Elk migration patterns, and some of the factors affecting movements in the Gallatin River drainage,
Montana
by Arthur R Brazda

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Abstract:

The marking of elk calves with plastic ear markers, initiated in 1949 and 1950, was continued in 1951 in the Gallatin River Drainage, Montana. Ninety-three were marked in 1951, making a total of 225 for the 3 years. Sight and kill records of marked individuals provided the basis for a study of elk migration patterns. Observations of marked calves on the calving grounds (upper winter range), showed no movement away from this area until the close of the calving season. Observations of marked calves from June 27 to July 31 indicated movements to generally higher elevations as the season progressed. Sight records of marked calves during August showed no movement beyond that for July. Observations of marked calves indicated summer range on both sides of the river: head of the Gallatin River and the Bacon Rind Creek-Migration Creek areas. The pattern of sight records suggested 5 possible migration routes during the upward movement of the elk. Fall movements, represented by hunter kills, suggested 3 possible routes in their downward movements. Thirty-four winter records suggested that the elk reached the limits of their downward movement by December. Data further suggested that the lower limits of the winter range were the Buffalohorn Creek-Porcupine Creek area and the Taylor Fork-Meadow Creek area. The upper limit may have extended to the mouth of Bacon Rind Creek, but was probably centered near the Gallatin Ranger Station. Thirty-one sight records indicated considerable intermingling of east and west side (Gallatin River) animals during the winter. Movements of individual elk substantiated the migration routes implied by the pattern of sight records. Observations of 4 marked calves suggested restricted movement on the winter range. Observations and kill records indicated that some elk return to the same winter and summer range year after year. Sight records of Yellowstone and Gallatin marked animals on the same summer range showed considerable intermingling during the summer. Positive evidence was indicated by 3 marked animals on winter range. Plastic marker returns pointed out that best results were obtained when heavy, durable material was used. Some markers were retained in perfect condition for 18 months. A study of tabanid populations, for certain localities on the summer range, suggested an inverse relationship between tabanid numbers and elk numbers. A study of the development of the vegetation indicated that the large numbers of elk did not arrive on the summer ranges until the majority of the vegetation was well developed. Parturition may have been an important factor governing the upward movement of the cows. Snowcover was apparently not a factor in retarding the upward movement during the spring of 1951.

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ELK MIGRATION PATTERNS, AND SOME OF THE FACTORS AFFECTING
MOVEMENTS IN THE GALLATIN RIVER DRAINAGE, MONTANA

by

ARTHUR R. BRAZDA

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ABSTRACT

The marking of elk calves with plastic ear markers, initiated in 1949 and 1950, was continued in 1951 in the Gallatin River Drainage, Montana. Ninety-three were marked in 1951, making a total of 225 for the 3 years. Sight and kill records of marked individuals provided the basis for a study of elk migration patterns. Observations of marked calves on the calving grounds (upper winter range), showed no movement away from this area until the close of the calving season. Observations of marked calves from June 27 to July 31, indicated movements to generally higher elevations as the season progressed. Sight records of marked calves during August showed no movement beyond that for July. Observations of marked calves indicated summer range on both sides of the river: head of the Gallatin River and the Bacon Rind Creek-Migration Creek areas. The pattern of sight records suggested 5 possible migration routes during the upward movement of the elk. Fall movements, represented by hunter kills, suggested 3 possible routes in their downward movements. Thirty-four winter records suggested that the elk reached the limits of their downward movement by December. Data further suggested that the lower limits of the winter range were the Buffalohorn Creek-Porcupine Creek area and the Taylor Fork-Meadow Creek area. The upper limit may have extended to the mouth of Bacon Rind Creek, but was probably centered near the Gallatin Ranger Station. Thirty-one sight records indicated considerable intermingling of east and west side (Gallatin River) animals during the winter. Movements of individual elk substantiated the migration routes implied by the pattern of sight records. Observations of 4 marked calves suggested restricted movement on the winter range. Observations and kill records indicated that some elk return to the same winter and summer range year after year. Sight records of Yellowstone and Gallatin marked animals on the same summer range showed considerable intermingling during the summer. Positive evidence was indicated by 3 marked animals on winter range. Plastic marker returns pointed out that best results were obtained when heavy, durable material was used. Some markers were retained in perfect condition for 18 months. A study of tabanid populations, for certain localities on the summer range, suggested an inverse relationship between tabanid numbers and elk numbers. A study of the development of the vegetation indicated that the large numbers of elk did not arrive on the summer ranges until the majority of the vegetation was well developed. Parturition may have been an important factor governing the upward movement of the cows. Snowcover was apparently not a factor in retarding the upward movement during the spring of 1951.

INTRODUCTION

A system for tagging elk calves with plastic markers was initiated in the Gallatin Drainage, Montana in 1949 and continued in 1950 and 1951. Johnson (1951) reported the use of these markers for 1949 and 1950 in his paper on the elk calf. The writer worked with Johnson in 1950 and continued the project in 1951, when 93 calves were marked. The same shaped symbols were used. The color combination designating 1951 was red and yellow. Thus 225 calves were marked in the 3 years. Johnson (op. cit.) has pointed out the value of these markers for migration studies, so far as durability and visibility are concerned, but his data were too few to indicate the migration routes although he did suggest the general pattern of elk migrations. Since then, many more sight and kill records of elk marked as calves have accumulated. The present paper is an attempt to evaluate these records on the basis of movement, and to show the migration routes of the Gallatin River drainage elk herd. In addition, the writer gathered information on some factors which possibly affect elk movements. Methods are described in the text. For a description of the study area see Johnson (op. cit.).

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PATTERNS OF ELK MIGRATIONS

Movement During The Calving Period

According to Johnson (1951), the extremes of the calving periods for 1949 and 1950 were May 21 and June 12. Observations during 1951 indicated extremes of May 17 and June 15.

Observations of marked calves during the calving seasons for these years indicated no movement away from the calving grounds during this period (Table I). Only 3, of 31 positively identified, had moved from the drainage where they were marked. In all instances, the movements were less than a mile and to an interlocking drainage on the calving ground. Two moved into the head of Daly Creek; 1 from the north side of the head of Black Butte Creek, the other from the south side of upper Tepee Creek. One moved from Daly Creek to Sawmill Gulch (Figure 1). Nineteen marked on Daly Creek, 7 marked on Fan Creek, and 2 marked on Sawmill Gulch were observed in the drainage where marked. The identity of 20 marked calves seen in Daly Creek drainage was not established. In light of the behavior of the identified calves, it is probable that a high proportion of these were Daly marked.

These data suggest that the calves remain on the calving grounds

until the close of the calving season and in most instances movement is restricted to a single drainage.

TABLE I

Observations of marked calves during the calving periods of 1949, 1950, and 1951. Localities:-DC, Daly Creek; FC, Fan Creek; SG, Sawmill Gulch; BBC, Black Butte Creek; TC, Tepee Creek.

No.	Dates Marked	Locality	Dates Observed	Locality	Movements .5 Airline Miles
1949					
3	5/29-6/3	DC	6/2-6/7	DC	1 (.125 - 2)
2	6/1-6/8	FC	6/8-6/12	FC	1 (.5 - 1.75)
1950					
2	6/3-6/10	SG	6/10-6/16	SG	.5 (.5 - .75)
2	5/27-6/9	DC	5/31-6/11	DC	1.5 (.25 - 2.5)
1951					
10	5/23-6/9	DC	6/4-6/20	DC	1 (0 - 2.5)
5	6/7-6/15	FC	6/14-6/18	FC	.5 (0 - 2)
1	6/3	BBC	6/4	DC	1
1	6/8	TC	6/9	DC	1
1	6/3	DC	6/14	SG	1
20	5/23-6/9	DC	5/31-6/20	DC	1.25 (0 - 2.5)

Summer Movements

Observations of marked calves during the period June 27 to July 31 are shown in Table II. Only 1 of 19 was seen in the drainage where marked, and it was seen on June 28. Four others seen during June, after calving season, had moved away from the drainage where tagged, but only for short distances (2.5 to 3.5 miles). From July 1 to July 15 observations of 5 marked calves showed an average movement of about 11.4 airline miles (8-18). Seven observations, July 16-31, showed an average movement of about 14.8 airline miles (6.5-18). Movements were generally to higher elevations as the season progressed.

Observations of marked calves during August indicated no movement

TABLE II

Observations of marked calves from June 27 through July for 1949, 1950, and 1951: Localities:- FC, Fan Creek; UGR, Upper Gallatin River; DC, Daly Creek; SG, Sawmill Gulch; GD, Gallatin Drainage; FP, Fawn Pass; BRC, Bacon Rind Creek; HGR, Head of Gallatin River; WSP, West Stellaria Pass; MC, Migration Creek; GP, Grayling Pass.

No.	Dates Marked	Locality	Dates Observed	Locality	Movement .5 Airline Miles
1949					
2	6/12	FC	6/28	UGR	2.5 (2 - 3)
1	6/12	FC	6/28	FP	2.5
1	6/4	UGR	7/26	BRC	8
1950					
1	6/2	DC	6/28	DC	2.5
2	6/9-6/11	DC	7/11	FC	11 (10 - 12)
1	6/1	DC	7/15	BRC	9
1	6/3	SG	7/15	BRC	8
1	5/21-6/11	DC	7/26	HGR	17
1951					
1	6/10	FC	6/27	WSP	3.5
1	5/22-6/20	GD	6/28	UGR	----
1	6/7	FC	7/18	MC	6.5
1*	6/2/50	DC	7/26	HGR	18
1	6/3	DC	7/13	HGR	18
3	6/3-6/9	DC	7/26	HGR	18 (18)
1	5/22-6/20	GD	7/31	GP	----

* observed as yearling

beyond that for July (Table III), suggesting that the animals reached the limit of their migration during the latter month. Eight of 10 were seen in drainages where marked calves had been seen in July. Two, seen at the head of Stellaria Creek, represent first observations, but observations were made in the same general area at the head of the Gallatin River and on West Stellaria Pass during June and July.

Sight records of marked calves indicate summer range on both sides of the Gallatin River (vicinity of the head of the Gallatin River, Bacon Rind Creek-Migration Creek areas). Records show that calves marked on the east side of the Gallatin River may or may not summer on the same side. Of 21 seen on summer range, or enroute from the calving grounds to summer range, 15 had not crossed over and 6 had gone into the Bacon Rind Creek-Migration Creek area.

Only two sight records of calves marked on the west side of the river were obtained. Both remained on the west side, moving from Sawmill Gulch to the Bacon Rind Creek-Migration Creek area.

The pattern of the sight records provides some basis for speculating on migration routes.

Twelve Daly Creek marked calves were seen as follows: 1, Daly Creek, June 28; 2, Fan Creek, July 11; 6, head of Gallatin River, July 13-26; 1, head of Stellaria Creek, August 2; 1, Migration Creek, August 8; 1, Bacon Rind Creek, July 15. The first 10 listed possibly suggest a migration route as follows: Daly Creek through Fan Creek to the head of the Gallatin River and vicinity. The other two do not fit into this pattern since they were seen across the Gallatin River in the Bacon Rind Creek-

TABLE III

Observations of marked calves during August for 1949, 1950, 1951.

Localities:- UGR, Upper Gallatin River; DC, Daly Creek, SG, Sawmill Gulch; LC, Lodgepole Creek; U, unknown; GD, Gallatin Drainage; FC, Fan Creek; BBC, Black Butte Creek; HGR, Head of Gallatin River; MC, Migration Creek; HSC, Head of Stellaria Creek.

No.	Dates Marked	Locality	Dates Observed	Locality	Movement .5 Airline Miles
1949					
1	6/4	UGR	8/5	HGR	5.5
1950					
1	5/21-6/12	DC	8/8	MC	8
1	5/21-6/12	SG or LC	8/8	MC	7.5
1	5/21-6/12	U	8/8	MC	12 approx.
1951					
1	6/8	DC	8/2	HSC	13.5
1	5/22-6/20	GD	8/2	HSC	-----
1*	6/15/50	FC	8/16	MC	5.5
1	5/22-6/12	GD	8/16	MC	-----
1	6/4	BBC	8/16	MC	6.5
1	5/22-6/20	GD	8/16	MC	-----

* Observed as yearling

Migration Creek area.

Six Fan Creek marked calves were seen as follows: 2, upper Gallatin River, June 28; 1, Fawn Pass, June 28; 1, West Stellaria Pass, June 27; 2, Migration Creek, July 18-August 16. The two upper Gallatin River observations strengthen the possibility of a migration route through Fan Creek drainage to the head of the Gallatin River, as suggested by observations of 10 Daly Creek marked calves. The Fawn Pass and West Stellaria Pass observations could very logically be interpreted as adding further evidence in support of this possible migration route because of their proximity to the head of the Gallatin River (Figure 1). The other 2 Fan

Creek calves, like 2 of the Daly Creek calves, were seen across the Gallatin River in the Bacon Rind Creek-Migration Creek area. This gives a clue as to the route followed by the Daly Creek calves in reaching the Bacon Rind Creek-Migration Creek areas. The suggested route is Daly Creek through Fan Creek to the Bacon Rind Creek-Migration Creek area.

Two upper Gallatin River marked calves were seen as follows: 1, Bacon Rind Creek, July 26; 1, head of Gallatin River, August 5. The first strengthens the possibility of movement across the Gallatin River to the Bacon Rind Creek-Migration Creek area from upper Fan Creek and vicinity. The second falls into the Daly Creek-Fan Creek-head of the Gallatin River pattern.

Two Sawmill Gulch marked calves were seen as follows: 1, Bacon Rind Creek, July 15; 1, Migration Creek, August 8. These calves could most directly reach the Bacon Rind Creek-Migration Creek area by remaining on the west side of the Gallatin River. However, there was nothing to prevent them from crossing the river into Daly Creek and moving into this area by way of Fan Creek. It follows that Daly Creek calves could cross to Sawmill Gulch and take the direct route to the Bacon Rind Creek-Migration Creek area. One example is available to substantiate this: a calf marked June 3 on Daly Creek was seen in Sawmill Gulch on June 14.

One Black Butte Creek marked calf was seen on Migration Creek August 16. This calf could presumably take one or the other routes intimated for Daly Creek calves.

Six calves, whose marking locality is unknown, were seen as follows: 1, upper Gallatin River, June 28; 1, Grayling Pass, July 31; 3, Migration

Creek, August 8-16; 1, head of Stellaria Creek, August 2.

The suggested migration routes are shown on Figure 1.

Fall Movements

No effort was made to obtain sight records in September, 1949 and 1950. Attempts in September, 1951 were unsuccessful. The location of marked animals when killed by hunters during October and November for 1950 and 1951 are shown in Table IV.

Marked calves were killed as follows: 21, Buffalohorn Creek-Porcupine Creek area; 6, Taylor Fork-Meadow Creek area; 4, Tepee Creek; 1, Sage Creek; 1, Daly Creek; 1, Indian Creek (Madison drainage); 1, Buck Creek; and 1 unknown.

These elk were killed in the same general areas or below the areas where they were marked as calves. The appearance of marked calves in these lower-areas further indicates a considerable down country fall movement of Gallatin elk, as evidenced by sight records of marked calves in the head of the Gallatin River and Bacon Rind Creek-Migration Creek areas during July and August.

Of 29 calves marked on the east side of the Gallatin River, 24 were killed on the east side and 5 on the west side. Of 6 marked on the west side, 4 were killed on the west side and 2 on the east side. The drainage where tagged and the area of kill for the 35 animals are given below. Seventeen Daly Creek marked calves were killed as follows: 12 Buffalohorn Creek-Porcupine Creek area, 2 Tepee Creek, 1 Sage Creek, 1 Taylor Fork-Meadow Creek area, and 1 unknown; 6 Fan Creek calves: 4 Buffalohorn Creek-Porcupine Creek area, 1 Taylor Fork-Meadow Creek area, 1 Buck

TABLE IV.

Locality of hunter kills of marked calves from October 15 to November 30 for 1950, 1951. Localities:-FC, Fan Creek; LC, Lodgepole Creek; DC, Daly Creek; MC, Meadow Creek; BC, Buffalohorn Creek, BBC, Black Butte Creek; TC, Tepee Creek; UGR, Upper Gallatin River; DHC, Dead Horse Creek; SG, Sawmill Gulch; BuC, Buck Creek; SC, Sage Creek; U, Unknown; TFC, Taylor Fork Creek; EC, Elkorn Creek; ICM, Indian Creek, Madison; PC, Porcupine Creek, TCC, Twin Cabin Creek.

No.	Dates Marked	Locality	Dates Observed	Locality	Movement .5 Airline Miles
1950					
1*	6/12/49	FC	11/13	BuC	18
1	6/10/50	LC	11/15	TC	1
1*	6/6/49	DC	11/17	TC	1.5
1	5/30/50	MC	11/21	MC	0
1	6/11/50	DC	11/23	SC	4
3	6/11/50	DC	11/24	BC	3.5 (3-4)
1	6/3/50	BC	11/24	BC	0
1	6/2/50	BBC	11/24	BC	6
1951					
1*	6/2/50	DC	10/15-11/9	U	----
1*	6/1/50	TC	10/27	TFC	6.5
1**	6/4/49	UGR	10/27	DC	7.5
1*	6/6/50	DC	10/28	EC	6.5
1**	5/28/49	DHC	10/29	TC	9
1*	5/30/50	MC	10/31	TFC	2.5
1*	6/7/50	FC	11/9	TFC	13.5
1*	6/4/50	MC	11/12	ICM	10
1**	6/1/49	FC	11/7	BC	13.5
1**	6/12/49	FC	11/7	PC	21
2*	6/1/50	TC	11/2-11/8	PC	8.5 (8-9)
1*	6/6/50	DC	11/6	BC	5
2	6/10/51	FC	11/1-11/9	PC	19.5 (19-20)
1	6/8/51	DC	11/5	EC	6
1	6/8/51	DC	11/7	TCC	9.5
1*	6/1/50	DC	11/5	TCC	8.5
1**	6/13/49	DC	11/8	PC	11.5
1	6/3/51	DC	11/7	PC	10.5
1*	6/1/50	DC	11/7	PC	8.5
1*	6/1/50	TC	11/1	PC	9.5
1*	6/3/50	SG	11/1	TFC	7.5
1*	5/31/50	DC	11/3	TC	2
1**	5/29/49	DC	11/6	TFC	7.5
1	6/4/51	DC	11/4	BC	5

* Yearling ** Two Years Old

Creek; 1 upper Gallatin River calf: Daly Creek; 4 Tepee Creek calves: 3 Buffalohorn Creek-Porcupine Creek area, 1 Taylor Fork-Meadow Creek area; 1 Black Butte Creek calf: Buffalohorn Creek-Porcupine Creek area; 1 Buffalohorn Creek calf: Buffalohorn Creek-Porcupine Creek area; 4 Taylor Fork-Meadow Creek calves: 2 Taylor Fork-Meadow Creek area, 1 Indian Creek (Madison drainage), 1 Tepee Creek; 1 Sawmill Gulch calf: Taylor Fork-Meadow Creek area; 1 Lodgepole Creek calf: Tepee Creek. The first 14 Daly Creek calves, the first 4 Fan Creek calves, the upper Gallatin River calf, the first 3 Tepee Creek calves, the Black Butte Creek calf, and the Buffalohorn Creek calf possibly indicate the reversal of the Daly Creek-Fan Creek-head of the Gallatin River migration pattern and/or the Daly Creek-Fan Creek-Bacon Rind Creek pattern noted during the upward movement.

The last 2 Daly Creek calves, the last 2 Fan Creek calves, 1 Tepee Creek calf, 3 Taylor Fork-Meadow Creek calves, and 1 Sawmill Gulch calf were killed on the west side of the Gallatin River. It is probable that these elk moved from the Bacon Rind Creek-Migration Creek area. Both sight records of calves marked on the west side of the river were in that area. Furthermore, there are sight records of Daly Creek and Fan Creek calves in the Bacon Rind Creek-Migration Creek areas.

One Taylor Fork-Meadow Creek calf and 1 Lodgepole Creek calf killed on Tepee Creek suggest the possibility that the elk intermingle somewhat after they reach the winter range. This possibility is substantiated in a later section. It is highly probable, however, that most of the elk were killed soon after leaving the sanctuary of the Gallatin Game Preserve or

Yellowstone Park because of intensive hunting pressure. This suggests that the majority was killed on or near their downward migration route. The possibility of elk ranging on both sides of the Gallatin River during the winter is far greater and of much less significance than in summer. In summer most elk move to higher elevations adjacent to the river, while in winter they are generally concentrated in areas much closer to the river.

Winter Movements

Thirty three sight records and one hunter kill for December, January, February, and March of 1949, 1950, and 1951 are shown in Table V. No observations were made at lower elevations than those for October and November, suggesting that the elk reached the limits of their downward movement by December. Thirteen were recorded in areas where others had been recorded in October and November: 9, Taylor Fork-Meadow Creek area (ave. 8.3 airline miles from place marked); 4, Tepee Creek (4.8). Eighteen seen at elevations above those recorded for October and November are: 3, Gallatin Ranger Station (2); 1, Upper Gallatin River (7); 1, Wickiup Creek (1.5); 3, Black Butte Creek (1); 1, Lava Butte (1); 1, Crown Butte (2); 1, Snowslide Creek (5); 2, Monument Creek (3); Sawmill Gulch (5); 2, Snowflake Springs (7.5).

These records, plus the observations recorded in the previous section, suggest that the lower limit of the winter range, on the east side of the Gallatin River, is the Buffalohorn Creek-Porcupine Creek area; on the west side, the Taylor Fork-Meadow Creek area. It is further indicated that the upper limit may extend to the mouth of Bacon River Creek, but is probably centered near the Gallatin Ranger Station.

TABLE V.

Observations of marked elk calves during December, January, February, and March of, 1949, 1950, and 1951. Localities:- LC, Lodgepole Creek, DC, Daly Creek; FC, Fan Creek; YD, Yellowstone Drainage, U, Unknown; BBC, Black Butte Creek; DHC, Dead Horse Creek; MC, Meadow Creek; SG, Sawmill Gulch, MoC, Monument Creek; MHS, Mammoth Hot Springs; SS, Snowflake Springs; TC, Tepee Creek; MBRC, Mouth of Bacon Rind Creek; WC, Wickiup Creek; GRS, Gallatin Ranger Station; TFC, Taylor Fork Creek, SC; Snowslide Creek; LB, Lava Butte; CB, Crown Butte.

No.	Dates Marked	Locality	Dates Observed	Locality	Movement - .5 Airline Miles
1*	6/6/49	LC	12/21/49	TFC	3.5
1950					
1	6/3/49	DC	1/12	MoC	4.5
1**	6/12/49	FC	1/19	MHS	18
1	6/6/50	DC	12/9	TC	2
1	6/16/50	LC	12/12	BBC	2
1**	/50	YD	12/12	DC	----
1	6/14/50	FC	12/14	SS	11
1	5/30/50	MC	12/14	SS	4.5
1	5/24/50	FC	12/14	SG	8.5
1	6/14/50	FC	12/27	DHC	19
1	- /50	U	12/14	SG	----
1	5/24/50	BBC	12/14	BBC	0
1	6/4/50	DHC	12/22	TC	9.5
1	5/25/50	MC	12/22	TC	6.5
1	6/9/50	DC	12/29	MBRC	7
1951					
1	5/24/50	BBC	1/4	WC	1.5
2	5/24/50	BBC	1/26-3/15	GRS	1.5 (1.5)
1	6/4/50	MC	1/3	TFC	2
1	6/2/50	DC	1/3	TFC	7.5
1	6/6/50	DC	1/16	SG	1.5
1	6/10/50	SG	1/26	SC	5
1	6/9/50	DC	1/29	LB	1
2	6/14/50	FC	2/20-3/6	TFC	13 (12-14)
1	5/24/50	BBC	2/6	LB	1
1	5/24/50	BBC	2/22	CB	2
1	6/10/50	SG	2/6	BBC	1.5
1	6/10/50	SG	2/9	MoC	1.5
1	6/9/50	DC	2/9	GRS	3
1	6/9/50	DC	2/6	TFC	3.5
1	6/11/50	DC	2/14	TC	1.5
1	6/1/50	DC	2/26	MC	7.5
1	6/3/50	SG	2/26	TFC	6.5

* Hunter Kill ** Changed Drainage

Of 21 sight records, representing 12 calves marked on the east side of the Gallatin River, 10 were recorded on the east side and 11 on the west side. Of 10 records, representing 8 calves marked on the west side, 6 were observed on the west side and 4 on the east side. These data suggest that there is more intermingling of east and west side (Gallatin River) marked calves during the winter than at any other season. The probable reason for this is intimated earlier in the paper. It further suggests that east or west side marked calves are not restricted to one side of the river on their winter range.

Three sight records have no bearing on this section; the marking locality of one was unknown, two involved animals that changed drainages (discussed in a later section).

Movements of Individual Elk

Elk seen more than once after marking, supply some basis for evaluating the migration routes indicated by the pattern of sight records (Table VI).

Calf 24, marked 6/12/49 on Fan Creek, was observed 6/28/49 on Fawn Pass (Gallatin River side) and was killed 11/7/51 on Porcupine Creek. Calf 74, marked 6/8/51 on Daly Creek, was seen 8/2/51 at the head of Stellaria Creek and was killed 11/5/51 on Elkhorn Creek. These calves fit into the migration route: Daly Creek through Fan Creek to the vicinity of the head of the Gallatin River and return.

Calf 83, marked 6/1/50 on Daly Creek, was seen 7/15/50 on Bacon Rind Creek and 2/26/51 at Meadow Lake on Taylor Fork. This seemingly verifies the possibility that some of the Daly Creek elk, summering in the Bacon

TABLE VI

Marked individuals recorded more than once during 1949, 1950, and 1951.

Localities:- FC, Fan Creek; DC, Daly Creek; BBC, Black Butte Creek;
 SG, Sawmill Gulch; MC, Meadow Creek; FP, Fawn Pass, PC, Porcupine Creek; BRC, Bacon Rind Creek; TFC, Taylor Fork Creek;
 SS, Snowflake Springs; DHC, Dead Horse Creek; WC, Wickiup Creek, GRS, Gallatin Ranger Station; LB, Lava Butte; CB, Crown Butte; BC, Buffalohorn Creek;
 SC, Snowslide Creek; MoC, Monument Creek;
 HGR, Head of Gallatin River; SSC, Head of Stellaria Creek; TC, Teepee Creek.

No.	Date Marked	Locality	Date Observed	Locality	Movement - .5 Airline Miles
1949					
24*	6/12/49	FC	6/28/49	FP	2.5
			11/7/51 -	PC	21
1950					
83	6/1/50	DC	7/15/50	BRC	9
			2/26/51	TFC	7.5
171*	6/6/50	DC	12/9/50	TC	2
			10/28/51 -	EC	7.5
154*	5/30/50	MC	12/22/50	SS	4.5
			10/31/51 -	TFC	1.5
118	6/14/50	FC	12/14/50	SS	11
			12/27/50	DHS	19
			2/20/51	TFC	13.5
			3/6/51	TFC	12
82	5/24/50	BBC	12/14/50	BBC	0
			1/4/51	WC	1.5
			1/26/51	GRS	1.5
			2/6/51	LB	1
			2/22/51	CB	2
			3/15/51	GRS	1.5
1951					
169*	6/6/50	DC	1/16/51	SG	1.5
			11/6/51	BC	5
135	6/10/50	SG	1/26/51	SC	5
			2/6/51	BBC	1.5
			2/9/51	MoC	1.5
131	6/9/50	DC	1/29/51	LB	1
			2/9/51	GRS	3
32	6/3/51	DC	7/13/51	HGR	18
			7/26/51	HGR	18
74*	6/8/51	DC	8/2/51	HSC	13.5
			11/5/51 -	EC	6
141*	6/3/50	SG	2/26/51	TFC	6.5
			11/1/51	TFC	5.5

* Hunter Kill

Rind Creek-Migration Creek area, stay on the west side of the Gallatin River in their downward movement as suggested earlier. The possibility of these elk moving to the latter locality after reaching the winter range cannot be overlooked. Winter movements of calves subsequently discussed, however, seem to somewhat discredit the possibility of such a movement.

Four calves were seen as follows: calf 82, marked 5/24/50 on Black Butte Creek was seen 12/14/50 on Black Butte Creek (0 ave. airline miles from drainage marked), 1/4/51 Wickiup Creek (1.5), 1/26/51 Gallatin Ranger Station (1.5), 2/6/51 Lava Butte (1), 2/22/51 Crown Butte (2), 3/15/51 Gallatin Ranger Station (1.5); calf 118, marked 6/14/50 on Fan Creek - 12/14/50 Snowflake Springs (11), 12/27/50 head of Deadhorse Creek (19), 2/20/51 Taylor Fork (13.5), 3/6/51 Taylor Fork; calf 131, marked 6/9/50 on Daly Creek - 1/29/51 Lava Butte (1), 2/9/51 Gallatin Ranger Station (3)/: calf 135. marked 6/10/50 on Sawmill Gulch - 1/26/51 Snowslide Creek (5), 2/6/51 Black Butte Creek, 2/9/51 Mouth of Monument Creek. The greatest radius of movement in airline miles for each was: calf 82 (2); 118 (4.25); 131 (1.12); 135 (1.75). These data seem to indicate that movement of elk on their winter range is restricted, although they may or may not cross the Gallatin River.

The possibility that elk return to the same winter range year after year is suggested by animals 24, 169, 171, 141, and 154. The first was killed as a two year old, the other 4 as yearlings. Data are as follows: calf 24, marked 6/12/49 on Fan Creek was observed 6/28/49 on Fawn Pass, 11/7/51 Porcupine Creek; calf 169, marked 6/6/50 on Daly Creek - 1/16/51

Sawmill Gulch, 11/6/51 Buffalohorn Creek; calf 171, marked 6/6/50 on Daly Creek - 12/9/50 Tepee Creek, 10/28/51 Elkhorn Creek; calf 141, marked 6/3/50 on Sawmill Gulch - 2/26/51 Meadow Lake on Taylor Fork, 11/1/51 Taylor Fork; calf 154, marked 5/30/50 on Meadow Creek - 12/22/50 Snowflake Springs, 10/31/51 Taylor Fork. Animals 116 and 155 (Tables II and III) indicated return to the same summer range. Both were observed as yearlings in the company of marked calves. One marked on Daly Creek, was seen with 3 Daly Creek marked calves. The other, marked on Fan Creek, was seen with a Black Butte calf.

Calf 32 was marked 6/3/51 on Daly Creek, and was observed 7/13/51 and 7/26/51 at the head of the Gallatin River. This strengthens the possibility that elk reach the limit of their upward movement during July as intimated earlier.

Movements to Another Drainage

Johnson (1951), from summer observation of 12 Yellowstone marked calves in the high country between the Yellowstone and Gallatin drainages, suggested the possibility of intermingling between the Yellowstone and Gallatin elk herds on summer ranges. Twenty-four Yellowstone marked calves and yearlings observed in this general area in 1951, further strengthen the possibility (calves were also marked in the Yellowstone drainage in 1951, as described by Johnson for 1950).

Johnson further reports a Gallatin marked calf as having been trapped in the Yellowstone drainage during the winter. A Yellowstone calf was seen on Gallatin winter range in December, 1950. An elk marked 6/7/50 on Fan Creek, Gallatin drainage, was killed 1/9/52 on

Phelps Creek, Yellowstone drainage. These latter examples provide evidence of intermingling between the two herds (Table VII).

EVALUATION OF THE MARKER

Johnson (1951) reported that eight 1950 markers on hunter kills had been retained for 6 months, and only 2 were damaged. His report for 1949 markers was less favorable. Many sight records, previously discussed, during 1950-51, indicated that some of the 1950 markers were retained for as long as 18 months.

The 1951 hunting season, when 25 animals marked in 1949, 1950, or 1951 were killed, provided an opportunity to more critically evaluate the durability of markers (Table VIII).

Of 5 animals marked in 1949, 1 had lost the marker and ear tag; 4 had lost the marker only. These data suggest that the marker was generally torn from the ear tag. Johnson (1951) pointed out that the thin celluloid material used in 1949 was of a less durable nature than the plastic used in 1950.

Fourteen animals, marked in 1950, were killed during this period. Three had lost both the marker and ear tag. Three markers were returned in perfect condition. Eight were broken when received. Two were broken, but not enough to destroy their legibility. One, a square, had a small crack near one corner. The other, a half-moon, had a slight chip off the curving edge. Six had at least 1/5 of the marker broken off. All could be identified in the hand, but some could not have been recognized at a distance. Hunters who turned in broken markers were solicited to determine whether markers were broken at the time of kill. The results

TABLE VII.

Observations of Yellowstone and Gallatin marked calves indicating or suggesting intermingling of the two herds. Localities:- YP, Yellowstone Drainage; GD-FC, Gallatin Drainage-Fan Creek; HGR, Head of Gallatin River; HPC-HIC-FC, Head of Panther Creek-Head of Indian Creek-Fawn Creek; DC, Daly Creek; UGR, Upper Gallatin River, MHS, Mammoth Hot Springs, PC, Phelps Creek.

No.	Date Marked	Locality	Dates Observed	Locality	Movements - .5 Airline Miles
8	1950-51	YD	6/26/51	HGR	9-13
16	1950-51	YD	6/29/51 8/23/51	HPC-HIC FC	9-13
1	1950	YD	12/12/50	GD-DC	17-23
1	6/12/49	GD-FD	6/28/49 1/9/50	UGR MHS	2.5 19
1	6/7/50	GD-FC	1/9/52	YD-PC	17

TABLE VIII

Condition of markers received during the 1951 hunting season.

Yr. of Marker	No. of Markers	Marker & Ear Tag Lost	Marker Only Lost	Marker Perfect or Legible	Marker Broken - (1/5 or more)		
					Before Kill (Hunters' Report)	After Kill (Hunters' Report)	Unknown
1949	5	1	1	--	--	--	--
1950	14	3	--	5	2	2	2
1951	6	--	1	1	--	3	1

were as follows: 2 had been broken after time of kill, 4 were broken before the time of kill (includes the 2 slightly damaged), and for 2, no further information was obtained. These data substantiate the possibility of marker damage after the time of kill as suggested by Johnson (1951). It further indicates, that when heavy material was used, the ear tag had to be torn from the ear before the marker was lost.

The plastic material used for the 1951 markers was of two thicknesses; .67 and 1.07 mm. Six 1951 marked animals were killed. Four markers of the heavier material were recorded as follows: 1 was in perfect condition; 2 were reported by hunters as having been in perfect condition at the time of kill; condition of the other is unknown. One marker of the lighter material had been lost, and 1 was verified as having been in perfect condition at the time of kill. These data strengthen the possibility of considerable marker damage after the time of kill. This is also suggested by broken markers with clean breaks. It further indicates the value of durable material.

FACTORS INFLUENCING ELK MOVEMENTS

Horseflies (Tabanidae)

The effect of tabanid flies on red deer (Cervus elaphus) movements in Scotland has been discussed by Darling (1937). The emergence of the smaller tabanids during the early spring season provoked the deer into moving into the high country before the vegetation had developed. Early in the fly season, the deer came to lower elevations during the night to feed, but later, as the larger flies emerged, they went high to stay for the remainder of the season. Here they occupied well winded areas and came down only during periods of rainfall when the flies were inactive. Tabanid activity reached its peak about the middle of hot, sunshine days, usually ceasing around 6:00 P.M.

Johnson (1951) suggested that insect infestations were a major nuisance to elk during July and August in the Gallatin drainage. During this period, elk occupied the high, windy ridges as much as possible. Rush (1932) and Murie (1951) further attribute considerable annoyance to flies.

An attempt was made to evaluate the effect of tabanid flies on elk movements. It was necessary to devise a method for sampling the tabanid population. Since the writer accomplished the field work on horseback, it seemed logical to use the horse as a "collecting agent" to measure the relative abundance of tabanids in a given place at a given time. Then it was necessary to determine whether tabanids that molested horses were the same species as those that molested elk. Collections were made from horses and a captive elk in the same general area in the Gallatin

drainage. The results are listed in Table IX. Five species were collected from the elk. All were included in collections from the horses. This seemed to justify the use of a horse for measuring tabanid population that would molest elk. Four species of blood sucking flies, other than tabanids, were found on horses, one of which was also found on the elk.

A method was devised to show a tabanid population index for a given area: two observers, one on each side of the horse, counted the flies which hovered near or landed on the horse during a ten minute period. The total number was then divided by 2 to get an average which was used as an index of the population. Counts were made as near the middle of the day as possible, when tabanid activity was supposedly at its peak. An attempt was made to correlate the index with elk numbers in that area.

Evidently the emergence of tabanids did not affect the upward movement of elk from the winter range because no tabanids were seen on the summer range until July 13, after the elk had moved into these areas.

To determine the effect on daily movements, counts were made at low and high elevations in the same area of the summer range during the fly season (July 13 to August 21). If possible, the counts were made in areas recently vacated by elk to get counts as near to elk as possible. The results of 10 samples are listed in Table XI.

TABLE IX

Species of insects collected from horses
and elk in 1950 and 1951

Species	Horse	Elk	
	1951	1950	1951
<u>Hybomitra rhombica osburni</u>	59	4	31
<u>Hybomitra sonomensis</u>	19	1	
<u>Hybomitra rupestris</u>	16		3
<u>Hybomitra frontalis septentrionalis</u>	13		
<u>Hybomitra opaca</u>	8		
<u>Hybomitra tetrica hirtula</u>	7	1	1
<u>Hybomitra affinis</u>	3		
<u>Chrysops furcata</u>	4	1	
<u>Chrysops noctifera pertinax</u>	3		
<u>Glaucops fratellus</u>	3		
<u>Atylotus incisuralis</u>	1		
<u>Symphoromyia atripes*</u>	5		
<u>Symphoromyia hirta*</u>	1		
<u>Haematobia serrata*</u>	5	1	11
<u>Muscina assimilis*</u>	4		

*Blood sucking insects not tabanids

TABLE X

Tabanid population indices on the elk summer range. Localities:-
GP, Grayling Pass; GC, Grayling Creek, UGR, Upper Gallatin
River; HGR, Head of Gallatin River; WSP, West Stellaria
Pass; HIC, Head of Indian Creek.

Count No.	Date	Local- ity	Population Index		No of elk	Time of day	Type of Area
			Relative Elev.				
			High	Low			
1	7/15/51	GP	0		110	1:30 PM	Dry, open basin
2	7/15/51	GC		55	0	2:30 PM	Moist, open meadow
3	7/26/51	UGR		28	0	11:30 AM	Open area
4	7/26/51	HGR	6		305	2:30 PM	Well-drained, open basin
5	7/26/51	GP	7.5		134	5:00 PM	Dry, open slope
6	8/1/51	GC		7	0	11:30 AM	Moist, open area
7	8/1/51	GC		25	0	12:50 PM	Moist, open meadow
8	8/1/51	GC		119	0	2.15 PM	Timbered area near creek
9	8/2/51	WSP		59.5	15	12:25 PM	Moist, open park, medium elevation
10	8/15/51	HIC	12.0		2	2:30 PM	Dry, open basin

Count 1 was made 7/15/51 at 2:30 PM., in the high country on Grayling Pass. No tabanids were observed, and 110 elk were recorded. In comparison count 2 was made 1 hour later down low in a moist, open meadow along Grayling Creek. A high population index of 55 was recorded, and no elk were seen in the area.

Count 3, made low along the Gallatin River at 11:00 AM., 7/26/51, had an index of 28. No elk were seen. This count was compared with counts 4 and 5 made on the same day, in the adjacent high country. Count 4, 2:30 PM., had an index figure of 6 and 305 elk were recorded; count 5, 5:00 PM., recorded an index figure of 7.5, and 134 elk were observed.

Counts 6, 7, and 8, 8/1/51, were made down low on Grayling Creek in different areas within a half mile radius. Count 6, 11:30 AM., recorded an index of 7 and no elk were observed. The low index was possibly due to the short, hard rain which fell early that morning. (According to C. B. Philip, personal communication, tabanids are inactive after a rainstorm). Count 7, 12:50 PM., had an index of 25 which was much higher than count 6 possibly because of the later time allowing for more drying after the rain. No elk were recorded, but evidence of 40 beds indicated that elk had been there early in the morning about the time of the rainstorm. This is in accordance with Darling's observations that the red deer came down low during rainy weather when the flies were inactive. Count 8, 2:15 PM., had an index of 119 and no elk were observed. This count was made approximately 100 yards within the timber.

Count 9, 8/2/51, 12:25 PM., was made in a moist, open park at medium elevation. The population index was 59.5, and 15 elk were seen in

the area. At the exact time this count was made, 251 elk were observed bedded down on a high, breezy adjacent slope.

Count 10, 8/15/51, 2:30 PM., was made in a high, well drained basin. The index recorded was 12.5, and 2 elk were recorded.

Four counts, at high elevations, had low population index figures, and recorded elk in each case. Four counts, at low elevations, in the same general area, recorded high index counts and no elk. One low index was recorded at a low elevation, but this was probably due to a rainstorm before the time of the count. A high population index was recorded at a medium elevation with 15 elk in the area. These data indicate an inverse relationship between tabanids and elk numbers suggesting movements of the elk away from the infested areas.

The last tabanids recorded in this general area were on August 21. This suggests that the flies had no effect on the downward movement of the elk, as elk were seen in the area as late as September 18.

Development of Vegetation

Murie (1951) reports that many Jackson Hole elk follow the snowline back to the summer range, leaving areas where the new vegetation is well developed to go to high areas where the vegetation is scarce, possibly suggesting a higher palatability in the newest vegetation. Darling (1937) states that the red deer (Cervus elaphus) make definite journeys to certain areas in quest of certain species of vegetation.

In this study, an attempt was made to show the relationship between elk movement and vegetation development. Plants were collected at random throughout the upper winter and summer ranges from May 23 through

September 26, 1951. They were pressed, identified, and classified as to the stage of development: succulent-no flowers evident; succulent-flowers developing or developed; succulent or curing-flowers mature or degenerating, in or beginning to seed (Table XI).

During the periods when plant collections were made, all elk seen in the general area were recorded as an index of the population (Table XII).

An attempt was made to determine the choice of plants of feeding elk by direct observations similar to that of Cowan (1945). It was necessary, however, to closely examine the plants to determine those utilized (Table XI).

During the calving season, when large numbers of cows remained on the upper winter range, the vegetation was in early stages of development (Table XI). The average number of elk seen per day was somewhat consistent suggesting little or no movement from this general area at this time (this discussion chiefly concerns cows since only 47 of 1699 elk recorded were classified as bulls). This might lead one to suspect that the cows remained in this area because of the abundant new succulent vegetation, but other evidence would not support this. For one thing, the mature bulls apparently moved to higher areas during this period, as evidenced by their absence in daily counts and the evidence of elk migrations to higher areas (migration trails through snowdrifts). Rush (1932) states that the cows and newborn calves are the last to leave the winter range. Furthermore, an examination of Table XI clearly indicates that the vegetation was in a later stage of development on the summer range when large numbers of elk began to appear there.

Legend: A-Succulent, no flower evident; FD-Succulent, flower developing or developed
FM-Succulent or curing, flower mature or degenerating, in or beginning to seed
(Number following indicates number of specimens collected ~~that~~ duplicates
from different areas or different days.)

[illegible]

Cont'd

[illegible]

Cont'd

Poa sp.	A*					A*									
<i>Poleum alpinum</i>					FD2*	A	FD3*	FD*	FD,FM2	FD2,FM	FD2				FM
<i>Festuca idahoensis</i>							FD4*,FM	FD	FD	FD,FM2	FM	FM	FM	FM	
<i>Poa secunda</i>						FD	FD2*	FD	FD	FD2	FD				
<i>Poa alpina</i>						FM			FM		FM	FM			
<i>Poa reflexa</i>									FM2	FM	FD,FM2				
<i>Poa ampla</i>								FD	FM	FM			FM2	FM	
<i>Deschampsia atropurpurea</i>								FM	FD,FM2	FD,FM	FM				
<i>Deschampsia caespitosa</i>										FM		FM			
<i>Bromus anomalus</i>													FM	FM	
<i>Koeleria cristata</i>							FD2		FD				FM2	FM	
<i>Stipa viridula</i>								FD2	FD2	FD,FM	FM	FM	FM	FM	
<i>Trisetum spicatum</i>						FD	FD	FD	FD3	FD,FM	FM2				
<i>Juncus balticus</i>								FD	FD	FM2	FM				
<i>Melica spectabilis</i>					FD2	FD2			FM2	FM	FM		FM	FM	
<i>Agropyron trachycaulum</i>							FD	FD	FD3	FD,FM2	FD,FM		FM2	FM	
<i>Hordeum brachyantherum</i>												FM			
<i>Linum lewisii</i>						FD	FD		FD	FD,FM					FM
<i>Penstemon caelestinus</i>						FD	FD3		FD2	FD	FD				
<i>Pedicularis groenlandica</i>							FD		FD						
<i>Antennaria rosea</i>					FD2	FD	FD2			FD,FM2	FD	FM			
<i>Arenaria congesta</i>						FD	FD2	FD	FD	FD2	FD		FM		
<i>Carex geyeri</i>									FM						

* Indicates utilization by elk.

TABLE XII

Showing the Numbers and percentages of plants collected in each developmental category (from Table XI) and the average number of elk seen, by periods.
(Number in parenthesis following number of elk indicates number of observations).

	Upper Winter Range				Summer Range										
	5/23- 5/29	5/30- 6/5	6/6- 6/12	6/13- 6/20	6/26- 7/2	7/11- 7/17	7/25- 7/31	8/1- 8/7	8/8- 8/14	8/15- 8/21	8/22- 8/28	8/29- 9/4	9/5- 9/11	9/12- 9/18	9/19- 9/26
A stage	18(43%)	5(45%)	9(60%)	8(38%)	7(13%)	4(7%)	5(8%)	0	1(1%)	0	0	0	0	0	0
FD stage	24(57%)	6(55%)	6(40%)	13(62%)	43(83%)	50(89%)	55(90%)	29(97%)	72(80%)	41(54%)	24(49%)	5(24%)	2(8%)	0	0
FM stage	0	0	0	0	2(4%)	2(4%)	1(2%)	1(3%)	17(19%)	35(46%)	25(51%)	16(72%)	24(92%)	20(100%)	4(100%)
Ave.No. of Elk observed	76(5)	124(3)	71(4)	94(7)	60(6)	206(5)	371(3)	301(2)	34(2)	69(3)	61(2)	0(2)	0(1)	2(3)	25(2)

Unfortunately, no observations were made on the summer range for 6 days following the calving season. During the first week, 6/26/51-7/2/51, of operations on the summer range, an average of 60 elk was recorded for 6 observations. Thirteen percent of the plants collected were in the succulent-no flower evident stage, A; 83% were in the succulent-flowers developing or developed stage, FD; 4% were in the succulent or curing-flowers mature or degenerating, in or beginning to seed stage, FM. In the second period of observation, 7/11/51-7/17/51, an average of 206 elk were recorded for 5 counts: 7% of the plants collected were in the A stage, 89% in the FD stage, 4% in the FM stage. During the third period, 7/25/51-7/31/51, an average 371 elk was recorded for 3 counts: 8% of the plants collected were in the A stage, 90% in the FD stage, 2% in the FM stage. In the fourth period, 8/1/51-8/7/51, two counts gave an average of 301 elk: none of the plants collected was in the A stage, 97% were in the FD stage, 3% in the FM stage. These data seem to indicate that the majority of the elk did not move into the high summer range until many of the plants were well developed. The fact that the elk moved onto the summer range in early July is discussed previously in migration studies. It is possible that the cows would have moved to the summer range when the vegetation was in an earlier stage of development, had this not been the period for parturition. This seems logical because the bulls apparently moved to higher elevations before the cows. Obviously, the cows are retarded in their migration by calving duties. Newborn calves are definitely limited in their ability to move. Johnson (1951) reports that calves do little moving until the 3d or 4th day.

Observations in this study suggest that they are not capable of extended movements until they are much older. One calf, 3 or 4 days old, remained with 6 moving cows for about 300 yards, then lay down in a game trail and made no attempt to run when approached. A calf, marked at the age of 1 day, was found 3 days later, approximately 75 yards from the place marked. One, marked at 1 day, was found 4 days later, about 400 yards from the marking locality. A calf, marked at 7 days, was found a day later; it had moved about 75 feet. One marked at 3 days was found 10 days later in almost the same location. Another, marked at 8 days, was found 5 days later, approximately 1/4 mile from the place marked. Even after the calves of certain cows in the herd are capable of long movements, it does not follow that these cows move before others in the herd, because of the gregarious nature of elk. On June 20, 1951, two groups, one of 20 cows and 20 calves, and another of 50 cows and 25 calves, were observed.

Feeding observations (Table XI) indicated that the elk fed on a wide variety of plants in various stages of development. Plants that were grazed during the spring and/or summer are listed below by groups in order of preference, determined by their frequency in grazing observations. The grasses and sedges taken were as follows: Carex nubicola (Cloud Sedge), Carex raynoldsii (Raynolds Sedge), Poa epilis (Skyline Bluegrass), Phleum alpinum (Alpine Timoth), Festuca ovina (Sheep Fescue), Festuca idahoensis (Idaho Fescue), Poa secunda (Sandbergs Bluegrass), 2 unidentified Poa spp.

The forbs taken most often were Agoseris glauca (Pale Agoseris), Trifolium rydbergi (Rydberg Clover), and Trifolium Haydeni (Hayden

Clover). The next 3 in preference were Lupinus sericeus (Hairy Lupine), Delphinium stachydeum (Tall Mountain Larkspur), and Rumex paucifolius (Slender Meadow Dock). Those recorded the least number of times were Taraxacum officinale (Dandelion), Viola nuttallii (Violet), Ranunculus glaberrimus (Buttercup), Aquilegia flavescens (Columbine), Balsamorhiza saggitata (Arrowleaf Balsamroot), Heracleum lanatum (Cow Parsnip, and 1 Ranunculus sp. Arrowleaf Balsamroot and Cow Parsnip were taken readily during August in local areas on the high summer range. No observations of elk actually taking these two species were made, but elk were recorded throughout the areas in question, and only their sign was observed around the grazed plants.

Of 11 plant species, recorded as grazed on the upper winter range, from May 23 through June 20, 1951, 9 were in the A stage of development, and 2 were in the FD stage (Table XI). The percentages for the two stages in relation to total plant development, indicate that the FD stage was more prominent during this period (Table XII).

Fourteen species grazed from 6/26/51-8/7/51, showed the following: 5 were in the A stage; 10 in the FD stage (Table XI). One species was grazed in both stages. In this period, the FD stage was by far the most evident on a total plant percentage basis (Table XII).

Nine species grazed from 8/8/51-9/26/51, indicated the following development: 1 in the A stage; 4 in the FD stage; 6 in the FM stage (Table XI). Two were grazed in both FD and FM stages. The percentages, in relation to total plant stages, show that the FM stage increased throughout the period (Table XII).

These data seem to indicate that the elk showed a preference for the species in the A stage while on the upper winter range. This could possibly be due to the fact that most of the species grazed were recorded only in the A stage during this period (7 out of 11). The possibility that the elk moved to higher areas to feed on the new vegetation is not borne out in the next period. The FD stage of development was most evident per species grazed. The suggestion that parturition may have been an important factor in determining the time of this movement, has been previously discussed.

Snowcover

The possibility that snowcover was a factor in retarding the upward movement of the elk during the spring of 1951, was not apparent. Elk marking operations were initiated May 22 on Fan Creek. Snowcover was negligible, with the open areas having only an occasional small patch of snow. The open area bordering both forks of Fan Creek (Figure 1) was practically void of snow.

On June 7, a trip up the Gallatin River to within about 4 miles of the head of the river, revealed no snow except in small localized areas on timbered slopes. High, open parks on the summer range were observed, with very little snow evident.

Snow conditions on Daly Creek were nonexistent throughout the period from May 23 through June 20 except for an occasional patch encountered during the first week of operations.

SUMMARY

1. The marking of elk calves with plastic ear markers, initiated in 1949 and 1950, was continued in 1951 in the Gallatin River Drainage, Montana. Ninety-three were marked in 1951, making a total of 225 for the three years.
2. Sight and kill records of marked individuals provided the basis for a study of elk migration patterns.
3. Observations of marked calves on the calving grounds (upper winter range), indicated no movement away from this area until the close of the calving season. Only 3 of 31 positively identified, had moved from the drainage where marked. In all instances, movements were less than a mile, and to an interlocking drainage on the calving grounds.
4. Observations of marked calves, from June 27 to July 31, indicated movements to generally higher elevations as the season progressed. Four of five marked animals observed in June, after the calving season, had moved away from the drainage where marked, but only for short distances (2.5 to 3.5 airline miles). From July 1 to July 15, 5 sight records indicated an average movement of 11.4 airline miles. Seven observations, July 16-31, showing an average movement of about 14.8 airline miles. Eight of 10 marked animals seen in August were seen in drainages where marked animals had been seen in July, suggesting that the animals reached the limit of their migration during July.
5. Sight records of calves marked on the east side of the river, indicated summer range on both sides: head of the Gallatin River area and the

Bacon Rind Creek-Migration Creek area. Fifteen of 21 had remained on the east side; 6 had crossed over. Two calves marked on the west side, remained on the west side (Sawmill Gulch to the Bacon Rind Creek-Migration Creek area).

6. The pattern of sight records suggested the following migration routes: Daly Creek through Fan Creek to the head of the Gallatin River; Daly Creek through Fan Creek to the Bacon Rind Creek-Migration Creek area; Daly Creek through Sawmill Gulch to the Bacon Rind Creek-Migration Creek area; Sawmill Gulch to the Bacon Rind Creek-Migration Creek area; Sawmill Gulch through Daly Creek through Fan Creek to the Bacon Rind Creek-Migration Creek area.
7. Fall movements are indicated by 35 hunter kills near or below the marking localities. Twenty-four suggested a reversal of the Daly Creek-Fan Creek-head of the Gallatin River migration pattern and/or the Daly Creek-Fan Creek-Bacon Rind Creek-Migration Creek pattern. Nine suggested a movement from the Bacon Rind Creek-Migration Creek area down the west side of the river. Two suggested the possibility that the elk intermingle somewhat after reaching the winter range.
8. Thirty-four winter records suggested that the elk reached the limits of the downward migration by December. No observations were made below those for October and November.
9. Data suggested that the lower limits of the winter range, were the Buffalohorn Creek-Porcupine Creek area and the Taylor Fork-Meadow Creek area. The upper limit may extend to the mouth of Bacon Rind Creek, but is probably centered near the Gallatin Ranger Station.

10. Thirty-one sight records, representing 20 calves, suggested considerable intermingling of east and west side (Gallatin River) animals during the winter.
11. Movements of the individual elk seen more than once, substantiated the migration routes intimated by the pattern of sight records.
12. Observations of 4 marked calves indicated restricted movement on the winter range, though they may or may not cross the Gallatin River.
13. Records of 5 animals, suggested that some elk return to the same winter range year after year; two suggested return to the same summer range.
14. Thirty-six Yellowstone drainage marked animals were observed on the same summer range as that used by Gallatin drainage elk. Five of the Yellowstone animals were seen with Gallatin marked elk. These data suggested intermingling of the two herds on the summer range. Positive evidence is indicated by the following records: 2 Gallatin marked animals recorded in the Yellowstone drainage during January; 1 Yellowstone animal observed during December in the Gallatin drainage.
15. Plastic marker returns from hunter kills in 1951, indicated much better results when heavy, durable material was used. Two thicknesses, .67 and 1.07 mm., of plastic material were used in 1951. Some of the markers were retained in perfect condition for 18 months. Verification by hunters who had turned in broken markers, substantiated the possibility of marker damage after the time of kill.
16. A study of tabanid populations for certain localities on the summer

range, indicated an inverse relationship between tabanid numbers and elk numbers.

17. Plants collected throughout the upper winter range, during the calving period when large number of elk were present, indicated that the vegetation was in an early stage of development. Later collections from the summer range, during the period when large numbers of elk began to appear there, indicated the vegetation in a later state of development. This suggested that the period of parturition was more important in governing the upward movement of cows than plant development.
18. Species of vegetation grazed were determined by careful examination of an exact area in which the elk had been feeding. Twenty-two were recorded: 9 grasses and sedges; 13 forbs. Carex nubicola (Cloud Sedge), and Carex raynoldsii (Raynolds Sedge) were recorded most often.
19. Snowcover was apparently not a factor in retarding the upward movement of the elk during the spring of 1951.

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