A. No particular age goal. One of our goals is not to go the full curl ram hunting, or something like that. It is getting to be a monetary thing in Montana. We have some outfitters charging as much as $5,000 for a ram.

DIFFERENCE BETWEEN YEARS AND NUTRIENT CYCLES

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Sheep, (Ovis canadensis canadensis) along with most other ungulates of the mountainous areas of Canada, undertake seasonal migrations to and from high alpine ranges. The downward migration appears to be weather induced while the motivation for the upward movement appears to be food oriented. The known facts of phenology and the associated changes in the chemical composition of plants suggests that one of the probable advantages to be gained is improved nutrition.

A group of adult ewes (1967-68) were maintained on a variety of forages (ration 36-57, alpine, winter) which changed in quality with season. During 1968-69, two groups of yearling sheep were maintained, one on winter range forage year-round while the other was changed from winter to alpine range to simulate the normal migratory pattern.

The winters of 1967-68 and 1969-70 could be considered mild with a light snowfall and relatively mild temperatures. This resulted in a short critical winter period (January and February) of both years and an early spring green-up. Precipitation was lowered, presumably resulting in lowered productivity and reduced succulence of the forage. The light snowpack of the two years did not knock down over-wintering forage and therefore did not allow ungulates to graze much of the spring growth until it reached 4 to 6 inches in height and in some cases emerged from the previous years growth. Observations showed that considerably less spring growth had been grazed in 1968 than in 1969. This is believed to have reduced the average nutrient intake of sheep grazing on the winter ranges during the early spring. The proportion of old growth to new, available to sheep is shown in Table 1.

The winter of 1968-69, although harsh resulted in many beneficial side effects. The abnormal snow depths produced abundant soil moisture and resulted in greater subsequent forage productivity as compared to the summer of 1968. In June a record rainfall of 6.02 inches caused forage to remain green and succulent later into the summer and greatly aided productivity. The extreme weight and compaction of the winter snow flattened all of the past years growth and allowed spring growth to emerge from old growth when only one to two inches in height (Table 1). This resulted in deer, sheep and elk utilizing the earliest spring growth in late March and early April.

Observations on the grazing habits of a tame bighorn lamb indicated the difficulty of a grazing animal to select high quality feed when old growth protected new growing forage. Bighorns tend to pull

Forage description	Date				
	1968	1969	1970		
Percent dry matter	July	July	May	June	July
	52	95-100	[illegible]	[illegible]	84.8
Percent dry matter	41	45	60.8	35.4	37.2

Table 1. The proportion of previous year's forage to the current year's growth, using Dahomian wheatgrass as the indicator species. (Percentages based upon field dried weights).

Date	Winter Range	Percent CP.	D.E. Mcal/kg
1968			
June 24	Bull River	7.8	4.11
July 24	Wigwam	5.9	4.31
1970			
June 15	Premier Ridge	10.1	4.45
July 1-20	" "	5.97	4.15

Table 2. A comparison of crude protein and gross energy values, for similar dates, between years, for diets approximately similar in species composition and phenology.

Animal group	Composition of diet	Date of collection	Average digestibility
[illegible]	Agropyron 65 percent	1908 June 5	54.3
[illegible]	"	July 2	50.6
Yearling ewes	Agropyron 65-70 percent	June 1-10	71.6
" "	Agropyron 65-90 percent	July 1-10	50.6

Table 3. A comparison of digestibility between years (1908 and 1909) on forages approximately similar in species composition and productivity.

grass blades from their sheaths rather than nip them off. This has recently been supported by Geist (1971, p.268) who suggests that a pulling or plucking type of grazing increases the nutrient content of each mouthful. During 1968 bighorns ingested considerable quantities of old growth while grazing in this fashion but not in 1969 when only new growth was available.

In early June, 1968 and 1970, previous year's growth comprised 65-75 per cent of the standing forage crop (Table 1) while in 1969 it was considerably less. This produced a 2.5 per cent difference in absolute crude protein values between June of 1968 and 1969. In July of both years crude protein content was similar, as current year's growth forms the bulk of the standing crop. Alpine forage sampled at approximately the same date in both years, contained similar quantities of crude protein, since no previous year's forage is present.

Similarly, gross energy of forage cut during June of 1969 is considerably higher (Table 2) than that cut in June of 1968 (difference of .34 Kcal/gm). During July the difference is reduced (.10 Kcal/gm) with the 1968 forage containing more gross energy than the 1969 cut forage. Alpine forage cut in August of 1969 contained approximately .13 Kcal/gm more gross energy than that of 1968.

Another component of the difference between the 1969 spring vegetation and that of 1968 is seen in the comparison of June and July digestibilities of experimental diets. In 1969, the digestibility of the June sample was significantly greater (26 per cent) than that of the July sample. In 1968, on the other hand, (Table 3) the digestibility was the same in June as in July and both were at the level of July 1969.

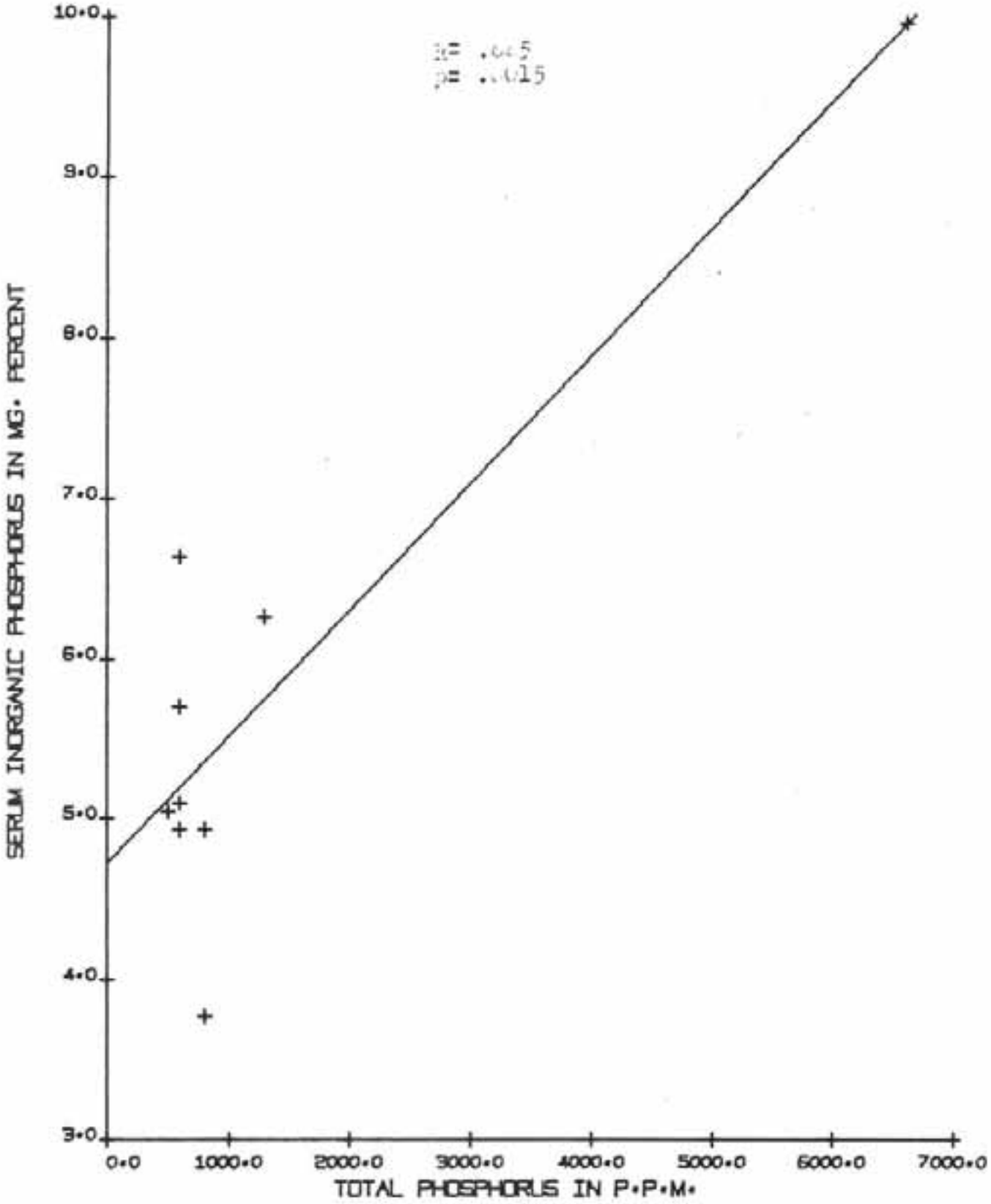
The situation of 1969 is considered "normal" when the proportion of old growth is minimal and does not mask the change in quality. Thus, the drop in digestibility from June to July is a direct result of the reduction in quality of the forage rather than to a change in composition.

Preliminary work during the summer of 1968 indicated definite yearly changes in crude protein and gross energy in winter range plants. Differences between summer and winter range plants indicated sufficient potential benefits to migrating animals to warrant a more extensive investigation in 1969.

In 1969-70, approximately 6,000 pounds of natural winter and summer range forages was selectively cut using hand clippers and in some cases a sickle mower, where the vegetation was sufficiently uniform. Diets were formulated on the basis of field selectivity trials using an imprinted bighorn lamb, pen selection trials, actual observation, availability of the forage and a review of the literature.

Periodic sampling was undertaken to document the course of the change in protein, energy and phosphorus values throughout a 12 month period, from initiation of new growth in April.

This indicated that CP declined from about 18 per cent to 2 per cent on the winter range while GE changed from 4.40 Kcal/gm to 4.1 Kcal/gm. Subsequently, on the summer range CP declined from about 17 to 11.6 per cent from July to October but changed minimally from November to May 18 (9.2 to 7 per cent CP). In contrast GE increased from about 4.44 Kcal/gm to about 4.56 Kcal/gm in the same period.


R= .645
P= .0015
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
SERUM INORGANIC PHOSPHORUS IN MG. PERCENT
0.0
1000.0
2000.0
3000.0
4000.0
5000.0
6000.0
7000.0
TOTAL PHOSPHORUS IN P.P.M.

The annual cycle of phosphorus parallels that of crude protein. Maximum phosphorus values of winter range grasses, mainly bluebunch wheatgrass and rough fescue, reached 2,600-2,800 ppm. in April but had declined to 1,600 ppm. by early July. Decline was abrupt between July and September, with a total decline for the period of about 57 per cent. Late winter values of 500 ppm. represented about an 81 per cent loss from maximum values, the previous spring. Declines are minimal from early to late winter, during the period when forage is frozen.

The alpine range, with its later commencement of growth, reached maximum levels toward the end of July (3,000 ppm.) and maintained these throughout August. By freeze-up in late September values had declined 56 per cent to 1,300 ppm.

Serum phosphorus showed minimal change while the sheep were on winter range forage (Hebert, 1972, J. of Range Mgmt. In Press). The relationship between serum and forage phosphorus is given in Figure 1 and is significant.

Winter range forage satisfied the requirements for phosphorus for gestation until June but were below the lactation and winter requirements. In contrast the summer range met requirements year around.

Literature Cited

Geist, V. 1971. Mountain Sheep. A study in behaviour and evolution. The University of Chicago Press. Chicago 383 pp.

Hebert, D. 1972. Serum and forage phosphorus values in bighorn sheep. J. of Range Mgmt. In press.

D. Hebert - Question Period

Q. Did you determine the phosphorus levels in individual species and did you find a correlation between the phosphorus levels you had in the winter time and the percentage of the diet that were forbs? Did you increase the content of your forbs?

A. I didn't look at that aspect. I know that in other work forbs were generally higher in phosphorus than were grasses, and you could manipulate the phosphorus content by changing your forb content. My diets were mainly grass diets. The forb component of the winter range areas was fairly small. On the alpine areas I imagine you could manipulate phosphorus content substantially by changing the forb component of the diet.

Q. Have you any data on protein levels of shrubs on winter range compared to grasses?

A. No. I didn't do individual species. There is a student working in that same area now on individual grass species, so I hope eventually to relate that to what I have done on nutrient changes in the diet.

Q. Did you supplement your lamb when it was on your forage trials?

A. No, my lamb was not supplemented.

Q. Was he strictly on natural forage?

A. Right.

Q. Does pen raising affect selection of forage?

A. From some of the work done by Longhurst I think it probably is very close to that which they would select in the wild. Their pen raised young animals selected virtually the same dietary composition as the adult animals taken in from the wild.

Q. You mentioned last night you were able to keep a sheep alive for a considerable time on a protein level down to 2 per cent - that was for how long?

A. Their diets contained approximately 3 per cent crude protein from October until February and 2 per cent until April.

Q. Have you any information to show changes in productivity with the various protein levels?

A. No, I was strictly interested in nutrition. I noted weight changes in various blood components and differences in digestibility, etc.

Q. Have you seen anything in the literature correlating winter protein levels and production?

A. Some of the work on deer, yes, but not on sheep.

Q. It does show correlation though?

A. Yes, I think so. Other workers used animals prior to the production stage. I think it would complicate things to get into productivity along with nutrition at this stage. A lot of the work done by Ullrey with pregnant white-tailed deer indicates that when he gets some of his animals down to the maintenance level he has the female decreasing its body weight and the fetus increasing its body weight and he may have a situation where the female actually is in negative nitrogen balance prior to what he thinks it is.

Q. Do you have any weights of the lambs you were holding?

A. Yes, I have weights for the whole year. The animals were measured weekly and before and after each trial.

Q. What would be the maximum weight?

A. By the time we reached the end of the alpine forage trial he was just over 100 lb. During the first year I kept him on maintenance and sub-maintenance diets, from weaning throughout the winter. There was considerable compensatory growth through the second summer and he picked up weight quite rapidly. He may have been 10-20 lb. heavier if he had been on a normal diet the first year without the compensatory growth.

Q. What is the lowest level of protein necessary to produce death of an animal.

A. I don't know - I didn't have any animals die. I am sure the group that was on winter range forage year around were pretty well at rock bottom by the end of that winter. We did a lot of blood work on them, such as blood urea, various minerals, hematocrit and hemoglobin. The animals were in extremely poor condition and I am sure if they had been out on the range with any kind of heavy snow or any other stress, they probably would have died, but under the pen conditions they probably stayed alive longer.

Q. You maintained the imprinted lamb at 36 lb. throughout the first winter of his life?

A. Yes. He was weaned at 20 lb. and for about 2 months while the temperature was fairly warm - September and October - he gained weight and then the temperature went down below freezing and he began losing weight for the rest of the winter. They were on maintenance diets. The established maintenance protein diet is about 6-7% and most of the diets I used were 5-6%. The second year he gained about 70 or 80 lb.

Q. Did you have this animal treated for worms or anything else?

A. No, I didn't use any such treatment. I didn't give them any antibiotics and I didn't treat them for any intestinal parasites.

Q. How did you prevent stressing? Did you keep them among people early in life?

A. Right. We kept them in the house for about the first 2 months of their life. He was imprinted so that he would come when he was called. I don't think he underwent too much stress at all. We checked the degree of stress through blood sampling procedures. We stressed some of the other animals and compared their SGOT values to his. There was virtually no change in his blood value, whereas there was a change with some of the other animals.

Q. The older animals - how did you keep them penned?

A. These animals were in metabolism pens at all times. The pens were 6 x 8 ft. in size. I had all the pens connected for purposes of weighing.

POST DIE-OFF RECOVERY OF EAST KOOTENAY BIGHORN SHEEP

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Introduction

Rocky Mountain bighorn sheep suffered severe losses in the East Kootenay of British Columbia during the mid-1960's. Bandy (1966) documented and described the etiology of the die-off which was ascribed to a pneumonia-lungworm-malnutrition complex.

Detailed population composition records have been obtained for most herds of bighorn in the East Kootenay since the early 1960's by the B.C. Fish and Wildlife Branch. The Wildlife Research Section has undertaken a comprehensive analysis of the population data with the objective of describing the dynamics of the area's bighorn population before, during and after the die-off. This paper presents a review of the changes in total numbers as a result of the die-off, a comparison of the post die-off response in two discrete herds and progress in bighorn habitat management and protection.