (1968) and NE across the river on the Nichols Coulee Resource Conservation Area (north study area) described by Knowles (1975).

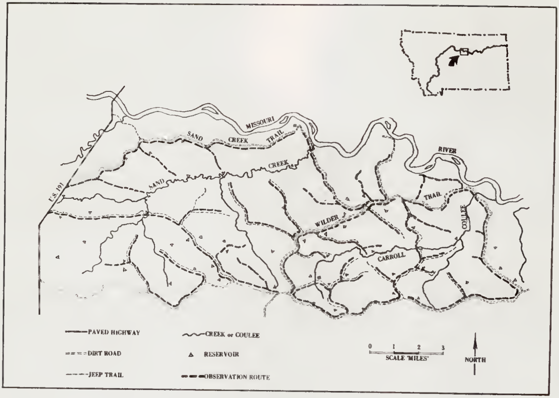

Figure 1. Map of the study area.

METHODS

Population data were obtained during fixed-wing surveys at various times of the year and helicopter surveys during December and March. Sex and age classifications and deer distribution and habitat use were obtained during 11 aerial surveys. Population estimates were made using data from helicopter surveys in most years. During the last year, sufficient numbers of marked deer were present on the study area to permit usage of the Lincoln Index (Overton and Davis 1969) for all aerial surveys. Supplementary information was obtained throughout the year from the ground during the course of normal activities.

Data on initial fawn production and subsequent fawn survival were obtained by aerial and ground reconnaissance. Survival was also measured by following radio-collared fawns. The river and reservoir ice was flown periodically during winter to check for coyote-killed deer. The uplands were checked for coyote-killed deer during aerial flights to relocate collared deer and during other normal activities. Carcasses are listed as probable coyote kills based on evidence of tracks in the snow, trails of blood on snow or vegetation and other site evidence.

Deer have been captured during winter in order to attach radio transmitters or observational collars. Methods used have included the cannon net (Mackie et al. 1975), the Clover trap (Clover 1954), a helicopter drive net and darting from a helicopter. Newborn fawns were caught by the method described by Dood (1978).

Aerial relocations of instrumented deer were obtained at 1-2 week intervals and relocations from the ground were made as time permitted.

Data on hunting mortality and physical measurements of deer were obtained from a check station on a major access road during the first weekend of the season, from field checks of hunters throughout the season and from voluntary hunter register boxes located along access roads.

Approximately 1 quart samples were obtained from rumens of deer killed by hunters, coyotes and other undetermined causes for analysis of food habits.

Soil moisture readings were made at approximately two week intervals.

Thirty-two permanent transects totaling 320 2x5 dm plots were established to determine year-to-year sweetclover abundance. Number of plants in each plot and life phase are determined each year.

Five forage abundance transects totaling 100 2x5 dm plots each were established and read during May, July and September on each of 5 habitat types. Browse plants and green grasses were recorded as present or absent in each plot while green forbs were recorded as number of plants per plot.

Following the graduate student study (Trout 1978) small mammal trapping has continued in order to estimate yearly changes in abundance of alternate prey species for predators. Snap trap lines utilizing Victor rat traps consist of 20 stations approximately 15 meters apart with 2 traps per station. Snap trap lines are run for three nights. The same livetrap lines utilized by Trout (1978) are run each year with Sherman livetraps. The mice captured are toe clipped so that they are individually recognizable. An attempt is made to operate traps until few new mice are captured, thus giving an estimate of total numbers. Headlight surveys to determine rabbit abundance are run for three nights during each survey period.

WEATHER

Weather data for the period November through March and winter severity indicies for the Roy 8NE weather station are presented in Table 1. Data are not available for computing weather severity indicies prior to 1968-69. Previously, the winter severity index of Picton and Knight (1969) was used. It was felt that this index overemphasized the effect of minor snow depths, so a new winter severity index was devised. The winter severity index was calculated as follows:

$$\text{Index} = [40^{\circ}\text{F} - (\text{ave. winter temp.})] + \frac{\text{No. days over } 12'' \text{ of snow}}{10} + \frac{\text{No. days over } 18'' \text{ of snow}}{5}$$

These weather data indicate that winter 1978-79 was slightly more severe than 1977-78. Both winters were the most severe in many years. Winter 1978-79 had only slightly lower snow depths than 1977-78, but the length of time that these extreme depths persisted was slightly longer in 1978-79. In addition, the average temperature for winter 1978-79 was significantly colder than 1977-78.

Table 1. Winter severity indicies and climatological data, Roy 8 NE, November through March 1968-1979.

Year	Average Temp. (F)	Total Snowfall (inches)	Maximum Depth (inches)	No. Days Snow on Ground	No. Days over 12 inches	No. Days over 18 inches	Severity[1] Index
1968-69	16.8	43	29	95	62	55	40.4
1969-70	26.8	32	9	49	0	0	13.2
1970-71	24.0	41	15	66	11	0	17.1
1971-72	21.7	62	28	114	71	44	34.2
1972-73	28.0	13	9	23	0	0	12.0
1973-74	27.5	25	6	57	0	0	12.5
1974-75	26.0	36	19	54	0	0	14.0
1975-76	29.3	42	9	51	5	0	11.2
1976-77	29.2	60	21	57	24	5	14.2
1977-78	19.0	86	56	128	108	90	49.8
1978-79	16.9	65	31	143	112	96	53.5

[1]Higher numerical value indicates greater severity.

Precipitation data were collected for two years on the study area from seven rain gauges approximately three miles apart along an east-west line across the study area. Data from these gauges and comparative data from adjacent official weather stations are presented in Table 2. Monthly ranges of precipitation often varied widely across the study area, but no consistent pattern emerged. Cumulative average precipitation for these rain gauges for the period April-October did not vary significantly from the cumulative total for the Roy 8NE station (Table 2). The time and effort to continue to monitor our gauges seemed unjustified and data collection ceased during 1979.

Table 2. Recorded precipitation on the study area compared with two adjacent official weather recording stations.

Month-Year	Number Recording Rain Gauges	ppt. Range	ppt. Ave.	ppt. Roy 8NE	ppt. Mobridge
April 1977	6	0.13-0.27	0.19	0.20	0.17
May	7	2.14-3.49	2.67	2.66	2.62
June	6	1.11-1.97	1.57	1.58	1.27
July	7	1.13-2.73	1.49	2.35	1.99
August	4	2.12-2.40	2.29	2.42	2.21
September	6	2.40-2.86	2.77	2.14	2.62
October	6	0.18-0.40	0.29	0.64	0.45
TOTAL			11.27	11.99	11.33
April 1978	6	0.93-1.31	1.12	1.39	1.14
May	6	4.50-5.45	4.98	4.87	3.50
June	4	3.25-4.00	3.54	3.98	3.28
July	6	3.40-5.02	3.91	3.81	2.83
August	5	0.80-1.15	0.96	0.91	1.57
September	4	4.02-4.55	4.25	4.04	3.54
October	6	0.20-0.28	0.24	0.31	0.20
TOTAL			19.00	19.31	16.06

Similarly, two recording hydrothermographs were used to record temperatures on the study area. Equipment malfunctions precluded gathering complete data during most months. In those months with complete records, average temperature varied less than one degree from the adjacent official weather stations. The recording of temperature data ceased during 1979.

POPULATION TREND

South Study Area

Population data for mule deer on the study area from 1960-61 through 1978-79 are listed in Tables 3 and 4. Figure 2 extends Mackie's (1978) population trend estimates through 1978-79. The population showed the first significant upward trend in 7 years during 1978. High fawn survival up to and through winter (Table 4) was associated with this upward trend. Population estimating techniques consistent with previous techniques placed the early winter

Table 3. Sex and age composition of mule deer population on the Missouri Breaks Study Area, 1960-61 through 1978-79. Data were derived as aerial or ground classifications during December or early January of each year except 1969-70 and 1972-73, when classifications were completed during February and March, respectively.

Year	Type of Observation	Number Classi-fied	Percentage			Ratios			% of Yrlg Males	
			Males	Female	Fawns	Males: 100 FF	Fawns: 100 FF	Fawns: 100 AD	Obsv.	Harv.
1960-61	Ground[1]	668	9.3	48.6	42.1	19.1	86.4	72.6	56	46
1961-62	Ground	430	15.5	60.7	24.0	25.3	39.5	31.5	74	47
1962-63	Ground	190	19.5	52.1	28.4	37.5	54.5	39.7	63	34
1963-64	Aerial[2]	362	16.0	45.6	38.4	35.1	84.2	63.3	47	36
1964-65	Aerial	611	22.7	47.8	29.5	47.6	61.6	41.7	47	43
1965-66	Aerial	434	21.4	58.1	20.5	36.9	35.3	25.8	33	13
1966-67	Aerial	289	17.3	52.6	30.1	32.9	57.2	43.1	46	
1967-68	Aerial[3]	115	20.0	40.0	40.0	50.0	100.0	66.7	--	
1968-69	None	-	-	-	-	-	-	-	--	
1969-70	Aerial	110	-	-	39.1	-	-	64.2	--	
1970-71	Aerial	776	18.8	48.1	33.1	39.1	68.9	49.5	47	
1971-72	Aerial	679	19.0	53.8	27.2	26.1	50.6	37.4	46	
1972-73	Aerial	235	-	-	19.1	-	-	23.7	--	
1973-74	Aerial	370	24.1	49.5	26.5	48.6	53.6	36.0	43	
1974-75	Aerial	315	25.6	55.1	19.3	46.0	35.1	24.0	50	
1975-76	Aerial	323	15.5	57.6	26.9	26.9	46.8	36.9	28	
1976-77	Aerial	258	17.4	57.4	25.2	30.4	43.9	33.6	40	
1977-78	Aerial	322	10.9	58.7	30.4	18.5	51.9	43.8	48	
1978-79	Aerial	501	13.2	42.3	44.5	31.1	105.2	3.2	55	

[1] Cumulative observations on area during December.
[2] All aerial observations by helicopter except 1969-70 (fixed wing aircraft).
[3] Only west half of area surveyed in 1967-68.

Table 4. Classifications and observed recruitment of fawns on the south side Missouri Breaks study area, 1975-76 through 1978-79.

Date	Total Numbers	Adults	Young	Females	Males	Uncl.	Fawns/ 100 Adults	Fawns/ 100 FF
Sept.-Oct. 1975	105	69	36	50	19	-	52	72
December 1975	323	236	87	186	50	-	37	47
March 1976	193	173	19	--	--	-	11	--
October 1976	159	110	49	79	31	-	45	62
December 1976	258	193	65	148	45	-	34	44
March 1977	293	225	68	--	--	-	30	--
October 1977	112	70	41	51	20	-	59	80
December 1977	322	224	98	189	35	-	44	52
March 1978	255	195	51	--	--	9	26	--
September 1978	176	102	74	69	33	-	73	107
December 1978	501	278	223	212	66	-	80	105
March 1979	409	248	161	--	--	-	65	--

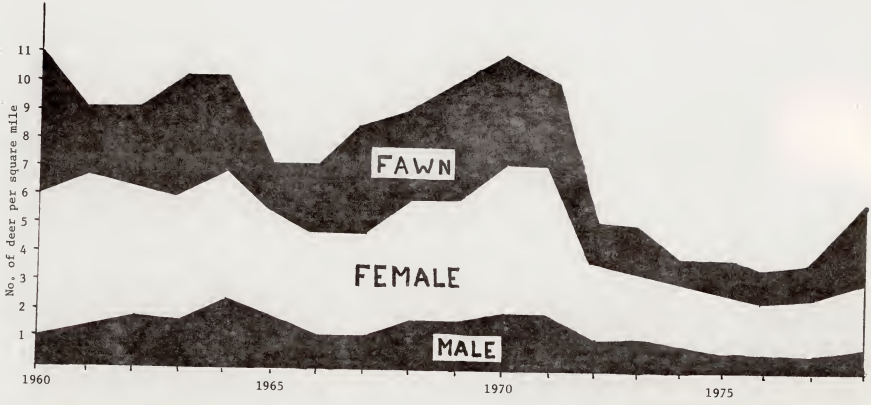

Figure 2. Population trend of mule deer on the Missouri River Breaks study area, 1960-1978.

estimate at around 600 mule deer. This estimate is relative to previous trend estimates and its precision has not yet been determined. Sufficient numbers of marked deer were present during the last year to enable use of the Lincoln Index (Overton and Davis 1969) in population estimation (Table 5). All population estimates derived by the Lincoln Index were higher than those given by previous estimation and are striking in their consistency. Results to date are preliminary, but continued usage of this technique should help to make population estimates more precise.

Table 5. Population estimates of mule deer on the south Missouri River Breaks study area.

Estimated No. Deer On Study Area	Date	Remarks
732	Dec. 1978	Lincoln Index - helicopter survey
667	Mar-Apr 1979	$\bar{X}$ Lincoln Index - March helicopter survey and April fixed-wing survey
639	March 1979	Based on December Lincoln Index minus est. 5% adult mortality and change in fawn/adult ratio
638	June 1979	Lincoln Index - fixed-wing survey-new fawns not included
638	July 1979	Lincoln Index - fixed-wing survey-new fawns not included

North Study Area

Population data for mule deer on the north study area from 1973-74 through 1978-79 are listed in Tables 6 and 7. The December survey was flown with a fixed-wing aircraft rather than with a helicopter so numbers observed are not directly comparable. If numbers of fawns that died overwinter (based on change in ratios) is added to numbers observed during the March helicopter flight, a minimum estimate can be made of 216 deer present in early winter. This puts the north study area population at about the same level as in early winter 1975, before the most recent decline. High fawn survival was associated with this increase.

Table 6. December population summaries for mule deer on the north study area, NCRCA[1].

Year	Total	Adults	Fawns	Females	Males	Yearlings	Mature	Fawns/100 Females	Fawns/100 Adults
Pastures 3 and 4									
1973	184	134	50	100	34	18	16	50	37
1974	201	144	57	104	40	17	22	55	40
1975	208	172	36	119	53	19	34	30	21
1976	88[2]	63	25	42	11	1	6	60	40
1977	122	90	32	63	27	12	15	51	36
1978	160[2]	107	53	70	37	19	18	76	50

[1]Nichols Coulee Resource Conservation Area.

[2]Total count not obtained in comparable manner to other years.

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Table 7. Classifications and observed recruitment of fawns on the north side Missouri Breaks study area, 1975-76 through 1978-79.

Date	Total No.	Adults	Young	Females	Males	Fawns/ 100 Adults	Fawns/100 Females
Sept.-Oct. 1975	84	62	22	36	26	36	61
December 1975	208	172	36	119	53	21	30
March 1976	115	109	6	--	--	5.5	--
Sept.-Oct. 1976	65	48	17	29	19	35	59
December 1976	88	63	25	52	11	40	48
March 1977	118	92	26	--	--	28	--
October 1977	47	28	19	17	11	68	112
December 1977	122	90	32	63	27	36	51
March 1978	76	68	8	--	--	12	--
October 1978	86	60	26	34	26	43	76
January 1979	160	107	53	70	37	50	76
March 1979	192	137	55	--	--	40	--

FAWN PRODUCTION AND SURVIVAL

Table 8 lists the known ratios of fawns/100 producing females and estimates the ratios of fawns/100 females for the population as a whole in June and mid-July 1976-1979. The estimate of fawns/100 producing females was obtained from fawns observed with females during fawn capture and marking in June and from those observed during aerial flights and ground observations in mid-July. The ratios for June are minimum estimates since some fawn mortality was known to have occurred during this period, at least in the first three years. Also, information from radioed fawns indicates that, occasionally, litters have been classified as singles when they were actually twins.

Table 8. Estimated mule deer fawn/female ratios in June and mid-July 1976-1979 on the south study area.

	Fawns/100 Producing Females		Percent Females Producing		Estimated Population Fawn/Doe ratio
June 1976	150:100(14)[1]	x	94[2]	=	141:100
July 1976	131:100(16)	x	71[3]	=	94:100
June 1977	152:100(27)	x	82[3]	=	125:100
July 1977	140:100(20)	x	76[3]	=	106:100
June 1978	165:100(26)	x	90[3]	=	148:100
July 1978	142:100(31)	x	83[3]	=	118:100
June 1979	176:100(37)	x	70[2]	=	123:100
July 1979	171:100(35)	x	70[2]	=	120:100

[1]Female sample size in parenthesis.
[2]Percent of female population older than yearling.
[3]Percent of females observed alone or with fawns.

Since no collections to determine _in utero_ productivity are made, the June observations are the closest estimate of initial productivity made on the study area. It is felt that the variations in initial fawns/100 producing females ratio (Table 8) is due to differing survival rates of fawns in the first few weeks of life rather than due to differing _in utero_ productivity during the four years. The ratios of fawns/producing female observed on the study area during June have equaled or exceeded _in utero_ ratios of fetuses/pregnant female in many other mule deer ranges and in some years are only slightly lower than _in utero_ rates for other high quality mule deer ranges.

Table 9 lists the expected ratio of fawns/producing female at birth and compares it to the observed ratio at capture. Since it is believed that this herd is inherently a highly producing herd and that there are no nutritional deficiencies (Hamlin 1978), near maximum estimates of in utero productivity are used. Data are not available to compute age composition of the female population in 1976. Although these mortality figures are only estimates, they are believed to be reasonable.

Table 9. Expected fawn/producing female ratio at birth compared to observed ratio at the time of fawn tagging, 1977-1979.

	Age of Female	% of Pop.	Fetuses Per Female	No. Fetuses	Expected Fawns/Prod. ♀	Obs. fawns/ Prod.♀-June	% 1-2 week Mortality
1977	1½	16	0	0			
	2½	5	1.3	7			
	3½+	79	1.8	142			
		84 prod.♀♀		149 fetuses	1.77	1.52	14%
1978	1½	9	0	0			
	2½	14	1.3	18			
	3½+	77	1.8	139			
		81 prod.♀♀		157 fetuses	1.73	1.65	5%
1979	1½	30	0	0			
	2½	6	1.3	8			
	3½+	64	1.8	115			
		70 prod.♀♀		123 fetuses	1.76	1.76	0%

Mule deer females which were trapped and marked apparently suffered no ill effects from the process. Twenty-eight of 36 marked females were observed with fawns between 14 June and 12 September 1979. These observations are spread throughout a normally high mortality period. Nevertheless, these 28 females produced a minimum of 52 fawns, including 7 singles, 18 sets of twins and 3 sets of triplets. This provides a fawn/100 producing female ratio of 186:100, even higher than the random sample of the population as a whole. Twenty-one of these females were captured during the last winter using the helicopter drive net. Of the 8 females not observed with fawns, 6 were not seen during the June-September period and 2 were observed only once, both early in the season when fawns are seldom seen with the doe. All of the marked does observed more than once had fawns, indicating that the pregnancy rate of does older than yearling was 100% or near 100% during 1979.

Tables 10 and 11 show estimated and observed fawn/producing female ratios and mortality rates for the south and north study areas, respectively during the period June 1975 to March 1979. Time has not permitted obtaining June fawn/producing female ratios for the north study area. During 1976 the ratio was arbitrarily set as the same as that for the south study area. Since that time, for comparative purposes, the ratios has been left the same as that for the first year. This has probably led to an underestimate of the total yearly mortality on the north area. The percent total fawn mortality for both study areas is also underestimated since the June ratio used is survival to that point rather than the ratio at birth as outlined in Table 9. The patterns of survival have been the same on both study areas during all years and the north study area has always had higher total mortality. During the past year, the mid summer to December mortality rate was lower than during any of the three previous years. December to March mortality was fairly high, but not high enough to prevent high overall first year survival. It is interesting to note that although survival to March was near or only slightly below historical highs, about 50% of those fawns born did not survive their first year.

The severe winter of 1977-78 apparently had little effect on fawn production (Hamlin 1978). Winter 1978-79 was even more severe than 1977-78 (Table 1). Although winter ended by the start of the last trimester of pregnancy, a cool, dry spring resulted in little forage production until late May. Initial fawn production again was near species' potential during 1979. As discussed in last year's report (Hamlin 1978), it appears that the condition of the deer going into winter has at least as much, and possibly even more, impact on deer survival and subsequent fawn production than the severity of the winter alone.

CAUSES OF MULE DEER MORTALITY

In an attempt to determine causes of summer fawn mortality, a graduate research project using radio-telemetry to monitor and evaluate fawn survival, was conducted during the summer of 1976 and 1977. During 1978 and 1979, these studies were continued by a summer student assistant. Eleven, 19, 16 and 22 fawns were monitored during the four summers 1976-1979, respectively. Table 12 presents the results of these investigations. Nonradioed cohorts (i.e., nonradioed member of a set of twins) are included in the fawns monitored column. Although natural abandonment occurs, one fawn each in 1978 and 1979 which appeared to have been abandoned shortly after capture was not included in Table 12. Dood (1978) found 36% and 32% fawn mortality during summer 1976 and 1977, respectively. S. Riley (pers. comm.) found 13% and 14% fawn mortality during summer 1978 and 1979, respectively. Eleven of 15 mortalities (73%) during the four summers were definite or probable coyote-caused mortalities. No fawns that died exhibited signs of poor condition prior to its death.

For the first year, in 1979, fawn radio transmitters lasted through the winter. Twelve fawns were monitored from September 1978 through March 1979. One radioed fawn was illegally killed by a hunter during October 1978. Two additional fawns were captured and marked in December. Three deaths occurred during February. Site evidence indicated that all three were killed by coyotes. The 23.1% mortality rate of marked fawns from December to March closely approximates the estimated fawn mortality rate for the population as a whole of 27% (Table 10).

Table 10. Fawn production and survival on the south Missouri Breaks study area, 1975-76 through 1978-79.

	Fawns Per 100 Initially Producing Females	Approximate Mortality Rate	Percent Total Fawn Mortality	Total Fawn Mortality
1975-76				
Mid-June	150			
		--	--	
Mid-July	--			
		--	--	
October	83			
		35	22	
December	54			
		70	28	
March	16			
				89%
1976-77				
Mid-June	150			
		33	45	
Mid-July	101			
		34	31	
October	67			
		30	19	
December	47			
		11	5	
March	42			
				72%
1977-78				
Mid-June	152			
		15	20	
Mid-July	129			
		24	27	
October	98			
		36	31	
December	63			
		40	22	
March	38			
				75%
1978-79				
Mid-June	165			
		21	43	
Mid-July	131			
		9	15	
October	119			
		2	2	
December	117			
		27	40	
March	85			
				48%

Table 11. Fawn production and survival on the north Missouri River Breaks study area, 1975-76 through 1978-79.

	Fawns Per 100 Initially Producing Females	Approximate Mortality Rate	Percent Total Fawn Mortality	Total Fawn Mortality
1975-76				
June	150			
		52	56	
October	72			
		51	26	
December	34			
		71	18	
March	10			
				93%
1976-77				
June	150			
		59	77	
October	61			
		18	10	
December	50			
		30	13	
March	35			
				77%
1977-78				
June	150			
		17	20	
October	132			
		52	49	
December	60			
		67	31	
March	20			
				87%
1978-79				
June	150			
		45	81	
October	83			
		0	0	
December	83			
		20	19	
March	66			
				56%

Table 12. Summer mortality and causes for marked mule deer fawns 1976-1979.

Year	No.[1] Marked Fawns	No. Died	% Mort.	No. Definite Or Probable Coyote Killed	No. Unknown	No. Accident	% Coyote Killed
1976[2]	11	4	36	4	-	-	100
1977[2]	19	6	32	4	1	1	67
1978[3]	15	2	13	1	1	-	50
1979[3]	21	3	14	2	1	-	67
Total	66	15	23	11	3	1	73

[1]No. marked fawns column includes unmarked twin of radioed fawn when this situation occurred.
[2]Data from Dood (1978) and personal communication.
[3]Data from S. Riley (pers. comm.).

Overwinter adult mortality (Table 13) has been consistently low in spite of the fact that the last two winters have been the most severe in at least the last 20 years.

Table 13. Overwinter (Jan.-Mar.) mortality of marked adult mule deer on the south Missouri River Breaks study area.

Year	No. Marked Deer	No. Died	% Mort.	No. Marked ♀♀	No. Died	% Mort.	No. Marked ♂♂	No. Died	% Mort.
1976-77	12	1	8.3	8	1		4	0	
1977-78	19	1	5.3	14	1		5	0	
1978-79	38	2	5.3	29	1		9	1	
Total	69	4	5.8	51	3	5.9	18	1	5.6

Other than legal hunting mortality of adult males little is known of recent causes of adult deer mortality. Two, 8 and 7 marked adult males were available to hunters during 1976, 1977 and 1978, respectively. One of the marked males was shot in each of the hunting seasons. Although this represents an average annual hunting mortality rate of 18%, the sample size is too small for confidence in its accuracy. One radio-collared adult female was known to have been illegally shot during September 1977 and one radio-collared adult female was a victim of coyote predation during January 1977. Additional known causes of mule deer mortality has been confined to coyote predation during winter (Table 14). Successively fewer coyote-killed deer have been found during winter in spite of expanded effort to locate carcasses.

Table 14. Probable coyote-killed deer found during winter (December-March).

	Uplands	Bottomlands	River Ice	Reservoir Ice	TOTAL
Mule Deer					
1975-76	9	2	1	33	45
1976-77	4	0	3	9	16
1977-78	5	0	2	1	8
1978-79	3	0	1	1	5
White-tailed Deer					
1975-76	1	10	9	0	20
1976-77	0	1	3	0	4
1977-78	0	1	0	0	1
1978-79	0	1	1	0	2

Known hunter harvest statistics to date for the hunting unit containing the study area are listed in Table 15. Hunting mortality should have been of negligible population consequence during the last four years since only adult males could legally be harvested. During this period of restrictive hunting seasons, only in the last year has the mule deer population increased in spite of the fact that there has been no hunting mortality of females and fawns.

Although hunting mortality should not have had any population impacts during the period 1975-1978, it is quite possible that hunting mortality during 1972-1974 aggravated the population decline and/or helped impede its recovery. During winter 1971-72, severe winter mortality approximating 30% in adults and 85-30% in fawns occurred (Mackie 1976). Prior

Table 15. Mule deer harvest statistics for HD 410 and the south side research area.[1]

Year	Mule Deer Bag Limit	HD 410[2] Harvest	Hunters	Min. known kill on research area	Open. day check sta. HD 410[2] Number Hunters	Kill
1959	2-ES	5,117	5,084			
1960	2-ES	5,769	6,486	150	407	129
1961	2-ES	5,951	7,091	151	224	70
1962	2-ES	5,964	6,482	81	350	70
1963	2-ES	6,683	5,925	37	89	37
1964	2-ES	6,800	6,860	73	117	55
1965	2-ES	2,945	3,680		141	26
1966	2-ES	4,086	4,468			
1967	2-ES	2,603	3,587			
1968	2-ES	3,061	4,031			
1969	2-ES	3,102	3,399			
1970	2-ES	3,271	3,774			
1971	2-ES	4,245	7,351			
1972	2-ES	3,050	7,385			
1973	1-ES	1,689	5,847			
1974	1-ES	1,531	5,614			
1975	1-MM only	890	5,560			
1976	1-MM only	738	2,742	7	48	4
1977	1-MM only	726	2,444	21	73	5
1978	1-MM only	688	2,961	10	36	2

[1]Point estimates for harvest from statewide hunter questionnaire.
[2]Data are for pre-1973 hunting district. HD 410 = present 410 + HD 417.

hunting patterns and population growth characteristics had probably placed a substantial portion of the female population in the vulnerable old age category (Mackie 1976). Thus, the population age structure resulting after the severe winter probably consisted almost entirely of prime-aged animals. Due to low fawn survival in subsequent years, almost no "biological surplus" existed. A year of heavy hunting pressure (2 deer - either sex) and high harvest and then 2 years of 1 deer - either sex seasons followed the severe winter of 1971-72. Since almost no "biological surplus" existed, hunting mortality was primarily directed toward prime-aged producing animals, further aggravating the population decline.

ALTERNATE PREY RELATIONSHIPS TO DEER MORTALITY

Population trends of *Peromyscus maniculatus* and various Microtine rodents for the south study area from 1976-1979 as determined by snaptrapping and livetrapping are given in Figures 3, 4, 5 and 6. Much of the data for 1976 and 1977 are calculated from data in Trout (1978). The equivalent population trends for the north study area are given in Figure 7. These figures indicate that 1978 was a peak year in *Peromyscus* populations. Populations remained high during summer 1979, but declined from 1978 levels. Microtine populations followed the same trend although they remained high through early summer 1979.

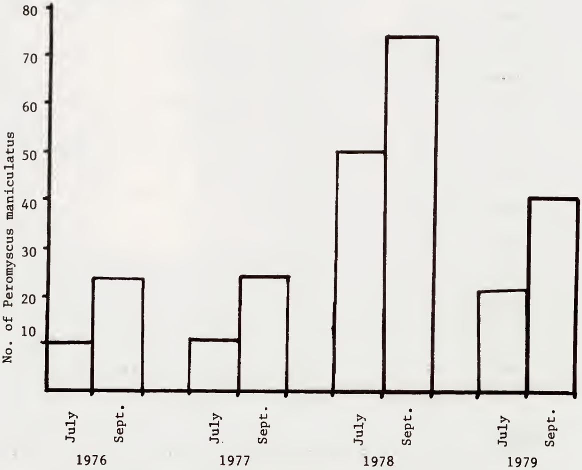

Figure 3. Population levels of *Peromyscus maniculatus* on the *Artemisia-Agropyron* grid on the south study area as determined by livetrapping.

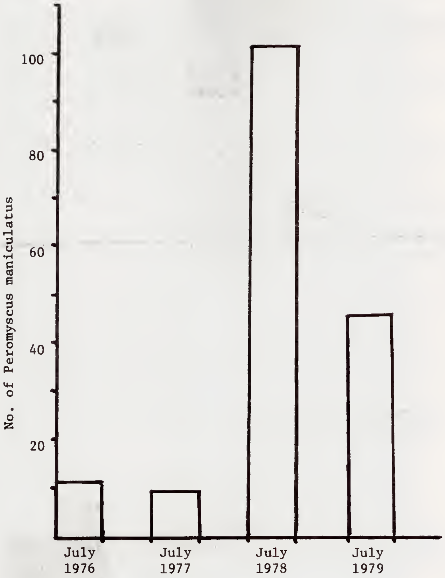

Figure 4. Population levels of *Peromyscus maniculatus* on the *Sarcobatus* grid on the south study area as determined by livetrapping.

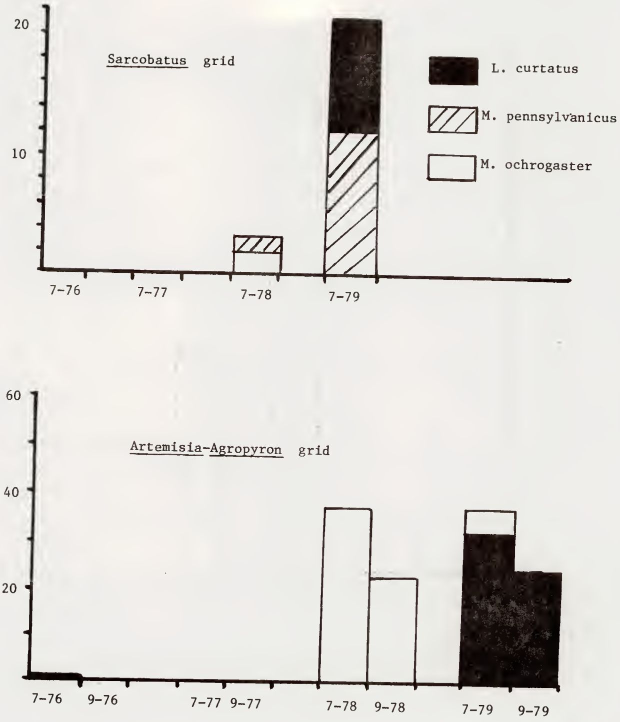

Figure 5. Population levels of Microtines on livetrap grids on the south study area 1976-1979.

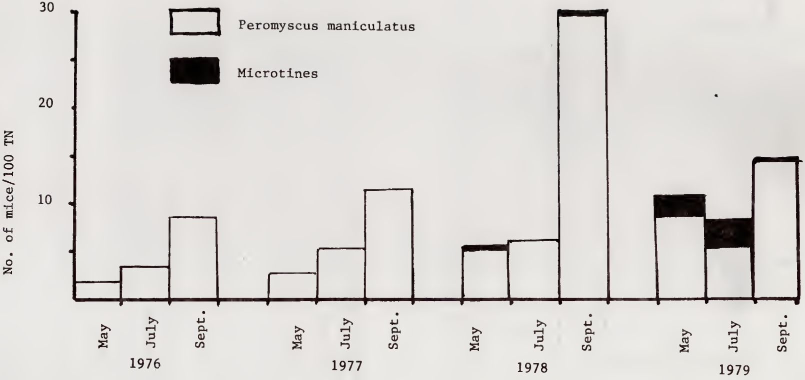

Figure 6. Population levels of mice on the south study area 1976-1979 as determined by snaptrapping.

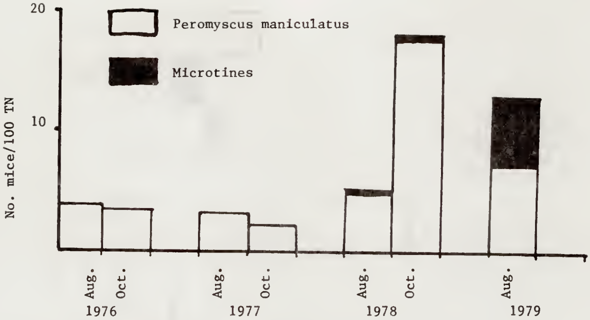

Figure 7. Population levels of mice 1976-1979 on the north study area as determined by snaptrapping.

Population trends for rabbits on the south study area are outlined in Figures 8 and 9. Much of the data for 1976 and 1977 on the prairie route are from Trout (1978). The drop in rabbit numbers during September 1978 may not be real since surveys had to be run during rainy, muddy conditions at that time. The overall indications are that rabbit populations were higher during 1978 and 1979 than during the two previous years. Population trends for rabbits on the north study area are outlined in Figure 10. Weather conditions were also bad on the north study area at the time surveys were run in 1978. It is not believed however, that rabbit populations were as high in 1978 as in 1977.

Figure 11 shows the estimated population levels of mice and rabbits on the study area from 1960-1970. These estimates were made by using written comments made by the staff of the Charles M. Russell Wildlife Range in their annual narrative reports. In combination with current information, this figure points out the probable cyclic nature of small mammal population levels on the area.

The trend in total coyote numbers, including pups, on both study areas as determined by siren survey (Pyrah 1977, 1978), indicated approximately the same level in 1976 and 1978 with numbers slightly lower in 1977. Observations of dens and marked and unmarked animals enabled estimates of numbers of coyotes during 1977 and 1978. The adult coyote population level remained about the same during 1977 and 1978 (Pyrah 1978). Most

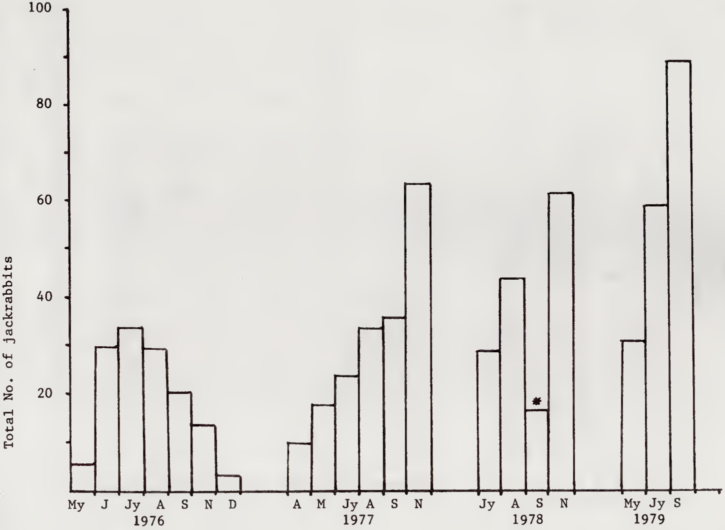

Figure 8. Population levels of jackrabbits on the prairie adjacent to the south study area as determined by headlight surveys.

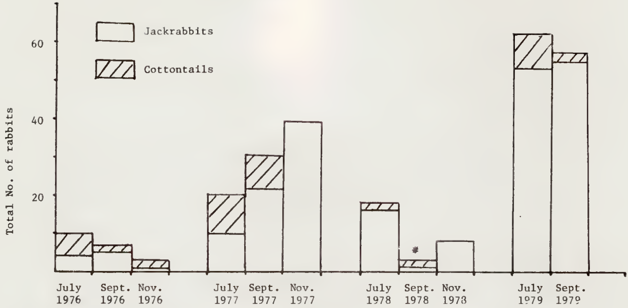

Figure 9. Population levels of jackrabbits and cottontails from the breaks type headlight survey route on the south study area.

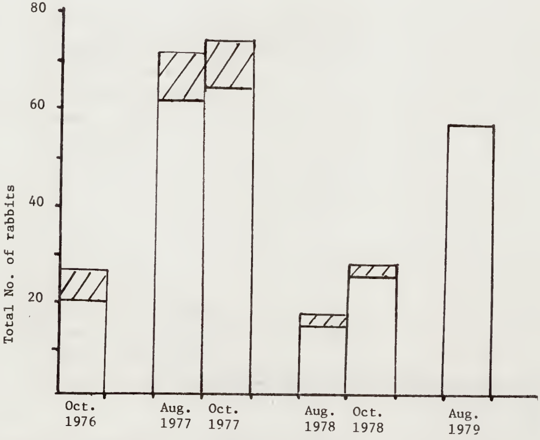

Figure 10. Population levels of jackrabbits and cottontails on the north study area as determined by headlight surveys.

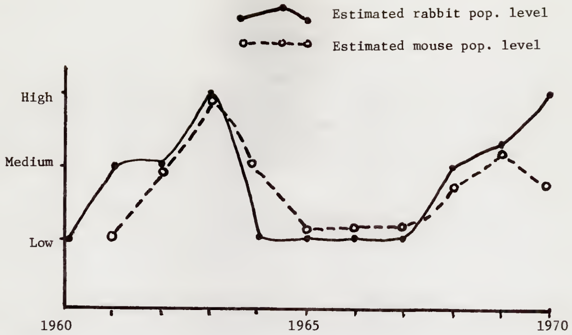

Figure 11. Estimated population levels of mice and rabbits on the study area 1960-1970.

of the pups marked in the fall of 1978 are known to have dispersed from the study area by spring 1979 (Pyrah pers. comm.). This occurred in spite of the fact that small mammal population levels appeared adequate to support many more coyotes than were present. Social factors and behavior may have at least as much control over the base coyote population level as food supplies (Pyrah pers. comm.).

The data indicate that mule deer fawn survival and recruitment has increased as small mammal populations, particularly mice, have increased. During the period of expanding small mammal populations, fawns survival did not appear to have any relationship to the number of coyotes on the study area. It might be argued that good forage conditions coincident with small mammal highs also beneficially affected fawn survival. Most available small mammal literature indicates that although the level of food may affect the ultimate level of population highs it does not affect the timing of the cycle. Hamlin (1978) indicated that the deer were in excellent physical condition during periods of high coyote-caused fawn mortality, before the recent excellent forage conditions. These factors seem to be indirect evidence that at the previously existing mule deer population levels coyote predation had an impact on fawn survival and recruitment and ultimately the mule deer population level.

FORAGE CONDITIONS

Table 16 summarizes general impressions of forage conditions on the study area from 1961 to the present. These forage conditions help give some explanation for past mule deer population fluctuations and patterns of fawn production and survival. Hamlin (1978) indicated that prior to the 1971 population crash, mule deer fawn survival to December appeared to be highly correlated with forage production.

Table 16. General impressions of forage conditions on the Missouri Breaks study area 1961-1979.

Year	Forage Conditions[1]
1961	Poor forage production, but fall green up of grasses
1962	Poor-ave. forage production early, but excellent late summer-fall
1963	Excellent forage production, especially yellow sweetclover
1964	Good forage production
1965	Exceptional growth of grasses and browse
1966	Poor forage production
1967	Adequate forage production - stayed green throughout summer
1968	Good forage production - yellow sweetclover on parts of area-fall green up
1969	Excellent forage production
1970	Good forage production
1971	Very poor forage production
1972	Excellent forage production - extensive 1st year sweetclover
1973	Extensive 2nd year sweetclover - fall green up
1974	Extensive 1st year sweetclover
1975	Extensive 2nd year sweetclover, but much grasshopper damage by mid summer
1976	Poor forage production - also grasshopper damage
1977	Poor forage production, but fall green up
1978	Excellent forage production - extensive 1st year sweetclover
1979	Extensive 2nd year sweetclover, but dried up by August

[1]Impressions of forage production from R. J. Mackie field notes, CMR annual narratives, BLM transects and photo plots and after 1975 from personal notes and impressions.

Yellow sweetclover (*Melilotus officionalis*) has been documented as an important forage source on the study area (Mackie 1970, Knowles 1975). Since 1977 quantitative documentation of sweetclover abundance on the study area has been attempted (Table 17). It is hoped that continuing documentation of sweetclover abundance and availability will help in interpretation of mule deer population dynamics on the study area.

Table 17. Relative abundance of yellow sweetclover on the south study area 1977-1979.

	First Year Sweetclover		Second Year Sweetclover	
Year	Total No. Plants in 320 Plots	% Frequency of Plants in 320 Plots	Total No. Plants in 320 Plots	% Frequency of Plants in 320 Plots
1977	11	1.9	0	0
1978	3229	43.1	21	3.4
1979	0	0	1407	38.1

Relative forage abundance on 5 habitat types is presented in Tables 18 and 19. This information should help to interpret the patterns of mule deer distribution and habitat use. Table 20 presents soil moisture conditions on the study area from 1976 through summer 1979. These data should also be helpful in explaining patterns of mule deer distribution and habitat use. Discussion of mule deer distribution and habitat use in the Missouri River Breaks will be presented in future reports.

FOOD HABITS

Table 21 updates fall-winter mule deer food habits information for the study area. Particularly noticable is that during fall 1978 the availability of yellow sweetclover resulted in its heavy use by mule deer. The heavy use of sweetclover when it is available was previously documented by Mackie (1970) and Knowles (1975). Forage used during winter 1978-79 as in 1977-78 probably reflects the extreme snow depth and limited forage availability rather than the preferences of the deer.

Table 18. Green forb abundance, excluding yellow sweetclover, by vegetation type and season on the South Missouri River Breaks study area.

Vegetation Type	MAY No. of Plants per 100 2x5 dm Plots	MAY % of Total Plants	JULY No. of Plants per 100 2x5 dm Plots	JULY % of Total Plants	SEPTEMBER No. of Plants per 100 2x5 dm Plots	SEPTEMBER % of Total Plants
Artemisia-Agropyron	702	53%	348	36%	38	28%
Pseudotsuga-Juniperus	207	16%	243	25%	54	39%
Pinus-Juniperus-Agropyron	175	13%	252	26%	31	23%
Pinus-Juniperus-shale	23	2%	57	6%	8	6%
Sarcobatus slopes	212	16%	70	7%	6	4%
Total Plants	1319		970		137	
Percent of total plants occurring in each season	54%		40%		6%	

Table 19. Percent frequency of occurrence of various shrub species in each of five vegetation types.

Shrub Species	VEGETATION TYPE Artemisia-Agropyron (300)[1]	Pseudotsuga-Juniperus (300)	Pinus-Juniperus-Agropyron (300)	Pinus-Juniperus-shale (300)	Sarcobatus slopes (300)
Artemisia cana			tr.[2]	tr.	
Artemisia longifolia			1		6
Artemisia tridentata	46	1	3	1	2
Atriplex nutalli					tr.
Chrysothamnus nauseosus	tr.		1		
Chrysothamnus viscidiflorus	tr.	tr.	tr.		
Eriogonum multiceps					3
Guteriesia sarothrae	3				
Juniperus scopulorum		57	5	17	tr.
Prunus virginiana		12	1		
Rhus trilobata		9	9	1	
Ribes spp.		7		tr.	
Rosa spp.	1	20	27	tr.	1
Sarcobatus vermiculatus	1				39
Symphorocarpus spp.		50	18	1	

[1]Number of 2x5 dm plots in each type (20 plots on each of 15 sites).
[2]tr. = trace = less than 0.5 percent.

Table 20. Estimated soil moisture conditions on the south study area 1976-1979.

Habitat Type - Exposure	Depth	Date Soil Moisture Fell Below Est. Wilting Point 6"	1'	Date Soil Moisture Fell Below Est. Wilting Point 6"	1'
Artemisia-Agropyron ridgetop	Year				
	1976	Aug. 1	Aug. 1	-	-
	1977	July 15	June 5	late Sept.	late Sept.
	1978	Aug. 10	Aug. 1	Sept. 10	Sept. 10
	1979	June 20	June 20	-	-
Pine-Juniper north slope	1976	*	*	*	*
	1977	Aug. 1	Aug. 1	-	-
	1978	Aug. 20	Aug. 20	Sept. 10	-
	1979	July 15	July 15	-	-

*Soil moisture did not fall below wilting point.

MOVEMENTS

The past two severe winters have resulted in the observation of marked and unmarked deer moving in some cases up to 10 miles to winter in specific topographical sites. Deer moved from drainage heads and other areas of shallow relief to areas near the Missouri River. These wintering areas almost always included a steep south-facing slope dominated by greasewood (*Sarcobatus vermiculatus*) and a steep north-facing slope with a *Pseudotsuga-Juniperus* habitat type. The marked deer that moved to these areas during winter 1977-78 and 1978-79 and for which information is available for the mild winter of 1976-77 did not move to these sites during that winter.

Transmitters on 1 female and 5 male fawns radioed in June 1978 lasted through at least late May 1979. This led to interesting observations of home range establishment and social organization of mule deer. As previously observed, during mid-to-late May, adult females seek solitude and are intolerant of other deer including their previous year's fawns. By mid June, 4 of the 5 male fawns had moved from 3 to 13 airline miles from their previous home ranges. After this time, either 3 of the 4 radios ceased to function or the deer continued to move much further and radio contact was lost. One radio has continued to function and this yearling male has apparently established a new home range about 6 miles from the area it used as a fawn. One yearling male has remained within its previous home range. The female fawn was still on her previous home range at the time her transmitter ceased to

Table 21. Fall-winter food habits of mule deer on the south side Missouri River Breaks, 1976-77 through 1978-79.

	FALL			WINTER		
Taxa	1976 (2)[1]	1977 (11)	1978 (8)	1976-77 (9)	1977-78 (5)	1978-79 (5)
GRASSES	tr.[2]/50	37/100[3]	tr./13	tr./44	-	-
FORBS						
Artemisia longifolia[4]	-	-	5/50	8/44	-	2/60
Chrysopsis villosa	-	tr./27	-	-	-	-
Compositae	-	-	-	tr./11	-	-
Glycyrrhiza lepidota	-	-	tr./25	-	-	-
Medicago sativa	-	1/9	-	-	-	-
Melilotus officionalis	-	tr./9	50/100	tr./11	-	tr./20
Phlox hoodii	-	tr./9	-	-	-	-
Yucca glanca	tr./50	-	tr./13	-	-	1/40
unid. forbs	10/50	1/45	tr./13	tr./22	1/20	12/60
Total Forbs	10/100	3/64	55/100	9/44	1/20	15/80
BROWSE						
Artemisia tridentata	-	-	-	13/89	19/100	22/100
Atriplex nutalli	-	-	-	4/44	11/40	-
Chrysothamnus spp.	67/100	20/82	tr./13	37/100	7/20	2/20
Juniperus scopulorum	tr./50	2/36	-	18/100	17/100	29/100
Pinus ponderosa	tr./100	-	-	-	33/100	16/60
Pseudotsuga menziesii	tr./50	-	-	tr./11	-	-
Rhus trilobata	tr./50	-	tr./25	8/78	12/80	5/40
Rosa spp.	8/100	1/82	4/88	tr./33	-	3/20
Sarcobatus vermiculatus	-	-	-	-	-	6/20
Symphorocarpos spp.	19/100	37/100	41/100	11/100	-	1/40
unid. browse	-	-	-	tr./38	-	1/40
Total Browse	90/100	60/100	46/100	91/100	99/100	85/100
OTHER						
Fungi	-	tr./18	tr./13	-	-	-

[1]No. of rumens.
[2]tr. = trace or less than 0.5 percent.
[3]Percent of diet by volume/percent frequency of occurrence.
[4]May include some Eriogonum multiceps.

function shortly after 25 June. Additionally, information is available on 1 male and 2 female fawns marked during winter 1977. The male fawn was observed with its mother until 23 May 1977, after which it was not observed again with the female. On 28 October 1977, this male, now a yearling, was shot by a hunter approximately 7 miles from its home range as a fawn. The two females have, for 2½ years, continued to occupy the same general home range area as their mother. Between September and mid May of each subsequent year they have often been observed with their mother in a group of deer. This social grouping then breaks up in mid May, shortly before fawning and reforms again generally during September.

Discussion of factors influencing daily and seasonal movements and home range size and use will be included in future reports.

DISCUSSION

The data available at present indicates the following conclusions:

1. A relatively high density deer population was severely reduced by winter mortality (1971-72) following a summer of poor forage production.

2. Heavy either-sex hunting pressure on a deer population with no biological surplus further aggravated the population decline during the period 1972-1974.

3. After 1974, hunting ceased to be a mortality factor for females and fawns. However, due to continued low fawn survival, in spite of adequate forage and mile winters, the population failed to increase.

4. During 1976-1979 coyote predation accounted for a minimum of 73% of the documented summer fawn mortality. The precentage of fall-winter mule deer mortality attributable to coyote predation was not reliably documented; however, coyote predation was the major source of documented fall-winter deer mortality.

5. During 1976-1979, fawn survival rates appear to have been closely and positively related to population levels of small mammals, but not to coyote density.

6. When the population level of breeding females decreases to an as yet undetermined threshold, any source of fawn mortality, including coyote predation, can have substantial population impacts. The threshold of impact probably depends on the mortality rate of adult females.

7. Myriad factors affect deer populations. When these factors act concurrently or consecutively, deer population levels can be substantially altered.

8. In view of the anticipated low levels of rodent populations during summer 1980, it is recommended that the monitoring of small mammal populations and coyote density continue through at least summer 1980. If coyote predation on mule deer increases because of low small mammal population, its effect on a mule deer population that could be up to three times its previous density should be documented.

It is anticipated that future reports will contain more information and discussion of estimation of mule deer numbers, basic mule deer ecology in the river breaks type, competition and comparisons with other mule deer studies throughout the state.

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Submitted by: Kenneth L. Hamlin

JOB TITLE: Population ecology and habitat relationships of white-tailed deer on bottomlands of the Missouri River in northcentral Montana.

ABSTRACT:

Limited information was collected on a white-tailed deer population on the Missouri River bottomlands of northcentral Montana. Population estimates for 1978-79 ranged from 123 to 172 white-tailed deer on the study area. A minimum density estimate was 15.6 deer/mi^2 comparing to a minimum estimate of 29.5 deer/mi^2 in 1971-72. Fixed-wing aerial surveys are apparently as effective as helicopter surveys in estimating total numbers of white-tailed deer on the Missouri River bottomlands. Severe spring flooding again disrupted normal habitat use patterns. Permanent raises of the water level of Fort Peck Reservoir have destroyed about 4.5 mi^2 of white-tailed deer habitat since 1964.

JOB TITLE: Population ecology and habitat relationships of white-tailed deer on bottomlands of the Missouri River in northcentral Montana, 1977-78.

JOB OBJECTIVE: To determine the environmental requirements of white-tailed deer and factors regulating whitetail population in major river bottom habitats of northcentral Montana.

To determine the effects of various potentially competing land use and management practices upon white-tailed deer in northcentral Montana.

To develop new and improved guidelines for management of northcentral Montana whitetail populations and their habitats.

INTRODUCTION:

Few data are available on the population ecology and environmental requirements of white-tailed deer *(Odocoileus virginiana)* populations associated with the floodplains of major rivers in Montana. The only existing study (Allen 1968) was conducted in 1964-65 and primarily concerned range use, food habits, condition and productivity of white-tailed deer on bottomlands of the Missouri River in northcentral Montana.

To meet the need for further information concerning white-tailed deer in river bottom habitats, this study was established during 1975 on the same area on which Allen's (1968) study was conducted. Field studies were initiated during early winter 1975-76 and preliminary findings have been reported by Mackie and Knowles (1976) and Hamlin (1977 and 1978). Due to other work demands, field studies have not been intensive and were confined primarily to obtaining population data and deer distribution.

STUDY AREA

The study area is located on the Charles M. Russell Wildlife Refuge, administered by the U. S. Department of Interior Fish and Wildlife Service. The study area consisted of 20 bottoms and 3 islands included in a straight line distance of about 23 miles (Fig. 1). The floodplain varied from ½ to 1 mile in width and bottoms, ranging in size from 144 to 644 acres, usually alternated between north and south sides of the river. The ridges overlooking the river are at approximately 2,900 feet elevation and slope at a relatively steep angle to the floodplain at approximately 2,270 feet.

Physiography, climate, land usage and vegetation of this area have been described in detail by Allen (1968). Mackie (1970) and Knowles (1975) provide similar information for adjacent uplands.

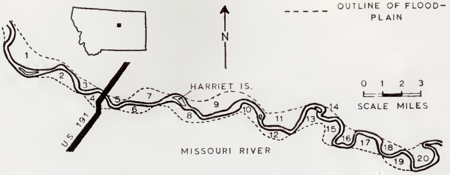

Figure 1. Map of study area.

METHODS

Existing data from prior management surveys and research studies on white-tailed deer on Missouri River bottoms of the study area were reviewed, analyzed and incorporated into the present report when applicable.

An early winter aerial survey, employing a helicopter, was conducted on 10 December 1978, to count and classify whitetails on the study area.

During February, four different white-tailed deer were captured with Clover traps (Clover 1954) on bottom 4 (Fig. 1). Two were fitted with radio transmitters and two with individual observation collars of Armortite fabric. Deer collared during previous winters were also available for observation.

Periodic ground and aerial (Piper Supercub) observations were made throughout the year to determine movements, distribution, mortality and survival of white-tailed deer.

RESULTS

Population Studies

In spite of the previous severe winter and March flooding of the bottoms, fawn/female and fawn/adult ratios reached their highest recorded level since 1971-72 (Table 1). These ratios, a noticeable improvement over the previous 4 years, are still substantially below species potential.

The 90 white-tailed deer observed during the helicopter survey was an underestimate of the total number present. A minimum estimate of the white-tailed deer present would be the 116 observed on a fixed-wing flight on 8 January 1979 plus seven marked deer present, but not observed (123 total). In addition to the marked deer missed, there were undoubtedly some unmarked deer missed on that flight. The average of three Lincoln indicies calculated from surveys conducted on 21 November 1978, 10 December 1978 and 8 January 1979 was 172 white-tailed deer (range 120-206).

Table 1. White-tailed deer numbers, sex and age composition from early winter surveys 1960-1976.

Year	Numbers							Ratios				
	Tot.	AD	YG	Fem.	Males[1]	Yrlg	Mat-ure	YG:100 AD	YG:100 FF	% YG	MM:100 FF	% YG MM
1973-74[2]	207	168	39	146	22	9	13	23.2	26.7	18.8	15.1	40.9
1975-76[2]	121	105	16	76	29	8	21	15.2	21.0	13.2	38.2	27.6
1976-77[2]	18	15	3	10	5	2	3	20.0	30.0	16.6	50.0	66.7
1977-78[2]	110	96	14	58	38	17	21	14.6	24.1	12.7	65.5	44.7
1978-79[2]	90	69	21	53	16	7	9	30.4	39.6	23.3	30.2	43.8

[1]Includes unclassified males.

[2]Helicopter survey. Complete coverage.

It appears that the helicopter survey could be discontinued without adversely affecting population estimates. During 1977-78, 110 white-tailed deer were counted from the helicopter. Subsequent fixed-wing flights resulted in counts of 90, 107 and 99 deer. During 1978-79, 90 white-tailed deer were counted from the helicopter whereas fixed-wing flights resulted in counts of 116, 105 and 97 deer.

Distribution and Movements

Severe flooding of all bottoms again occurred in March 1979, duplicating effects of flooding in March 1978. This type of flooding occurs when there is heavy winter snowfall with rapid spring runoff occurring before the river ice has broken up.

Although winter-spring distribution of white-tailed deer has remained relatively constant on a unit basis (Table 2) over the last 3 years, distribution on individual bottoms has fluctuated. Reasons for the changing winter use patterns of individual bottoms have not been determined. Limited information from individually marked deer indicates that this shifting distribution has occurred for individual animals as well as for the population as a whole. The tendency has been for those bottoms further upstream to receive increasing use each succeeding year. Units are delineated on the basis of severity and frequency of flooding, rather than as population units. Only deer wintering in the middle unit have been captured and marked to this time. Their summer-fall distribution includes bottoms in all three units.

Information on movements of individual white-tailed deer is limited at this time. Further available information is complicated by spring flooding for the last 2 years. Analysis of movements data will be presented when more relocations have been obtained.

DISCUSSION

A more permanent and regular flooding of some river bottoms occurs because of the rising levels of Fort Peck Reservoir. Major raises of the water levels of the reservoir occurred in 1964-65 and 1975 (Table 3). Although the precise elevations of each of the bottoms is unknown, Bottoms No. 12-20 have all or significant portions of their white-tailed deer habitat below 2,250 ft elevation. Therefore, all of these bottoms have been subject to spring-summer flooding since at least 1975. Bottoms No. 16-20 have been subject to total or partial permanent flooding since 1965.

Originally there were about 7,890 A (12.3 mi^2) of habitat available for white-tailed deer on the study area. Permanent and periodic flooding is estimated to have destroyed about 2,850 A (4.5 mi^2), or about 36 percent of the available habitat. On a strictly habitat-available-basis, only about 64 percent of pre-1964-65 population levels might be expected today. About 53 percent (Table 2) of the deer spent winter and early spring prior to 1965 on bottoms subsequently subjected to permanent and/or periodic severe flooding. This could mean that no more than about 47 percent of the pre-1964-65 population levels could be expected at present in the remaining habitat. Population data are available for only one year prior to the 1964-65 rise in the

Table 2. White-tailed deer distribution during winter and spring, 1964-77, listed by percent of total per Bottom, Island or Unit.

Date	No. of Obs.	Bottom Number (See Fig. 1) 1	Two Calf Isl.	2	3	4	5	6	7	Harriet Isl.	8	9	10	Isl.	11	12	13	14	15	16	17	18	19	20
Winter-Spring 1964-65	717	3	Tr	1	-	4	-	3	1	2	3	26	1	Tr	2	-	Tr	Tr	7	26	11	2	4	3
Winter 1971-72	267	3	-	4	-	Tr	9	9	8	3	-	17	6	5	-	-	15	-	20	Tr	-	-	-	-
Winter 1973-74	207	4	-	4	-	4	4	4	46	2	-	-	-	-	10	-	19	-	3	-	-	-	-	-
Winter 1975-76	121	18	-	7	-	-	44	12	-	-	-	12	-	-	7	-	-	-	-	-	-	-	-	-
Winter-Spring 1976-77	131	16	-	24	-	-	2	18	4	11	-	25	1	-	-	-	-	-	-	-	-	-	-	-
Winter 1978	406	25	1	15	-	15	-	13	17	4	-	5	-	-	4	-	1	-	-	-	-	-	-	-
Winter 1978-79	494	28	-	10	-	14	4	22	13	-	1	5	2	-	Tr	Tr	Tr	-	-	-	-	-	-	-

Date	No. of Obs.	Upper Unit	Middle Unit	Lower Unit
Winter-Spring 1964-65	717	8	36	56
Winter 1971-72	267	7	51	35
Winter 1973-74	207	13	56	32
Winter 1975-76	121	25	68	7
Winter-Spring 1976-77	131	40	61	0
Winter 1978	406	41	54	5
Winter 1978-79	494	38	61	1

Table 3. Maximum elevational levels of surface water of Fort Peck Reservoir (MSL), 1959-1978.

Year	Elevation	Year	Elevation
1959	2209.9	1969	2246.4
1960[1]	2217.7	1970	2247.0
1961	2209.0	1971	2243.6
1962	2202.6	1972	2243.8
1963	2216.0	1973	2241.7
1964[2]	2235.7	1974	2244.5
1965	2245.6	1975[3]	2251.6
1966	2242.1	1976	2249.0
1967	2245.4	1977	2239.7
1968	2244.4	1978	2249.2

[1]Maximum elevation prior to 1964-65.
[2]Reservoir level started rising in June 1964 and continued until August 1965.
[3]July 1975 represents the 2nd major raising of the reservoir level.

water level, so it is difficult to make a numerical population impact assessment for the first permanent raising of the reservoir's surface level.

During winter 1971-72, when an estimated 5,795 A (9.05 mi^2) of habitat were available, 267 deer were seen during the helicipter survey. This gives a minimum density estimate of 29.5 deer/mi^2 which is quite similar to the 30.5 deer/mi^2 estimated by Swenson (1978) for the Yellowstone River Bottom near Intake. A minimum estimate for the 7.85 mi^2 of habitat estimated available in 1978-79 is about 15.6 deer/mi^2, or about one-half of the 1971-72 density estimate.

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Submitted by: Kenneth L. Hamlin

JOB TITLE: Population ecology and habitat relationships of mule deer and white-tailed deer in the prairie-agricultural habitats of eastern Montana.

ABSTRACT:

Population dynamics of mule deer in the prairie-agricultural type are discussed and compared with previous findings. Population estimates indicate an approximate 30 percent increase in mule deer numbers since 1977-78. The mule deer population has increased each year since 1975. Moderate overwinter mortality occurred during 1978-79. Post-season male/100 female ratios indicated that harvests in this type of habitat and terrain can quickly reflect change in hunting season type and pressure.

JOB TITLE: Population ecology and habitat relationships of mule deer and white-tailed deer in the prairie-agricultural habitats of eastern Montana.

JOB OBJECTIVE: To determine the environmental requirements of mule deer and white-tailed deer and factors regulating deer populations in the prairie-agricultural habitats in eastern Montana.

To determine the effects of various potentially competing land use and management practices upon deer in eastern Montana.

To develop new and improved guidelines for management of deer populations and their habitats in eastern Montana.

INTRODUCTION:

The Terry deer study was initiated in September 1975 as a part of the statewide deer research project. The general objective was to determine factors affecting and limiting mule deer (*Odocoileus hemionus)* and white-tailed deer (*Odocoileus virginiana)*numbers in the prairie-agricultural types of eastern Montana. Field studies were conducted from September 1975 through May 1976, after which, fieldwork was continued on a part-time basis. During 1978-79 studies were limited to aerial surveys to make population estimates and follow population dynamics. Coincident with aerial surveys, information was obtained on deer distribution and habitat use. Information collected previously was reported by Hamlin (1976, 1977 and 1978).

STUDY AREA

The study area is located in north Prairie and southwestern McCone counties on the west side of Highway 253, starting approximately 10 miles northwest of Terry and extending north to approximately 4 miles south of Brockway. The study area extends as far west as Little Sheep Mountain on the southern boundary and 5 miles west of Brockway on the northern boundary (Fig. 1). Approximately 230 square miles are included within the study area boundaries.

A general description of the topography, vegetation, land uses and history of the area was included in Hamlin (1976).

METHODS

Fixed-wing (Piper Supercub) aerial surveys were made to obtain population estimates, sex and age classifications, distribution and habitat use during two periods in 1979: post-hunting season (January) and spring (March).

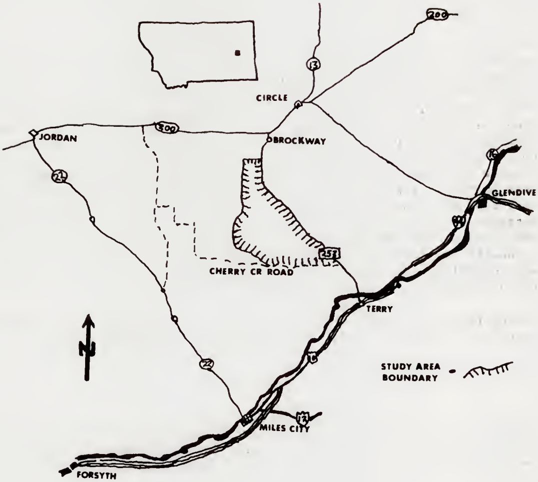

Figure 1. General location of the study area.

POPULATION TREND

The mule deer fawn/female and fawn/adult ratios during winter and spring 1979 (Table 1) were higher than during the same periods of any of the three previous years. Because of complete snow cover, observational conditions were considered good during the January flights. However, due to the relative severity of the winter, the fawn/adult ratio decreased by approximately 19 percent from January to March, but was still higher than the ratios for any of the previous three years. Fawn/adult ratios for white-tailed deer also indicated that while overwinter fawn mortality occurred, it was not severe. Prior classifications of deer on the study area can be found in Hamlin (1976, 1978).

Population estimates for mule deer and the computations involved in these estimates are shown in Figure 2 and Table 2. Population estimates indicated an approximate 30 percent increase in mule deer numbers over 1977-78. Hamlin (1978) discussed some of the reasons that observed population levels will differ somewhat from the expected levels even if every animal on the study area was counted. Estimates of total numbers are believed to be accurate within 5-10 percent. One of the largest discrepancies in observed vs. expected population levels occurs during winter in the adult male category (Table 2) because the expected population level does not account for hunting mortality (see hunting mortality). Additional variation has been introduced during the last two years due to apparent overwinter mortality. Without marked deer, estimates of adult winter mortality have been "educated guesses" based on the level of fawn mortality. An estimate of 5 percent overwinter mortality of adults has been used for the last two winters. The level of fawn mortality was determined from calculations based on changes in fawn/adult ratios, taking the 5 percent adult loss into account.

As previously discussed (Hamlin 1978), population estimates of white-tailed deer cannot be made on this area without more intensive effort.

HUNTER HARVEST

Numbers of mule deer killed on the study area were estimated by field checks in 1975, a telephone survey of permit holders in 1976, and by pre-to-post season changes in ♂♂/♀♀ ratios and observed versus expected number of males in 1977 and 1978. Hunting unit boundaries were changed prior to the 1976 hunting season, so figures are not entirely comparable. However, most of the decline in hunting pressure and harvest, 1975-78 (Table 3), appears to have resulted from more restrictive seasons rather than the boundary changes. The preliminary indication from post-season ♂♂/♀♀ ratios is that mule deer harvest in the type of terrain and habitat prevalent on the study area is easily influenced by type and intensity of hunting pressure.

Table 1. Deer classifications on the Terry study area during winter and spring 1979.

	Species	Total Animals	Total Males	Ylg. Males	Females	Adults	Fawns	Uncl.	Fawns/ 100 Adults	Fawns/ 100 Females
January										
South area	WTD	51	-	-	-	21	25	-	119	-
	MD	396	35	18	163	198	185	14	93	113
North area	WTD	91	-	-	-	37	18	36	49	-
	MD	121	-	-	40	40	38	43	95	95
Entire area	WTD	142	-	-	-	58	43	36	74	-
	MD	517	35	-	203	238	223	57	94	110
March										
Entire area	WTD	59	-	-	-	36	23	-	64	-
	MD	289	-	-	-	164	125	-	76	-

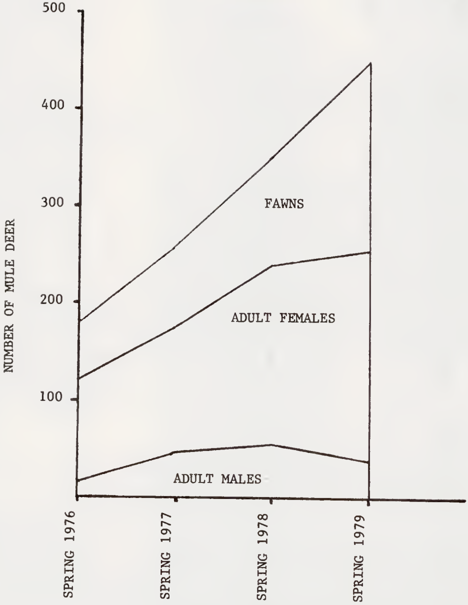

Figure 2. Spring population estimates of mule deer on the Terry study area.

Table 2. Population estimates for mule deer on the Terry study area.

	Total	Adults	Fawns		Adult Females	Adult Males
Observed Winter 75-76	153	105	48		93	12
+ 15% missed	180	124	56		109	15
Calculated				+	28	28
June 1976	180	180	--		137	43
				x	.58 --	58 Fawns/100 Adult Females observed, winter 1976-77.
					79 fawns	
Calculated Winter 76-77	259	180	79		137	43
Observed Winter 76-77	252	175	77		132	43
Calculated June 1977	260	260	--		178	82
				x	.75 --	75 Fawns/100 Adult Females observed, winter 1977-78.
					134 fawns	
Calculated Winter 77-78	394	260	134		178	82
Observed Winter 1977-78	413	261	152		204	57
Calculated* June 1978	348	240	108		188	52
	348	348	--		242	109
				x	1.10 --	110 Fawns/100 Adult Females observed, winter 1978-79.
					266 fawns	
Calculated Winter 78-79	614	348	266		242	109
Observed Winter 78-79	517	267	250		228	39
Calculated** June 1979	452	257	195		219	38
	452	452	--		316	136

*estimated 5% adult loss and 27% fawn loss overwinter
**estimated 5% adult loss and 22% fawn loss overwinter

Table 3. Hunting seasons and harvest in the hunting units including the study area, 1975-1978.

Type of Hunting Season	Year	No. of[1] Hunters	Est. no.[1] of WTD Killed	Est. no.[1] of MD Killed	Est. no. of MD Killed on Study Area	Post-season MD ♂♂/100♀♀ Ratio
2 deer E.S. "B" tag WTD only	1975	3,695	814	828	60	13/100
1 deer E.S.-WTD + 50 E.S. permits-MD	1976	1,147	517	27	0	33/100
1 deer E.S.-WTD + 200♂♂ permits-MD	1977	1,096	400	73	20	28/100
1 deer E.S.-WTD + 1 deer ♂♂ only-MD	1978	1,969	663	480	60	17/100

[1]Data from Montana Department of Fish, Wildlife and Parks harvest surveys.

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