AN UNSUCCESSFUL BIGHORN SHEEP (*OVIS CANADENSIS CANADENSIS*) TRANSPLANT ON THE MIDDLE FORK OF THE POWDER RIVER, WYOMING.

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ABSTRACT: In 1974, bighorn sheep (*Ovis canadensis canadensis*) were transplanted by the Wyoming Game and Fish Department into the Middle Fork of the Powder River located in the southern Bighorn Mountains. 127 bighorn sheep had been introduced into the area, however, by late summer 1978, only 16 individuals were observed. Lungworm treatments were begun in winter 1977-78, resulting in reduced lungworm larvae (*Protostrongylus stilesi* and *P. rushi*) counts. The treatment did not increase lamb survival. Ewe-lamb behavior was recorded during the summers from 1976 until 1978. Changes through the summer were noted for suckling intensity and time spent playing, resting, and feeding on vegetation. A factor which may have influenced the bighorn sheep's decline was competition with elk (*Cervus canadensis*) and mule deer (*Odocoileus hemionus*). Forage quantity and quality were also possible limiting factors. Comparisons are made between the Middle Fork of the Powder River introduction and two other Wyoming introductions.

INTRODUCTION

Bighorn sheep transplants have become important in recent years as a means of expanding existing bighorn sheep populations and for repopulating ancestral ranges. Both successful and unsuccessful trans-

plants have resulted. The factors responsible for unsuccessful transplants are not always easily determined. This study examines a bighorn sheep transplant that decreased in density after introduction and explores possibilities as to why this happened.

STUDY AREA

The Ed. O. Taylor Wildlife Unit, located 27 miles (43.5 km) west of Kaycee, Wyoming is on the southern flank of the Bighorn Mountain Range. The 10,185 acre (4121.9 ha) unit, bisected by the Middle Fork of the Powder River, ranges in elevation from 6000 feet (1828 m) to 7500 feet (2286 m). The most dramatic topographical feature is the steep and massive walls which rim the Middle Fork of the Powder River and a tributary, Blue Creek. The magnitude of relief associated with the canyon reaches 1000 feet (305 m) along several sections. The majority of the area is characterized by open grass and shrubland interlaced with rock outcroppings and belts of timber.

The vegetation is predominantly grass with an intermittent overstory of shrubs and/or trees. A range survey conducted in 1971 (Guest, 1971) found the composition of the grassland to include several species of bluegrass (Poa spp.), western wheatgrass (Agropyron smithii), Idaho fescue (Festuca idahoensis), needle-and-thread (Stipa comata), prarie junegrass (Koeleria cristata), bluebunch wheatgrass (Agropyron spicatum), sedge (Carex spp.) and several less important species. A fairly diverse flora of perennial forbs exist including lupine (Lupinus sericus), stonecrop (Sedum stenopetalus), Indian paintbrush (Castilleja spp.) and wildbuckwheat (Eriogonum ovalifolium).

Shrubs predominate in the canyon and consist of big sagebrush (Artemesia tridentata), curlleaf mountainmahogany (Cercocarpus ledifolius), wax currant (Ribes cereum), several species of rabbitbrush (Chrysothamnus

spp.), and juniper (Juniperus spp.)

The tree canopy is dominated by ponderosa pine (Pinus ponderosa) with Douglas fir (Pseudotsuga taxifolia) and limber pine (Pinus flexilis) also present. Patches of aspen (Populus tremuloides) are located along streams.

Grazing by domestic livestock was the primary land practice until 1971 when the Game and Fish Department purchased the land. Since that time, with the exception of trespass animals, no domestic livestock have grazed the area.

HISTORY

The Middle Fork of the Powder River is an ancestral bighorn sheep area but they disappeared from the area in the early 1900's coincident with the introduction of domestic livestock. The Wyoming Game and Fish Department transplanted bighorn sheep into the area in January 1974 and made additional transplants in 1976 and 1978. A student intern program initiated in summer 1976 continued through the summers of 1977 and 1978. The purpose of the program was to observe the bighorn sheep, determine reproduction and survival rates, locate mortalities, and observe and record ewe-lamb behavior. This report concentrates primarily on 1978 data when the author was an intern.

Because of evidence of lungworm caused mortality of lambs in 1976 (Watts, 1976), treatment for lungworms using fenbendazole in apple pulp bait was attempted in late winter 1976-77. This treatment was suspected of having little effect because of improper administration. The treatment with fenbendazole was repeated in January 1978. Nineteen sheep introduced into the area at that time were treated with cambendazole when trapped.

METHODS

Observations were made on foot and from a vehicle using binoculars and a spotting scope. Dates of observations were June 1 through August 23, 1976; June 6 through August 26, 1977; July 8 through August 21, 1978. Weather conditions were recorded daily on field forms along with records of sheep observations which included time, location, activity, and classification of sheep observed. When ewes with lambs were observed, their actions were timed and recorded using a cassette recorder. Later, the data were transferred to field forms. Definitions of sheep behavior and activities followed Geist (1971) and Horejsi (1976).

Mortalities were recorded on field forms and possible cause of death was indicated. The bone marrow of each adult carcass found was examined.

Fecal samples were collected periodically and larvae present per gram of feces was determined for pre- and post-treatment periods at the Wyoming Game and Fish Research Laboratory located in Laramie, Wyoming.

RESULTS

Sixty bighorn sheep were released in January and February 1974. By January 1978, a total of 127 bighorn sheep had been transplanted. Table 1 shows the sex and age structure observed by early August of each year. Only 2 or 3 lambs were observed each summer. In 1978, by the end of August, only one lamb was surviving. The population of 16 sheep in 1978 occurred even after 19 sheep were introduced into the area in January. Only four sheep from this final transplant were observed, including one mortality. One hundred-eight transplanted bighorn sheep were never located, dead or alive by 1978 (Table 2).

Table 1. Early August sex and age structure of bighorn sheep in the Middle Fork of the Powder River, Wyoming.

Year	Rams	Ewes	Yearling ♂	Yearling ♀	Lambs	Total
1976	6 Class I 4 Class II	38	3	5	2[a]	58
1977	3 Class I 2 Class II	21	0	0	3	29
1978	2 Class I 1 Class II	8	2	1	2	16

[a]12, 7, and 4 lambs were observed in early summer of 1976, 1977, and 1978, respectively.

Table 2. Numbers of missing bighorn sheep which should have been present in 1978 in the Middle Fork of the Powder River after transplanting in 1974, 1976, and 1978.

Rams		Ewes	
Class III	3	2-3 years	14
Class II	7	4-8 years	41
Class I	10	8 years	21
yearling	5	yearling	7
TOTAL	25	TOTAL	83

Bighorns were observed primarily in the upper levels of the canyon and within 400 m of the rim on the open grasslands. This population was not migratory and stayed in the same area year round. A daily movement pattern was observed in both the ewes and rams. They moved to open grasslands shortly after sunrise, grazed until 0800-0900, and moved back into the canyon. In the mornings and evenings the bighorns were often observed at the salt licks placed in the area. They remained in the canyon until late afternoon or evening when they moved to the upper grassland again. During the summer of 1978 there was one primary ewe-lamb group consisting of approximately eight ewes and up to four

lambs. Solitary ewes were occasionally observed interacting with the ewe-lamb group but normally they stayed some distance away from the ewes and lambs.

The number of ewes observed in the area decreased from 38 in 1976 to 8 in 1978. With such a small population, lamb:ewe ratios may be meaningless. The number of lambs observed by late June in 1976, 1977, and 1978 were 12, 7, and 4 respectively. This resulted in ewe:lamb ratios of 32:100, 35:100, and 50:100.

Lamb mortality in all years was extremely high. By late August the number of surviving lambs were 2, 3, and 1, respectively for 1976, 1977, and 1978.

Watts (1976) described the lambs' health and behavior throughout the summer 1976: "During late June all the lambs appeared in good condition. They were very playful, suckled often, and for long periods, and coughed only seldom. They were only occasionally refused a suckle. By the end of June several began feeding on vegetation. Also, about this time the lambs began coughing more frequently, were refused suckles more often, and spent little time in play. As July progressed the lambs became weak and relatively inactive. Much time was spent lying in the shade, very little was spent feeding, suckling, or playing."

In 1977 Lovewell (1977) observed that lamb growth was noticeable in June and early July, but by late July and August lambs grew more slowly. There was one exception, however. One lamb grew faster and was much larger than any of the others. This lamb replaced its juvenile coat in late July while others still had juvenile coats in late August. Replacement of the lamb's coat is an indication of the lamb's development and healthiness (Geist 1971). Variation in individual lamb body sizes were

also observed in 1978. Once again, one lamb was of a larger size and appeared in better health than the others.

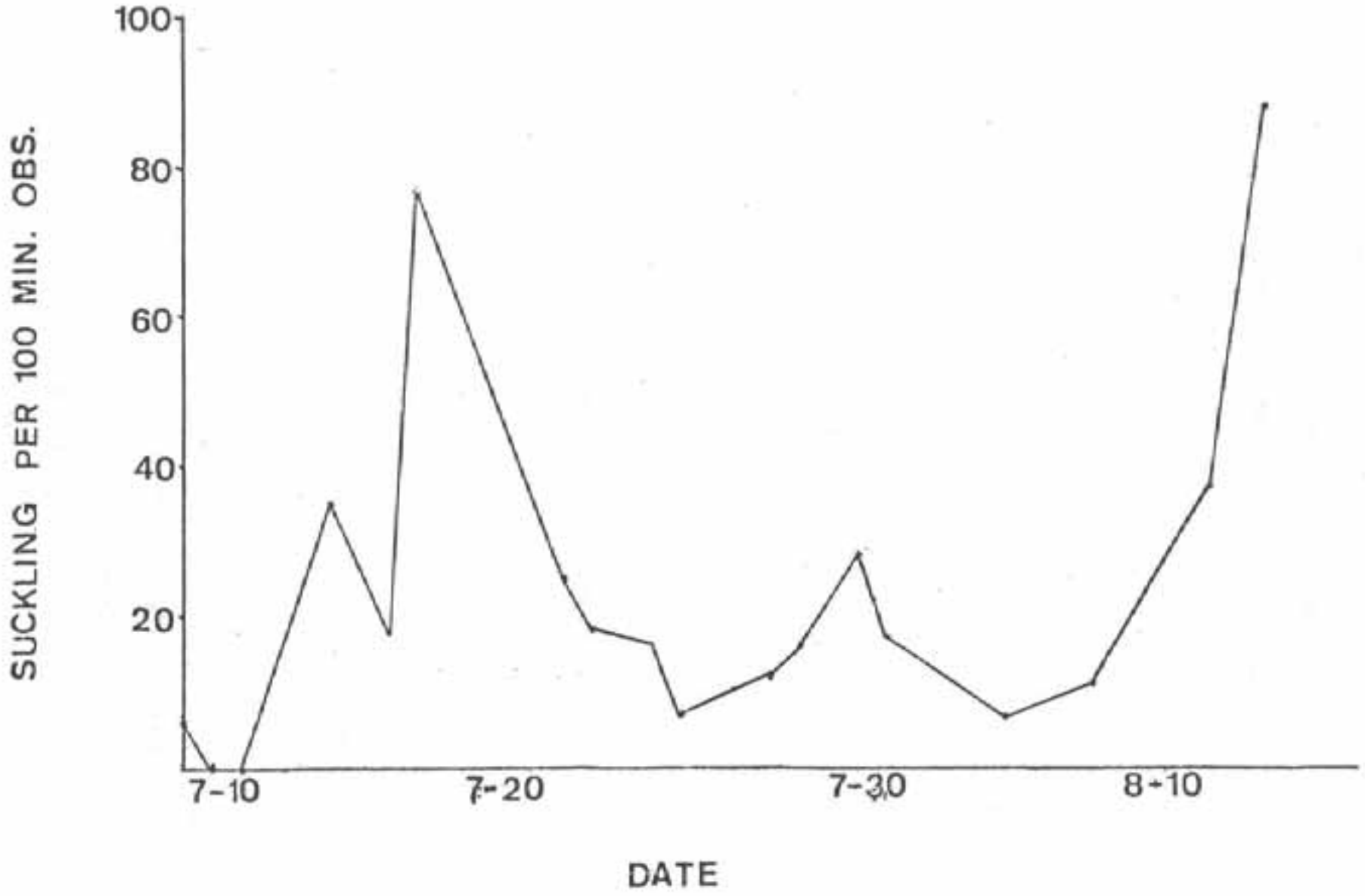
Figures 1-4 illustrate weekly changes in intensity of suckling, playing, resting (or inactivity), and foraging for 1978.

In 1978 suckling intensity increased early and was followed by a decrease. But suckling increased sharply near the end of August. By that time only one lamb remained alive and it was observed suckling from three different ewes. The lamb did not need to seek ewes to suckle because they ran to it. One ewe was observed to run 50 yards (45.7 m), abruptly stop next to the lamb, and allow it to suckle. This single surviving lamb appeared in good healty. The two surviving lambs in 1976 were also reported to appear healthy, though some coughing was noted.

Geist (1971) and Horejsi (1972) show that free-ranging Stone's and bighorn lambs from a high quality population and during a year of high survival suckle more frequently per hour than lambs from a low quality population or a low survival year. Snackleton (1973) observed that lambs from a poor quality population spent less total time obtaining milk than those from a high quality population.

Shackleton studied nursing intensity in two Canadian sheep populations, one described as poor quality and the other as high quality. Throne et al. (1979) studied the Whiskey Basin bighorn populations of Wyoming. These populations are the source of the Middle Fork transplants. A summary of suckling behavior from these two studies is compared to that of the bighorns of the Middle Fork in Table 3. Mean suckle duration between the Middle Fork population and the 1975 and 1976 Whiskey Basin populations was similar. These rates fell between those of Shackleton's low and high quality populations and they were below the 1977 Whiskey Basin population.

FIG.1 SUCKLING INTENSITY DURING JULY AND AUG.,1978



In addition to differences in suckling intensity between high and low quality population, differences in playing frequency also occurred. Lambs in low quality populations apparently have less non-essential energy reserves as they played only 0.06 minutes per 100 minutes of

	Canada[a]		Whiskey Basin[b]			Powder River
	poor quality	high quality	1975	1976	1977	1978
OBSERVATION PERIOD	4/6-7/27	3/6-7/25	6/21-8/21	6/16-7/26	6/21-8/8	7/10-8/17
SUCCESSFUL SUCKLES	78	79	164	56	41	47
MEAN SUCKLE DURATION	14.1	28.0	17.7	19.0	26.7	18.2
SUCKLING PER 100 MIN. OBS (SEC)	---	---	5.75	28.0	32.5	23.6
TOTAL OBS TIME (MIN)	1560	1242	4839	1949	1343	4004

[a]Shakleton (1973)
[b]Thorne et al. (1979)

observation while those of the expanding population played 0.13 minutes per 100 minutes (Shackleton 1973). Horejsi (1972) observed the same herd for two years, one of high lamb survival and one of low lamb survival. During high survival, lambs spent more time walking or being active than did lambs during the year of low survival. These differences were suggested to be due primarily to the nutritional status of the ewes and their ability to produce milk, which in turn reflected nutritional quality or condition of the range (Horejsi 1972).

Playing frequency (Figure 2) among lambs of the Middle Fork in 1978 increased in mid July, but sharply decreased by late July and was not observed at all after August 4th. Periods of inactivity (Figure 3)

FIG. 2 LAMB PLAYING FREQUENCY DURING JULY AND AUG., 1978.

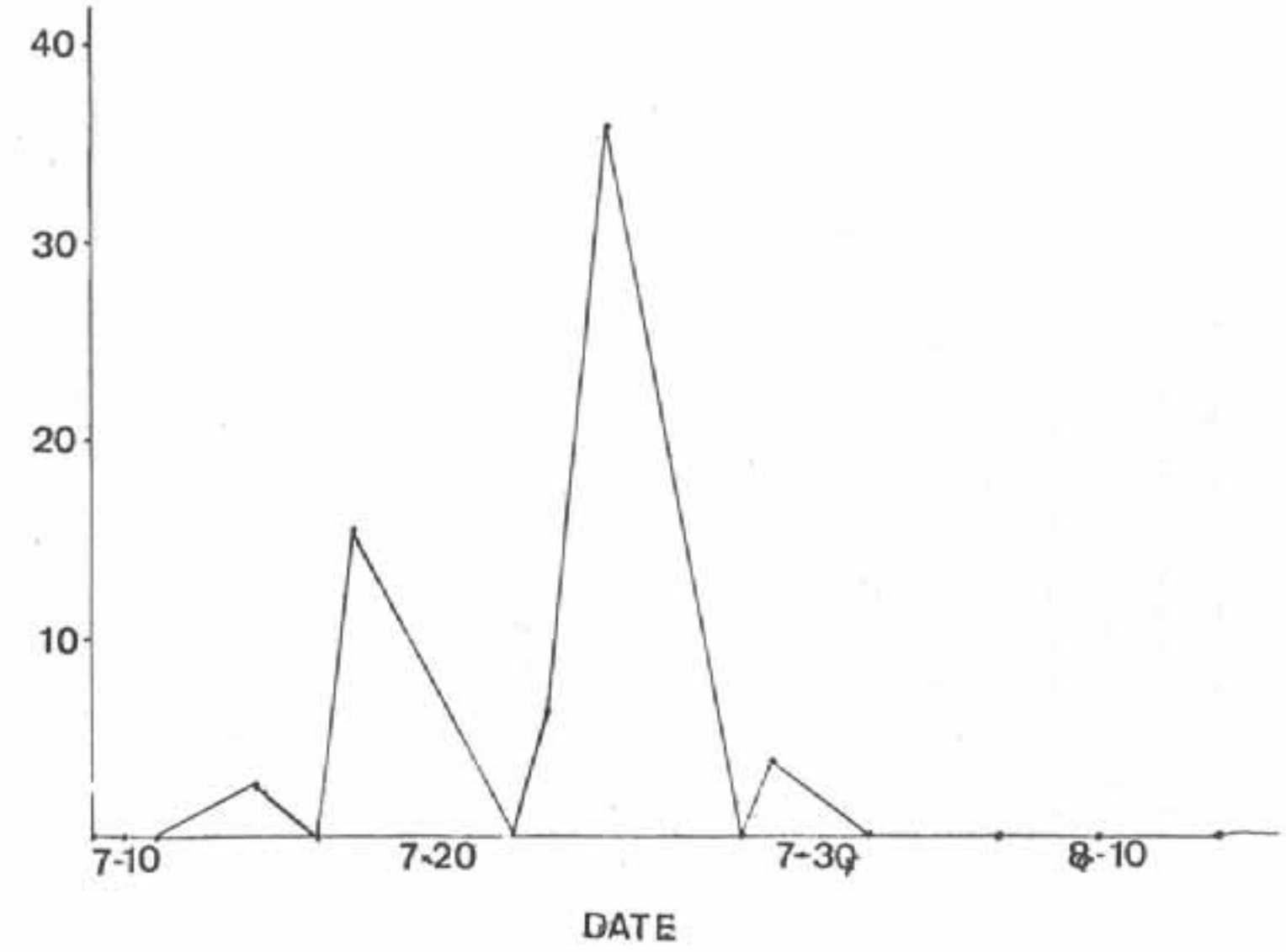
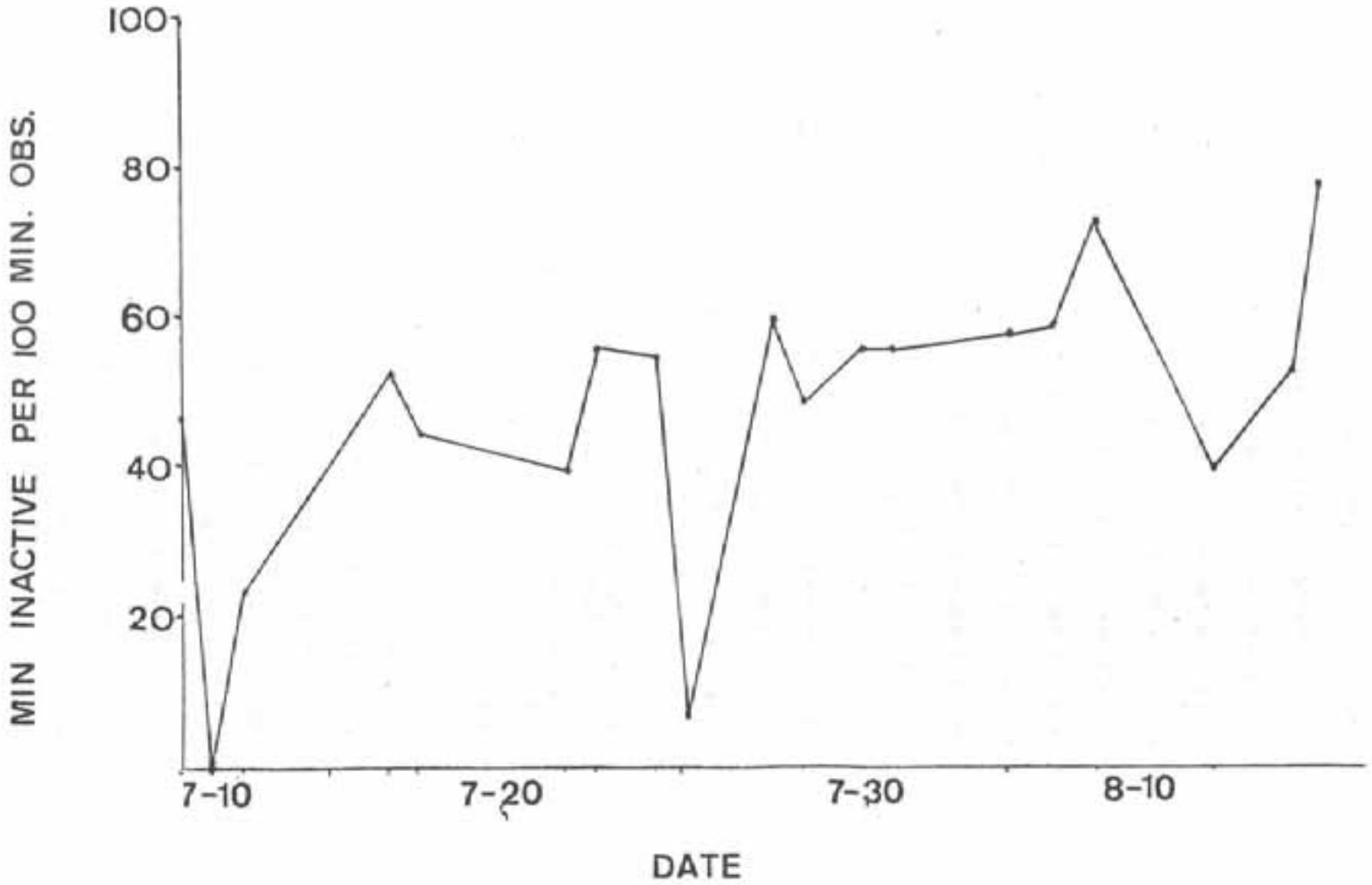


FIG. 3 TIME SPENT IN INACTIVITY DURING JULY AND AUG., 1978, BY LAMBS OF THE MIDDLE FORK.



increased early and gradually continued to increase throughout the summer. Time spent feeding on vegetation (Figure 4) was quite low through July then increased throughout August.

Shackleton (1973) observed grazing by lambs from low quality populations by two weeks of age. Long periods of grazing, lasting over two minutes, were observed at that early age. The high quality population did not have sustained periods of grazing until lambs were at least five weeks of age. Lambs of the Middle Fork population sustained grazing periods when four weeks old, if not sooner. The intensity of grazing declined again but then slowly increased through the summer.

Table 4 presents numbers of observed bighorn mortalities during each of the three years. In 1976 the first three lamb carcasses were frozen and necropsies were performed at the Sybille Wildlife Research Unit. All three lambs were underweight at 11, 12, and 13 pounds respectively (5.0, 5.4, 5.9 kg) (Thorne, pers. comm. 1980).

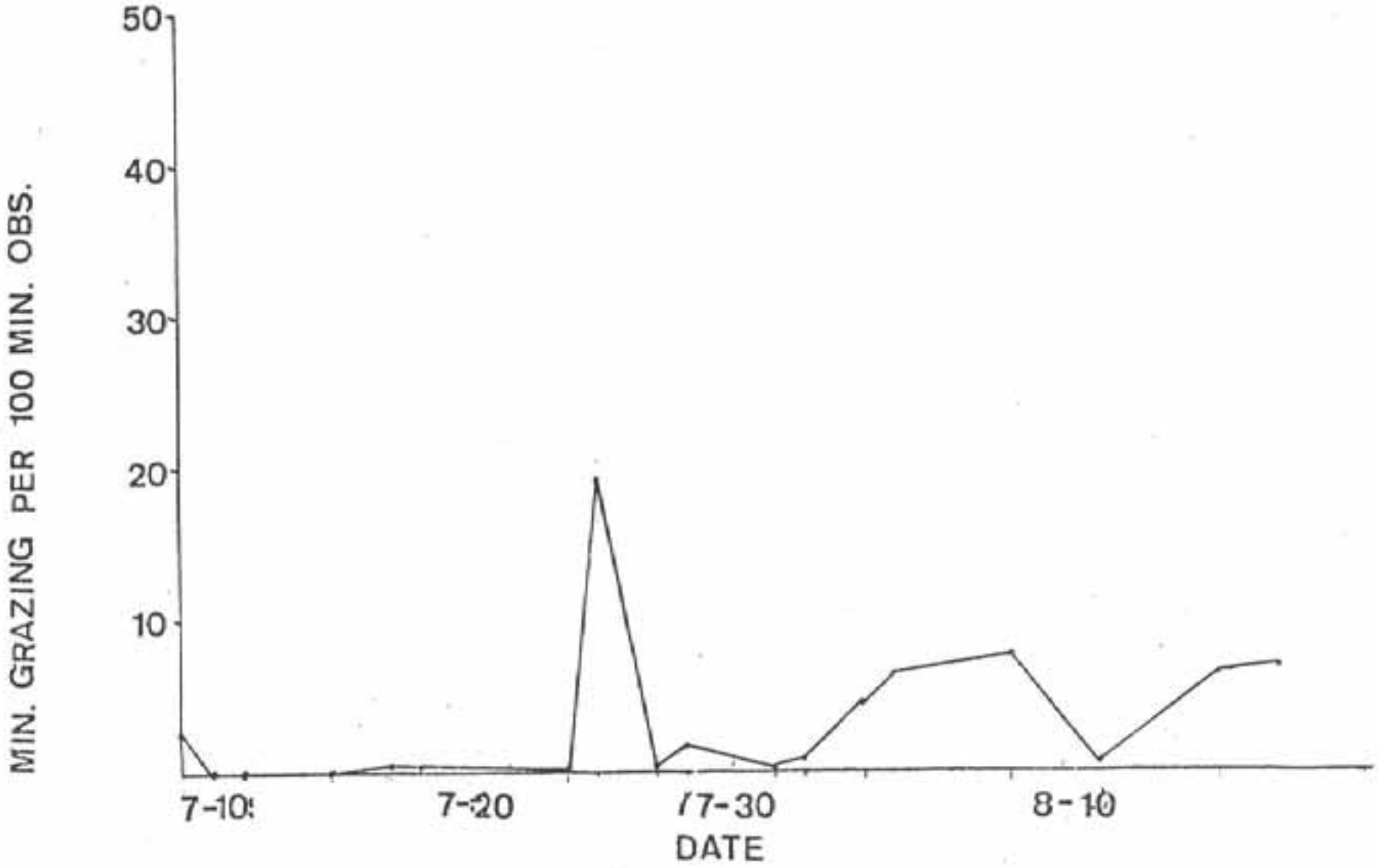
Table 4. Observed bighorn mortalities among bighorn sheep of the Middle Fork during the summers, 1976, 1977, and 1978.

YEAR	EWES	RAMS	LAMBS*
1976	0	0	5-10 (12)
1977	4	1	6 (7)
1978	3	2	3 (4)

*June population is in parentheses.

Cause of death was believed to be lungworm-induced pneumonia. All three lambs died after a cold rainy night with dense fog.

In 1978, a lamb showed the same signs and died following the pattern. It died during a cold, rainy period, but its carcass was never collected for necropsy. The other two lamb mortalities in 1978 were not expected since the lambs appeared in fair to good health and no inclement weather


MIN. GRAZING PER 100 MIN. OBS.
50
40
30
20
10
7-10
7-20
7-30
8-10
DATE

occurred during the period when they were thought to have died.

The lamb in poor condition and one healthy appearing lamb were seperated from their dam and apparently died shortly after. In both cases, the dam exhibited abnormal behavior by walking and running along the canyon rim occasionally emitting bleating sounds. Both ewes remained near where they lost their lambs for over 24 hours. The lambs were never seen again.

Four of the adult sheep mortalities in 1978 occurred in spring and one death of a ram occurred in mid summer. Spring, 1978, had above normal precipitation with a severe storm dropping up to five feet of snow on the area. This increased precipitation may have made forage inaccessible for a period. All four of these sheep had red, gelatinous bone marrow, which indicates poor nutritional condition prior to death (Cheatum 1949). A fisherman discovered the fifth adult bighorn sheep in early August. The carcass was never found by the investigator, so cause of death was undetermined.

A summary of lungworm larvae counts is given in Table 5. Counts of over 700 larvae/gm fecal sample were reduced to 178.7/gm fecal material after the fenbendazole treatment. The counts remained below 200 the entire summer and even decreased between July and August.

Table 5. Average number of lungworm larvae present in bighorn feces from the Middle Fork, 1978.

PERIOD	COLLECTION DATE	NO. OF SAMPLES	LARVAE PER GM FECES	NO. OVER 700
pretreatment*	1/3/78	21	731.5 (0.8-3200.0)	8
post-treatment	1/9/78	26	178.8 (0.0-1232.8)	3
	1/17/78	15	122.9 (0.0-1216.0)	2
	7/10/78	20	185.0 (8.7-917.6)	1
	8/16/78	22	70.9 (0.4-406.6)	0

*Treatment for lungworms was accomplished with fenbendazole in apple pulp bait. Ninteen sheep treated with cambendazole were introduced on January, 1978.

Numbers of larvae passed during winter by most mature ewes from Whiskey Mountain were as high as the average 566 larvae per gm of feces passed by bighorn ewes on Pike's Peak, Colorado during a period of high lamb mortality (Thorne et al. 1979). In the Canadian Kootenays during an extensive sheep die-off, an average of 1,072 larvae/gm of feces were present (Stelfox 1974).

DISCUSSION

For some reason the bighorn sheep population on the Middle Fork of the Powder River is not expanding but has declined since its introduction in 1974. The bighorn sheep were originally transplanted from the Whiskey Mountain populations. Two other transplants that originated from Whiskey Mountain were the Encampment and North Platte population. The Encampment herd, established in 1976, is located in southcentral Wyoming, along the eastern flank of the Sierra Madre Range. The area includes 20,142 acres within the Encampment River Drainage. This population has shown a 25% increase rate in 2.5 years (Haas 1979). The North Platte bighorn sheep population was established in 1970 on on the western slope of the Snowy Range. This herd showed a 50% increase in its first four years (Muchmore 1974).

Physical comparisons of the habitats of these areas show the most notable difference is in elevation. The Middle Fork's highest elevation (7000 ft.) equals the low elevation of the other two herd introduction sites. This may be significant in determining differences in forage quality greater in areas of higher elevation.

In all three areas the average group size for each transplant was about sixteen individuals (Table 6). The total number of bighorns introduced into the Middle Fork was almost double that of the Encampment population and triple that of the North Platte population. Another

difference is in the ram:ewe ratio with that of North Platte being much higher than either of the other areas.

Table 6. Transplant statistics for three Wyoming transplant populations.

POPULATION	DATE OF TRANSPLANT	NUMBER	RAM:EWE	% LAMBS	TOTAL TRANSPLANT	POP. EST.
Powder River	Jan. 1974	4	30:100	37	127	16 (1978)
	Feb.	17				
	Feb.	14				
	Feb.	15				
	May	10				
	Dec. 1975	29				
	Jan. 1976	19				
	Jan. 1978	19				
Encampment	Jan. 1976	30	35:100	45	69	98 (1978)
	Jan.	16				
	Jan. 1977	6				
	Feb.	17				
North Platte	Jan. 1970	13	58:100	54	41	200 (1977)
	Feb.	14				
	Feb.	14				

Haas (1979) noted a difference in food habits between bighorns of Whiskey Mountain and Encampment. These differences indicated an adaptability by bighorns to a variety of forage types. Wheatgrass and fescue were consumed in large quantities where available, but bighorns preferred needlegrass and sedges. According to a range survey done on the Middle Fork (Guest 1971) these four species were present though their availability is unknown.

The quality of forage on the Middle Fork is also undetermined. Guest (1971) determined the majority of the Middle Fork area to be in either high fair or low good range condition. Other ungulate herds in the area maintain stable populations which indicates forage quality to be sufficient for these species. Approximately 350 elk winter on the study area with

100 of those remaining year round. The mule deer population is estimated at 250-300 and there is an expanding pronghorn population of 30-50 individuals. All of these population appear to be expanding or stable (Wilson, pers. comm. 1980). Inter-specific competition could be a problem, especially if forage quality is low. Elk have been found to be important competitors with sheep (Haas 1979; Cowan 1947; Honess and Frost 1942).

By comparison the Encampment area had 150 elk and 300 mule deer during winter. Those population densities were below that of the Middle Fork Unit. Haas (1979) suggested some competition may have occurred between elk and bighorn sheep within the Encampment unit. It is quite possible that competition between bighorn sheep and other ungulates occurs on the Middle Fork.

Transplanted sheep were treated for lungworms on both the Middle Fork and Encampment areas. Pregnant ewes in a declining bighorn herd in Colorado were treated with cambendazole and treated ewes showed an increased lamb survival. Treatment had little effect on lamb survival rate of the Middle Fork herd. It has been determined that lungworms are not the primary cause of bighorn deaths (Morgan 1970; Thorne et al. 1979). Poor health of the bighorns may be due to poor quality forage, leaving them more susceptible to lungworm parasites. Getting rid of lungworm does not necessarily eliminate the primary problems.

CONCLUSION

Lungworm treatments were conducted in an attempt to increase lamb survival of the Middle Fork of the Powder River bighorn sheep population. As a result of the treatment, lungworm larvae counts did show a decrease, however, increased lamb survival did not occur. Lungworm could have

reduced the health of the population, however it did not cause the high lamb mortality. An evaluation of forage quality and quantity may reveal inadequacies in the forage resource. No more sheep should be transplanted into the Middle Fork until further analysis is performed.

Future bighorn sheep introductions to other areas should not be made without thorough evaluations of forage quality and quantity. Possible sources of competition with other ungulates must also be considered.

ACKNOWLEDGMENTS

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Dwight Smith: How about the habitat preference down in the steep canyons, were you getting that much direct competition from deer and elk on the areas the sheep were occupying?

Amber Long: I saw deer down in the canyon; same areas that the sheep were in though the sheep generally grazed in early morning and late evening up on the top grass areas in the same place that I saw all the deer. There was some grazing down in the canyon, but I would say that mostly they got their forage from the upper grasslands. So, where as direct competition may not be the problem, you might have competition for space. The sheep are only going to use, say up to maybe ¼ mile from the canyon. You put elk there too, and there isn't much place for the sheep to go.

Tom Butts: In your impression how similar is that to say, Encampment the area just in habitat, availability of habitat in the North Platte and Whiskey Mountain areas; is that similar or not?

Amber Long: I noted that the rainfall is the same, mean temperature is a bit the same. The major difference is in elevation. The Middle Fork doesn't go above 7,000 ft., whereas at Encampment and North Platte they do not go below 7,000 ft. In "65", Kline discovered that at higher elevation you have higher quality forage. That might be playing a part in this; I couldn't say for sure, only speculation at this point.

Tom Butts: Almost all your grassland in the area you looked at was on that plateau before it dropped off, right?

Amber Long: Right.

Tom Butts: Did the other two have grassland on steep slopes interspersed with escape terrain, or anything like that?

Amber Long: Just looking at Wendy's pictures before this, in that area I would say there was a difference.

Tom Butts: What's Whiskey Mountain like?

Amber Long: Whiskey Mountain, I haven't seen the area that much myself, although I have backpacked there. I think it looks more similar to the Encampment area than it does to the Middle Fork.

Malcolm Ramsey: Two questions, Amber. One, is there any possibility that your censusing method might be missing sheep, that perhaps as some of the other populations we've discussed today, the sheep might have emigrated away?

Amber Long: Emigration could definitely be a factor. When the 19 sheep were put in the area, one ewe was found halfway between Whiskey Mountain and the Middle Fork which is, it was seen just before it entered the Indian reservation, a substantial distance. It was never seen or heard from again. It's the general

impression of the Game and Fish (Wyoming Game and Fish Department) that the sheep have not migrated in any substantial numbers and established elsewhere, because if they had they would have been reported. Around the study there it is primarily private land, BLM land, with a lot of grazing and other human activity and the sightings just have not occurred.

Malcolm Ramsey: The other question was related to nutritional problems. Is there any evidence that the physical condition of the sheep is bad?

Amber Long: The physical condition of the lambs is extremely bad, generally right before I had assumed that they had died. As far as the adults go, they appeared in, I would say, fair condition, but I've not seen that many other bighorn sheep so I don't really have much to compare to. However, out of those 5 mortalities, the 4 that I found, I checked the bone marrow and in all it indicated malnutrition prior to death. The stickler on all the competition is, that those elk, mule deer and antelope that are in the area are all either stable or expanding. So those ungulate populations are not being hurt. For some reason the bighorn sheep are.

Matt Kniesel: Is Wyoming Game and Fish doing any follow-up study on this to determine whether it was nutrition, whether it was physical condition or they can relate back to the physical of these animals, are they doing anything to determine why now that transplant was not successful?

Amber Long: No they're not. In fact, last January they transplanted 19 more sheep in the area.

Marvin Hockley: It was 11 not 19.