Reproduction of moose in southwestern Montana
by James M Peek

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University

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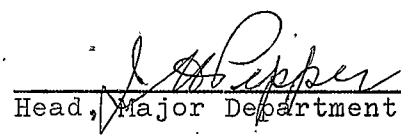

Head, Major Department

Chairman, Examining Committee

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ABSTRACT

Data on reproduction of moose (Alces alces) in the upper Ruby River drainage and adjacent areas of southwestern Montana were obtained during the summers and falls of 1958, 1959, and 1960. Cow-bull, cow-calf, and adult-yearling ratios were obtained from 779 moose observations. Factors influencing these observed ratios were discussed. The examination of 18 female and 17 male reproductive tracts as well as field observations were used to evaluate fecundity, extent of the breeding season, and status of yearling breeding. Forty-one moose calves were ear-tagged to gain movement information. Standard measurements and weights of nine moose calves were obtained. Utilization of three browse species occurring above 7500 feet elevation and two at about 6500 feet was evaluated.

INTRODUCTION

Recent studies by Edwards and Ritcey (1958) in British Columbia, Pimlott (1959) in Newfoundland, and Rausch (1959) in Alaska, have done much to clarify the reproductive status of moose (Alces alces) in those areas. No such studies of the Shiras moose of the northwestern United States are available. The upper Ruby River drainage and adjacent areas in southwestern Montana are an important moose habitat. Reports of the Montana Fish and Game Department (Hodder, 1948, South, 1953) indicate moose population increases in this area from the 1940's to the 1950's. Heavy utilization of willows by moose was noted as early as 1952 and 1953. Knowlton (1960) counted 53 moose along 13 miles of the Ruby River in March, 1959. The number of hunting permits issued by the Montana Fish and Game Department has gradually increased from five permits for bulls in 1950 to 125 permits for either sex in 1960.

Knowlton (1960) reported on the food habits, movements and populations of moose in this area. The present author worked with Knowlton from June 12 to September 29, 1958, and continued the field investigation independently on a full-time basis from June 1 to December 20, 1959, and from May 28 to September 20, 1960. Supplemental field work and laboratory analyses were conducted at various times through April, 1961. Emphasis was placed on reproduction and related factors.

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Kenneth Greer, and other members of the Montana Fish and Game Department for aid in planning and conducting field work; Dr. John Rumely, Montana State College, for aid in vegetation description and identification; Frederick Knowlton for advice and assistance; Arnold Foss and David Spaulding for aid in the field; Ralph Rouse, Melvin Wessel, Walter Sperry, and others for hospitality and aid.

DESCRIPTION OF THE STUDY AREA

The general study area has been described by Rouse (1957) and Knowlton (1960). To clarify vegetative types discussed in this paper, the following additional information is presented. The study area was located at the headwaters of the Ruby River, West Fork of the Madison River, and Long Creek, a major tributary of the Red Rock River, in Beaverhead and Madison Counties (Fig. 1). The Snowcrest Mountains, a steep and relatively inaccessible range, formed the western side of the area, and the Gravelly Range, more accessible, formed the eastern side. Elevations ranged from 6000 to over 9500 feet.

No attempt was made to quantitatively analyze the vegetation, but eight vegetative types were tentatively recognized. In general vegetative aspect, the area was a complex of coniferous and aspen timber and sagebrush-grassland stands (Figs. 2 and 3). Most of the area was in climax or near-climax stage (Daubenmire, 1952, Wright, 1948). Scientific and common plant names followed Booth (1950) and Booth and Wright (1959).

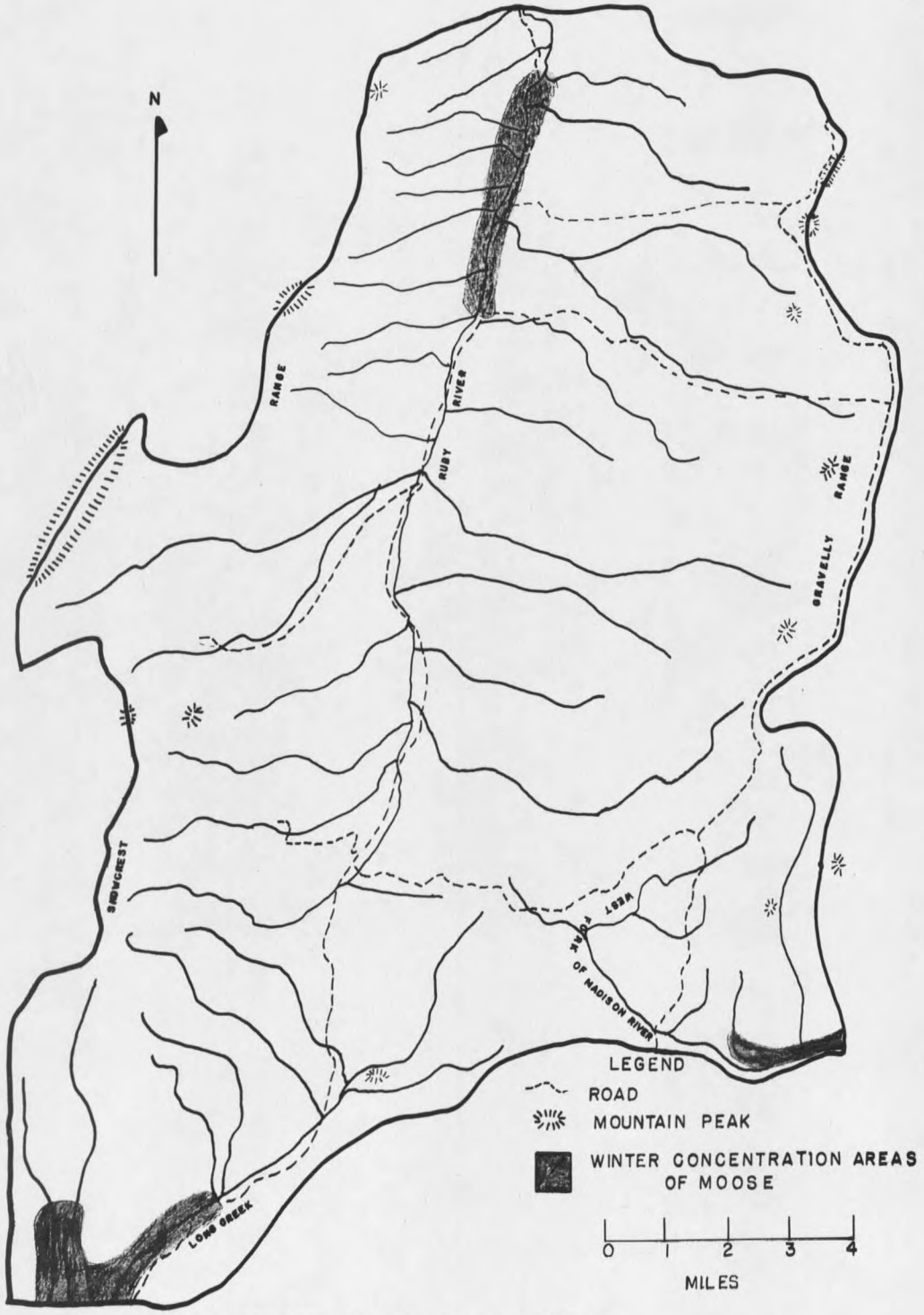

FIG. 2. A MAP OF THE STUDY AREA, AFTER KNOWLTON (1960)

Areas over approximately 8800 feet elevation were primarily alpine grassland with bluebunch fescue (Festuca idahoensis) and stonecrops (Sedum spp.) being common species.

Below 8800 feet, a sagebrush-grassland community was present which could be separated into three vegetative types. First, a sagebrush type occupied the most area. Big sagebrush (Artemesia tridentata) and three-tip sagebrush (Artemesia tripartita) characterized the general appearance, with bluebunch fescue, mountain brome (Bromus marginatus), wheatgrasses (Agropyron spicatum, A. smithi, A. trachycaulum, A. subsecundum) and numerous forbs being abundant understory species. Snowberry (Symphoricarpos albus) was abundant in limited localities. The second type, a fescue-wheatgrass community, had similar characteristics, except sagebrush was scattered or absent. Wright and Wright (1948) and Evanko and Peterson (1955) present evidence that this type represents the climax in this area, and that areas heavily populated with sagebrush represent a grazing disclimax. The third, a forb type, was present between 8800 and 7500 feet in certain areas, with sticky geranium (Geranium viscossissimum) being the most conspicuous plant. Lupine (Lupinus spp.), cinquefoils (Potentilla spp.), and various composites were also common. Grasses and sagebrush were minor associates in this type.

Two conifer types were recognized. Timber above 8000 feet was mostly dominated by Engelmann spruce (Picea engelmanni) and subalpine fir (Abies lasiocarpa) with varying amounts of whitebark pine (Pinus albicaulis) and limber pine (Pinus flexilis) on drier slopes. A douglas fir (Pseudo-

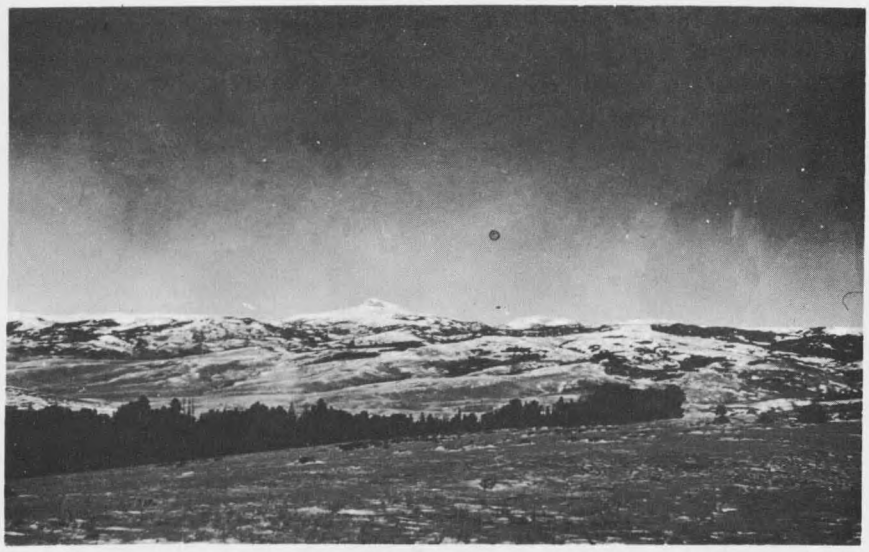

Fig. 2. Gravelly Mountains.

Fig. 3. Snowcrest Mountains.

tsuga menziessi) and lodgepole pine (Pinus contorta) type was prevalent below 8000 feet. Understories commonly contained pinegrass (Calamagrostis rubescens), low red huckleberry (Vaccinium scoparium), gooseberry (Ribes spp.), sticky geranium, bluebunch fescue, wheatgrasses, and elk sedge (Carex geyeri).

Aspen (Populus tremuloides) stands, below 8800 feet, contained meadow rue (Thalictrum occidentale), sticky geranium, mountain brome, pinegrass, and cow parsnip (Heracleum lanatum) in the understory.

Since moose are commonly associated with willows (Salix spp.) on western ranges, the extent of willow type in this area becomes important. A United States Forest Service report (1960) revealed that only 144 acres of this type occurred along 20.8 miles of streams surveyed within the study area. This type occurred between 6500 and 8800 feet. Sedges and shrubby cinquefoil (Potentilla fructicosa) were common understory plants. Bog birch (Betula glandulosa) occassionally occurred with willow on the Snowcrest Mountains.

Below 6500 feet, a willow-water birch (Betula occidentale) type was found. It was more extensive than the willow type. Silverberry (Eleagnus commutata), Rocky Mountain juniper (Juniperus scopulorum), dogwood (Cornus stolonifera), and various sedges and rushes (Juncus spp.) were present.

COW-BULL, COW-CALF, AND ADULT-YEARLING RATIOS

Sex and age classes of moose observed between June 15 and September 15

each year are given in Table I. In 1958, most observations were made on the West Fork of the Madison River area of the Gravelly Range. In 1959 and 1960, observations were about equally distributed between the Snowcrest Range and the Gravelly Range. Some variation in the observed sex and age ratios appeared due to this difference in areas of observation.

Table I. Sex and age classes of moose observed in three summers.

	1958[4]	1959	1960
Bulls[1]	167	128	85
Cows	81	134	52
Calves[2]	56 (0)	71 (0)	28 (2)
Yearlings (both sexes)	-	36	12
Cow-calf ratio	100:69	100:53	100:54
Cow-bull ratio	100:206	100:96	100:163
Adult-yearling ratio[3]	-	100:16	100:10

1 Includes yearling cows.
2 Sets of twins in parentheses.
3 Number of yearlings divided by number of adults, both sexes.
4 After Knowlton (1960).

The observed cow-bull ratios of 100:206 in 1958, 100:96 in 1959, and 100:163 in 1960 were biased in favor of bulls. Use of different vegetative types by cows and by bulls constituted the most important bias. Summer observations of moose in relation to vegetative type and density are presented in Table II. Percentagewise, more bulls than cows were observed each year in open cover, which allows more bulls than cows to be recognized at great distances. Pimlott (1959) and Peterson (1955) also found this differential use of vegetative types by sexes.

Table II. Summer observations of moose in relation to vegetative type and density.

	OPEN[2]		DENSE[3]		WILLOW[4]		TOTAL
	No.	%	No.	%	No.	%	No.
1958							
Bulls[1]	98	59	24	15	42	26	164
Cows	39	51	15	20	22	29	75
Cows & Calves	22	41	15	28	17	31	54
Total	158	54	54	18	81	28	293
1959							
Bulls	55	43	19	23	44	34	118
Cows	43	32	53	40	38	28	134
Cows & Calves	11	15	40	56	20	29	71
Total	109	34	112	35	102	31	323
1960							
Bulls	28	33	34	40	23	27	85
Cows	8	16	23	44	21	40	52
Cows & Calves	6	23	13	50	7	27	26
Total	42	26	70	43	51	31	163

1. Cows with calves also included.
2. "Open" represents moose observations in sagebrush-grassland and sparsely wooded areas of good observation.
3. "Dense" represents observations in moderate to heavily timbered areas.
4. "Willow" represents willow type.

Most of the moose observed in 1958 occurred in open areas, while dense cover provided the lowest percentage of observations. The reverse was true in 1960. The 1959 observations were about equally distributed between open and dense cover types. Observations of moose in willow types varied little over the three summers. Records from a weather station twenty miles southeast of the study area indicated 1958 was the wettest and 1960 the driest of the three summers (Table III). The influence

of weather on moose distribution apparently affected observations. More moose were observed at higher elevations, mostly in aspen and conifer timber, on the Snowcrest Range in 1960 than in 1959. Increased use of the higher, more dense vegetative types may characterize drier summers.

Table III. Precipitation records for Lakeview, Montana (USDC, Climatological Data, Montana. Annual summaries. 1958, 1959, 1960.)

	1958	1959	1960
Four month total [1]	11.34	8.32	3.74
Yearly total	22.65	19.65	14.43

1. June-September, recorded in inches.

Moose feeding site examinations in this area also reflected the differences in distribution between years. Knowlton (1960) reported that forbs, mainly sticky geranium, constituted the main food item during the wet summer of 1958. These forbs were most abundant in sage-grassland areas. Most of these feeding site examinations were made on the West Fork of the Madison River area. Feeding site examinations by the writer in 1959 and 1960 were concentrated on the Snowcrest Range and north of the 1958 observations on the Gravelly Range. A few observations were made in the 1958 area. The 1959 and 1960 data indicated a marked preference for browse species, mainly willow. The locality of observation doubtless contributed to some of the differences in observed food preferences for the different years, but the data suggest that moose in this area may prefer forbs during wet summers and browse during dry

summers. Sampson (1952) indicated that forage production was greatly influenced by deviations in annual and seasonal precipitation. DeWitt and Derby (1955) reported that nutritive values of plants may reflect differences in seasonal rainfall and average temperatures. Swank (1958) found that species with consistently high moisture content were among those most heavily utilized by deer. These factors could help explain the observed annual variations in food preferences of moose in the area.

Observed cow-calf ratios were influenced by the same factors that influenced observed sex ratios. The highest cow-calf ratio, 100:69, was observed in 1958. Ratios of 100:53 and 100:54 were observed in 1959 and 1960, respectively (Table I). More cows with calves than lone cows were seen each year in dense cover types (Table II). Fewer cows with calves, percentagewise, were seen in dense cover in 1958 than in 1959 or 1960. The more open understories of the areas under observation in 1958 may have contributed considerably to the higher observed cow-calf ratio that year.

Summer movements of moose may also influence observed ratios. Knowlton (1960) reported 0.5 mile maximum distances between summer observations for individually recognizable cows and calves observed in 1958. In 1959, the maximum distances between summer observations of marked individuals increased to three miles, and in 1960 to five miles. The 1960 data include sightings in the area most under observation in 1958. Summer movements of moose in this area may increase during drier summers. This increased

movement would allow a greater number of different moose to be seen on a given area. The cow-calf ratios would then be derived from a larger proportion of the total moose population. The 1958 ratio was apparently derived from more intense observations of a smaller, more sedentary segment of this population than were those for 1959 and 1960, and probably reflects reproductive success more accurately. The observed cow-calf ratios from this study are among the highest on record, probably reflecting the open characteristics of the area under observation. Cow-calf ratios of 33 per cent (Cowan, 1950), 52 per cent (DeVos, 1956), 45 per cent (McDowell and Moy, 1942), 36 per cent (Pimlott, 1959), and 60 per cent (Spencer and Chatelain, 1953) have been reported in other areas.

The occurrence of twins is among the lowest recorded. No twins were seen in 1958 and 1959, and only two sets, constituting four per cent of 28 calves, were seen in 1960. Observations by local ranchers substantiate the low twin occurrence. Pimlott (1959) lists observed twin-calf percentages for seven studies in Canada and Alaska as ranging from 2 to 28 per cent. McDowell and Moy (1942) observed no twins in Montana. Hosley (1949, quoting Bailey, 1930) states that twins seemed to be the rule in Yellowstone National Park in the 1920's.

Yearlings were classified by total size, length of face, depth of chest, size of bell, and antler development. Bulls classified as yearlings by field observation and by examination of hunter kills had antlers ranging from one-inch spikes to small forks and small palms. Yearlings

were most accurately identified when accompanied by an adult. Experience provides the best basis for yearling determination. Altmann (1957, 1958, 1960) mentioned no trouble in identification of yearlings.

The yearling data in Table I represent a minimum figure. The tendency was to "over-age" moose older than calves, especially when the animal was at a distance. This was also reported by Peterson (1955) and Pimlott (1959). The adult-yearling ratios of 100:16 in 1959 and 100:10 in 1960 compare closely to observations in Canada (Cowan, 1950, Peterson, 1955, Pimlott, 1959) and in Alaska (Spencer and Chatelain, 1953).

FEMALE REPRODUCTIVE TRACT EXAMINATION

Female reproductive tracts of fourteen adults, two yearlings, and two calves were collected during the 1958 and 1959 hunting seasons from hunter kills in the study area. Hunters were very cooperative in helping to obtain the collections. Ovaries and uteri, severed at the cervix, were stored in 10 per cent formalin until examination. Ovary preparation for examination followed Pimlott and Mossman (1959), and uterus examination followed Cheatum and Morton (1946). A cow was considered to be old-aged when the infundibula of lower molar one were worn away.

Table IV presents results of the reproductive tract examinations. Following Pimlott (1959), secondary corpora lutea were designated as those less than half as large as those designated primary corpora lutea. No ovary pair contained more than one primary corpus luteum, indicating an ovulation rate of one ovum per estrus. This substantiates the low number of observed twins. The lowest ovulation rate found by Pimlott

in Newfoundland was 1.1, accompanied by a three per cent occurrence of twins *in utero*. Rausch (1959) stated the number of corpora lutea of pregnancy in Alaska moose ovaries usually corresponds to the number of fetuses present.

Table IV. Condition of 18 female moose reproductive tracts collected during the hunting seasons of 1958 and 1959.

No. ovary pairs	Date range	Age	Per Pair of ovaries: Primary corpora lutea No. with		Pigmented scars No. with				Size largest follicle (mm)	Extra-embryonic tissue	Calf[1]
			0	1 Size (mm)	0	1	3	5			
2	10-10 11-21	calf	2	0 -	2	0	0	0	4	0	0
2	10-21 11- 8	yrlng	2	0 -	2	0	0	0	7-17	0	0
9	10-19 11-21	adult	3	6 14-21	6	2	1	0	5-17[2]	2	3
5	10-19	old	1	4 10-18	0	1	3	1	5-17	0	1

1 Calf at side when killed.
2 One follicle in eruption stage.

At least six of the cows examined were considered sexually active during late October and November as indicated by the presence of large follicles. Edwards and Ritcey (1958) found four estri, occurring in early September, late September or early October, late October, and late November, to be possible with moose in British Columbia. Primary corpora lutea listed in Table IV may include corpora lutea of estrus and of pregnancy. Calves examined did not exhibit evidence of ovarian activity.

The two yearlings had large follicles suggesting they could come into breeding condition. No evidence of lowered productivity in the old age group was apparent.

More pigmented scars were present in ovaries of cows "aged" as old than in younger cows. Rausch (1959) also found this. Embryonic tissue was either too small to see macroscopically, was missed, or was not present in uteri except in two specimens. A December or later collection would provide more conclusive information about the current year's breeding success in this area.

MALE REPRODUCTIVE TRACT EXAMINATION

Testes from two calves, two yearlings, nine adults and four old adults were collected from October 19 to November 8 during the 1958, 1959, and 1960 hunting seasons. Testes and attached epididymides were preserved in 10 per cent formalin. Testes were dissected from the tunica vaginalis and the epididymis and weighed to the nearest 0.1 gram. Volumes were obtained by water displacement to the nearest cubic centimeter. A portion of a cauda epididymis and of a testis from each male were then embedded in paraffin, sectioned at 14 microns, stained with eosin and Harris' hematoxylin (Guyer, 1953), and examined for presence of sperm (Table V).

The two calves' testes were small and no mature sperm were found. All testes examined from animals aged as yearlings or older contained mature sperm. The testes of the two yearlings were near the lower size limit of older moose. The nine adult males examined exhibited a wide variation in testes sizes between animals, and in some cases between

testes of the same animal (Table V). The four old males exhibited no decrease in reproductive status over adults, either in testis size or presence of sperm. Bull number 17, collected November 8, 1959, had shed both antlers and had extremely worn teeth, indicating very old age. The data represent a period when testes were decreasing in size, since the collections were made after the peak of the rutting period (see breeding season).

Table V. Condition of testes and epididymides of 17 moose.

No.	Date Killed	Age	Testes weights (gms)		Testes volumes (cc)		Sperm present testes	Sperm present epididymis
1	10-21	Calf	6.9	-	7	-	No	No
2	11-22	Calf	11.1	-	10	-	No	No
3	10-19	Yrlng	48.4	40.1	50	42	Yes	Yes
4	10-23	Yrlng	39.2	34.2	38	32	Yes	Yes
5	10-19	Adult	69.6	68.9	68	64	Yes	Yes
6	10-20	Adult	55.9	55.5	52	52	Yes	Yes
7	10-20	Adult	37.9	47.3	36	46	Yes	Yes
8	10-20	Adult	60.4	63.0	58	60	Yes	Yes
9	10-20	Adult	68.7	66.5	65	64	Yes	Yes
10	10-22	Adult	49.5	45.4	48	44	Yes	Yes
11	10-22	Adult	41.2	-	41	-	Yes	Yes
12	11- 5	Adult	42.8	49.5	40	47	Yes	Yes
13	11- 8	Adult	46.4	44.2	45	45	Yes	Yes
14	10-20	Old	40.1	40.0	39	38	Yes	Yes
15	10-22	Old	60.1	49.6	59	48	Yes	Yes
16	10-23	Old	56.4	46.4	54	46	Yes	Yes
17	11- 8	Old	52.4	39.1	50	40	Yes	Yes

Table VI presents average weights of testes of adult males and old males for two collection periods. The average sizes are seen to decrease from October and November.

Table VI. Average weights of testes of adult and old males for two collection periods.

Dates included	Number males	Average weight of testes (gms)
Oct. 19-23	10	52.4 (37.9-69.6)
Nov. 5- 8	3	45.7 (42.8-52.4)

YEARLING BREEDING

The status of yearling breeding has been evaluated by examination of reproductive tracts and by field observations. Edwards and Ritcey (1958) found no pregnant yearling moose in British Columbia. Pimlott (1959) and Rausch (1959) concluded that yearling females bred, but at a lower rate than adults in Newfoundland and Alaska. Rausch (1959) found that yearling males contributed substantially to the breeding success in areas where hunting had reduced the age structure of males to approximately 90 per cent yearlings. Dodds (1958) noted that in Newfoundland, when breeding began, yearlings were complete outcasts, save for one that occasionally remained with a cow. Altmann (1959) described the battle of females whereby the older, more aggressive female drove away the younger female during the rut. She further described the partial tolerance of a yearling male by the adult male during the rutting season, in some cases. Altmann (1960) suggested a partial activation of the sex drive in both sexes as yearlings, but stated it is more intense in juvenile males. She mentioned that the dominance of mature moose suppressed the rutting drive in yearlings of both sexes.

The examination of reproductive tracts of yearlings (Tables IV,V) suggested that this age class was capable of breeding successfully in this area. Field observations during September, 1959 and 1960, helped evaluate the extent of yearling breeding. Instances observed include adult females driving away yearling females and males, with or without an adult male being present. Adult males were observed to display interest in some yearling females during the breeding season. No attempts by a female to drive away a calf, either in the presence or absence of a male were observed. Altmann (1959) stated mating groups of moose may include a male and female, or a male, female and calf. These observations would further indicate that some yearlings are capable of breeding.

Calving records (Figure 4) and summer observations indicated that most calving was completed in a short period. No late calving was noted. This indicated that late breeding, presumably done mostly by the younger animals, was of little consequence. The writer concludes that the dominance and high percentage of older animals in this population did suppress yearling breeding. Yearlings probably contributed little to the productivity of this herd. Perhaps yearling breeding is strongly influenced by population structure.

BREEDING SEASON

Altmann (1959), Dodds (1958), and others have discussed pre-rutting and rutting behavior of moose. The present study largely corroborated their findings. In late August and early September, use of the willow

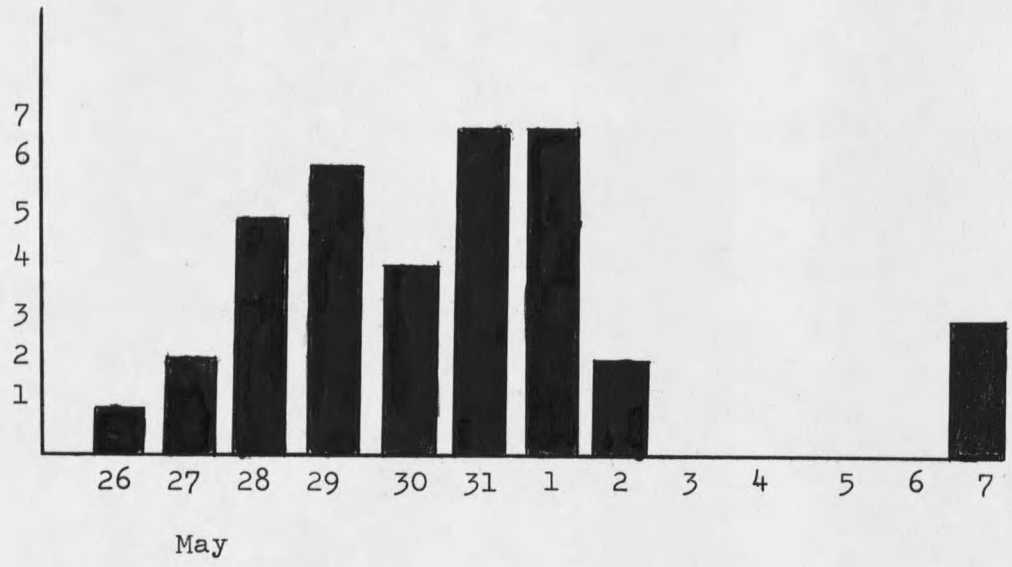

Figure 4. Calculated birth dates for 38 moose calves.

Table VII. Weights and standard measurements of nine moose calves.

No.	Sex	Age (days)	Total length (inches)	Hind foot length	Ear length	Tail length	Weight (pounds)
3	Male	2-3	33.5-39	16.25-17	5.75-6	1-2	-
1	Female	2-3	40	16.75	5.75	1.5	33
1	Male	4-5	41	17.5	6.25	1.5	40-45[1]
2	Female	4-5	41.6-43.75	16.9-17	6.5-6.75	1.25-2	46
1	Male	5-7	43.25	17.5	6.6	1.5	-
1	Female	7-10	41	18.25	7.6	2.25	62

1. Measurements not taken on one 4-5 day old calf.

type by bulls increased. Groups of two to six bulls were observed in these areas where antler rubbing and other preliminary rutting activity occurred. A definite dominance of larger, more aggressive bulls over other bulls was observed. These bull groups were seen less frequently in late September. Cows did not congregate in the willow type during the pre-rutting period.

Rutting groups, which consisted of a bull and cow, or a bull, cow, and calf, were found mostly on the summer range. One rutting group, observed from September 22 to 24, 1959, moved three miles during that period. Another group, observed September 29 and 30, 1959, moved 1.5 miles. A third group moved 0.5 mile in one hour on October 10, 1959.

Field observations indicated that the main breeding season occurred in late September and early October. The approximate birth dates of 38 calves (Fig. 4), when correlated with a gestation period of 240 days (Murie, 1934) indicated late September and early October conception dates. Testes data previously discussed indicated the main breeding season occurred previous to late October.

CALVING

Information on 41 moose calves was obtained in late May and early June, 1956 through 1960, in and adjacent to the study area, by members of the Montana Fish and Game Department, including the writer. Calves were marked with aluminum livestock ear tags with attached plastic markers and ribbons. Anodized aluminum ear tags in blue, green, violet, and yellow,

without plastic markers attached, were used in 1960. Calves were weighed, measured, and ages determined following Johnson (1951).

The findings (Fig. 4) suggested a late May-early June calving peak for moose in this area, which coincided with that reported by Altmann (1958), Peterson (1955), and Rausch (1959). Cows with calves two days old or less were seen mainly on dry, open sagebrush areas at 7000 to 7500 feet, at or below the lower limits of the summer range. Cows with slightly older calves were seen more frequently in aspen timber or willow types at the same elevations. Murie (1934), Peterson (1955), and Rausch (1959) indicated that cows frequently gave birth in secluded brushy areas on peninsulas and islands.

The area used by a cow for parturition may or may not be a part of the summer home range of that cow. Four individuals with marked calves were observed the summer following marking, 3.5, 4.5, 4.5, and 12 airline miles respectively from each individual marking location. Three different cows with calves were observed in early June on the west side of the Ruby River, and later on the east side. One cow with a day-old calf crossed the river the night following marking. They were then seen the following day, in aspen timber nearly two miles from the marking location, indicating that a moose calf is able to move a considerable distance. Altmann (1958) in Wyoming, found that a cow with a calf stayed within a small area the first few days after parturition.

Table VII presents standard measurements and weights of nine moose calves. These data, and those for one calf in Wyoming (Denniston, 1956), fall within the range of four Alaska moose calves of similar age (Rausch, 1959).

BROWSE CONDITION

Several studies (Edwards and Ritcey, 1958, Morton and Cheatum, 1946, Taber, 1953) have suggested a relationship of range condition to productivity of various big game species. An attempt was made to assess condition of willow, quaking aspen, and bog birch on areas above 7500 feet, and of willow and silverberry on the Ruby River wintering area at about 6500 feet. Feeding site examination and rumen analysis (Knowlton, 1960, Greer, 1961) have indicated that willow, quaking aspen and silverberry are important browse species used by moose in this area. Bog birch was not noted in rumens or feeding site examinations, but Cowan, Hoar, and Hatter (1950), and Harry (1957) indicated that this species is palatable to moose. Measurements of browse species were made in areas observed to be frequented more by moose than by other browsing species.

The period of use of areas above 7000 feet by moose became important in understanding browse conditions in this area. Observations by Knowlton (1960), Rouse (1961), and the author indicated that most moose spent 10 months of 1959 and 1960 and eight months of 1961 above 7000 feet. This long period of use of the higher ranges, plus the scarcity of willow type above 7000 feet made evaluation of the higher range important.

Table VIII presents information obtained from nine willow and three bog birch transects on areas above 7500 feet. The method used follows Cole (1959).

Estimates of leader use were not obtained on bog birch. Current year's growth was limited to a few short leaders on most plants. Catkins were found on only a few plants. The apparent lack of vigor, poor form

class, and high percentage of decadent plants indicated severe browsing pressure.

Willow form classes and number of decadent plants suggested that this species was also subject to heavy use on higher areas. Utilization of current year's growth was found to be 44 per cent for 1959 and 51 per cent for 1960. The 1960 readings were taken in two feet of snow, thus obscuring many smaller plants which were observed in 1959, which probably accounted for most of the variation in form classes for the two years. Willow plants were observed to be in progressively poorer condition as elevations increased on the higher range, and the extent of willow areas decreased.

Table VIII. Condition of nine willow and three bog birch stands located above 7500 feet.

Plant	Date	Form class percentages[1] 1	2	3	4	5	6	Per cent[2] decadence	Per cent[3] leader use
Willow	12-1959	1	72	14	0	10	3	51	44
Willow	12-1960	0	26	62	0	4	8	51	51
Bog birch	8-1960	0	0	100	0	0	0	65	-

1. 1- all available, little or no hedging. 2- all available, moderately hedged. 3- all available, severely hedged. 4- partly available, little or no hedging. 5- partly available, moderately hedged. 6- partly available, severely hedged.
2. Decadent plants contained 25 per cent or more dead stems standing within the crown of the plant.
3. Leaders were considered to be current year's growth.

Table IX presents data from eight aspen stands. Density of mature trees and of resprouts was obtained by using the quarter method (Cottam

and Curtis, 1956). Trees under eight feet, considered to be as high as generally browsed by moose, were designated "resprouts". Resprouts under three feet tall, usually less than three years old, were also noted. The mature trees were examined for evidence of bark use ("barking"). Resprouts were form-classed after Cole (1959).

Density of mature trees was considerably greater than that recorded for resprouts. Factors other than browsing probably contributed to this. The information suggested that mature aspen stands produced considerable amounts of forage in the form of resprouts. The percentage of trees showing evidence of bark use suggested moderate utilization. Form-class data for the resprouts, and high percentage of resprouts recorded as being under three feet tall, indicated suppression of aspen reproduction by browsing. Whether moose suppress this reproduction more than other browsing species combined or separately, is open to question, since elk, sheep, and cattle have been observed to use resprouts heavily on areas other than those measured. At least the data revealed that a palatable and important moose forage plant was being severely browsed.

Table IX. Condition of eight quaking aspen stands above 7500 feet.

MATURE TREES		RESPROUTS				
Per cent barked[1]	Density[2]	Density	Form class per cent 1	2	3	Per cent under 3 feet
39	611	470	19	14	67	92

1. Per cent of mature trees showing evidence of use of bark.
2. Number of individuals per acre.

The winter concentration area data, obtained in April or May each year (Table X), suggested severe use of willow and silverberry.

Table X. Condition of three willow and two silverberry stands located on the winter concentration area.

Plant	Year	Form class percentages 1	2	3	4	5	6	Per cent Decadence	Per cent leader use
Willow	1959	0	86	14	0	0	0	73	56
Willow	1960	0	28	72	0	0	0	-	66
Willow	1961	0	0	98	0	2	0	84	59
Silverberry	1959	0	80	20	0	0	0	0	70
Silverberry	1960	0	28	72	0	0	0	0	66
Silverberry	1961	0	0	100	0	0	0	28	63

Edwards and Ritcey (1958) have suggested that poor nutritional levels may be reflected in lowered multiple births among moose. The extremely low number of twins observed in this study could in part be due to poor range.

SUMMARY

A study of moose reproduction in the upper Ruby River and adjacent areas in southwestern Montana was conducted during the summers and falls of 1958, 1959, and 1960. The area was a complex of coniferous and aspen timber and sagebrush-grassland stands. Eight vegetative types were recognized. Cow-bull ratios of 100:206 in 1958, 100:96 in 1959, and 100:163 in 1960, were biased in favor of bulls. Each year, more bulls than cows were found in open cover. The cow-calf ratios were 100:69 in 1958, 100:53 in 1959, and 100:54 in 1960. Weather apparently influenced

moose distribution, which was reflected in observed cow-bull and cow-calf ratios, food habits, and summer movements. No twins were seen in 1958 or 1959 and only two sets were seen in 1960. Adult-yearling ratios of 100:16 in 1959 and 100:10 in 1960 were judged low due to the tendency to "over-age" moose older than calves. Examination of 18 sets of ovaries indicated an ovulation rate of one ovum per estrus, substantiating the low number of twins observed. Ovaries of two yearling females contained large follicles suggesting these cows could come into breeding condition. Testes of two yearling males contained mature sperm. Suppression of yearling breeding by adult moose was indicated. The main breeding season occurred in late September and early October. Calving data suggested a late May-early June calving peak. Nine moose calves, two to ten days old, weighed between 33 and 62 pounds and measured between 33.5 to 43.75 inches in total length. Assessment of willow, quaking aspen, and bog birch above 7500 feet, and of willow and silverberry at about 6500 feet suggested heavy utilization of these species. The low twin incidence may have been related to poor range conditions.

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