



Range vegetational types, range condition, and range sites in relation to the incidence of Urolithiasis in range cattle  
by Karl G Parker

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Montana State University  
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**Abstract:**

This study treats the relationship of range vegetational types, range condition, range sites, and other characteristics of range land environment to the incidence of urolithiasis (water-belly) in steers. It is an exploratory study.

Ranch units were studied in pairs. The two ranch units in a pair were selected for contrasting experience with urolithiasis and for as much comparability as possible as to size of unit, kind of cattle, climatic conditions, soils, and management.

Information was obtained by actual visits to ranches over a period of two years. Twenty-five ranches were selected for study. Range condition was determined with the use of the Soil Conservation Service range condition guides.

A corollary study of range forage mineral content of seven important grasses and one sedge was conducted. Samples were taken from one location at two-week intervals from May through January and at monthly intervals from February through April. Grazing samples and water samples from paired ranch units were also analyzed.

The percentage of incidence of urolithiasis varied widely in the six vegetational types encountered; Incidence of the disease in vegetational types containing a substantial amount of palatable shrubs was approximately one-tenth that of the vegetational types containing only grasses or grasses and unpalatable shrubs.

There appeared to be no regular relationship between the incidence of urolithiasis and range condition. In several instances, ranches in a higher state of range condition had a higher incidence of urolithiasis than units with lower range condition. There were fewer instances to the contrary.

Where overflow and saline upland sites were grazed independently of clayey and savannah sites, there was only a low incidence of urolithiasis. Incidence of the disease was high in savannah (pine) sites.

During each of the two years of this study, the seasonal incidence of urolithiasis varied markedly. A theory is offered, that because of snow cover on range, reduced intake of cured range grass together with increased feeding of good quality hay, were effective in reducing) the incidence of urolithiasis in the winter of 1955-56.

The study of minerals in range forage in relation to incidence of urolithiasis revealed a highly significant relationship between the amount of phosphorus, calcium, magnesium, and silica and the disease. The relationship was positive in the case of silica and negative in the case of the other minerals.

A distinct annual trend in the amount of silica in seven range grasses and one sedge was traced. It was highest during December and January and lowest during the rapid growth stages in June and July, Seasonal trends in silica coincided with the seasonal trends in urolithiasis.

Calcium had a similar trend to that of silica but seldom exceeded .30 per cent. Potassium, magnesium, and phosphorus were higher in the summer and lower in the winter. Additional research is needed.

RANGE VEGETATIONAL TYPES, RANGE CONDITION, AND RANGE SITES  
IN RELATION TO THE INCIDENCE OF UROLITHIASIS IN  
RANGE CATTLE

by

KARL G. PARKER

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### ABSTRACT

This study treats the relationship of range vegetational types, range condition, range sites, and other characteristics of range land environment to the incidence of urolithiasis (water-belly) in steers. It is an exploratory study.

Ranch units were studied in pairs. The two ranch units in a pair were selected for contrasting experience with urolithiasis and for as much comparability as possible as to size of unit, kind of cattle, climatic conditions, soils, and management.

Information was obtained by actual visits to ranches over a period of two years. Twenty-five ranches were selected for study. Range condition was determined with the use of the Soil Conservation Service range condition guides.

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The percentage of incidence of urolithiasis varied widely in the six vegetational types encountered. Incidence of the disease in vegetational types containing a substantial amount of palatable shrubs was approximately one-tenth that of the vegetational types containing only grasses or grasses and unpalatable shrubs.

There appeared to be no regular relationship between the incidence of urolithiasis and range condition. In several instances, ranches in a higher state of range condition had a higher incidence of urolithiasis than units with lower range condition. There were fewer instances to the contrary.

Where overflow and saline upland sites were grazed independently of clayey and savannah sites, there was only a low incidence of urolithiasis. Incidence of the disease was high in savannah (pine) sites.

During each of the two years of this study, the seasonal incidence of urolithiasis varied markedly. A theory is offered, that because of snow cover on range, reduced intake of cured range grass together with increased feeding of good quality hay, were effective in reducing the incidence of urolithiasis in the winter of 1955-56.

The study of minerals in range forage in relation to incidence of urolithiasis revealed a highly significant relationship between the amount of phosphorus, calcium, magnesium, and silica and the disease. The relationship was positive in the case of silica and negative in the case of the other minerals.

A distinct annual trend in the amount of silica in seven range grasses and one sedge was traced. It was highest during December and January and lowest during the rapid growth stages in June and July. Seasonal trends in silica coincided with the seasonal trends in urolithiasis.

Calcium had a similar trend to that of silica but seldom exceeded .30 per cent. Potassium, magnesium, and phosphorus were higher in the summer and lower in the winter. Additional research is needed.

## INTRODUCTION

### Background

Beef cattle production is one of the most important agricultural enterprises of the West and, in fact, of the entire United States. It has been estimated (Clark, 1955) that over half, or 950 million acres, of our total land area is range land. This land furnishes forage for about one-half of our cattle and three-fourths of the sheep while at the same time providing forage for wild life.

The 1950 agricultural census reported that 75.5 per cent of all farms and ranches have cattle as a part of the enterprise. In the state of Montana, cattle and sheep graze a total of approximately 60 million acres of range land.

One of the problems which reduces the efficiency of the livestock operations is urolithiasis. This disease is commonly known as urinary calculi or water-belly.

Among range men, urolithiasis is commonly thought of as being strictly a range problem. Livestock feed-lot operators think of it as being strictly a feed-lot problem. It is actually common to both types of enterprises.

Numerous research projects devoted to this problem have been conducted over a period of years. Practically all of these studies were devoted to finding the cause of urolithiasis as it occurs in feed-lots. So far, the cause of the feed-lot urolithiasis has not definitely been established. Because a majority of the cattle enterprises of the West depend, to a large extent, upon range it is obvious that more information is needed on the relationships between the various characteristics of range land and the

incidence of urolithiasis.

This thesis is primarily limited to cattle and the range upon which they graze. Occasional reference will be made to range sheep, feed-lot sheep, and feed-lot cattle.

The fact that urinary calculi is almost universal, although less intense in some areas than in others, has produced a large interplay of theories as to reasons for the occurrence of the disease.

In an effort to solve the problem, single factors such as quality of water, quantity of water, and vitamin A have been selected and manipulated. Numerous such efforts have resulted in disappointment. All this has resulted in the conclusion that the urinary calculi problem is complex beyond understanding.

In the meantime, numerous ranchers in the great plains short grass and mixed grass vegetational types have been forced to accept steer losses during the winter as a normal occurrence. Steer losses on ranches familiar to the author range from none to as high as 25 per cent.

Losses are not limited to desexed males or even to males. Female cattle are also known to suffer from urolithiasis (Mathams and Sutherland, 1951).

It is reasonable that with the great diversity in plant species on the range, both with regard to abundance and chemical composition, that certain plant associations may have profound effect on the animal health, and thus on efficiency of production. This area of range science is relatively unexplored, particularly in regard to the incidence of urolithiasis.

The nutritional requirements of cattle have been quite well known for some time. That range "grasses" furnish all of the nutrients needed and in the right proportion has been taken much for granted. It has not seemed very necessary to base range grazing practices on a knowledge of nutritional values of range forage and seasonal variations in the nutrients of range plants including minerals, carbohydrates, vitamins, and proteins. A better understanding of the qualities of range forage in the various vegetational types and of range conditions and sites might contribute to greater efficiency in the use of the great range resource. Although this thesis is devoted to the study of range and range plant characteristics in relation to one common problem, the information derived and the knowledge gained may be of general use.

#### Objectives

The prime purpose of this project is to establish practical means by which ranchers may reduce the extensive losses due to urolithiasis in range cattle. The problem is approached with full knowledge of its great complexity.

This is an effort to develop a better understanding of factors which may or may not be related to this range problem. It is an exploratory study. Possibly a most worthy objective of this project is to establish one or more reasonably sound bases for more intensive research into this problem.

## REVIEW OF LITERATURE

The urolithiasis or urinary calculi problem is not a new one. Mr. Charles M. Holliday, long time rancher near Martinsdale, Montana, related his experience in operating on "water-belly" cattle in 1895.

That the malady existed during the earlier days in western agriculture history is not contradicted. However, there is considerable disagreement as to whether or not incidence is higher now. It is the consensus of opinion among many younger ranchers that the incidence of water-belly has increased during the past twenty years. "Urinary calculi, which lead to the condition commonly called water-belly, are becoming increasingly serious as a cause of death in cattle and lambs in Colorado." (Deem, 1950).

One correlation study, (Peters, 1953) on the range phase of the urolithiasis problem, was conducted by the Canadian Department of Agriculture. Questionnaires were sent out by mail to ranchers. Feed and water samples were collected from ranches in southern Alberta and Saskatchewan. Samples were subjected to chemical analysis. Results of this study were inconclusive.

A recent survey of problems and practices of the American cattlemen, conducted cooperatively by the Washington State College Experiment Station and the American National Cattlemen's Association (Ensminger et al., 1955), stated that 60 per cent of all reported nutritional disease death losses were attributed to bloat, poisonous plants, and urinary calculi. The specific percentage attributed to urinary calculi alone was 13.1 per cent.

Table I shown on the next page was compiled from the above study.

TABLE I. THE FREQUENCY OF URINARY CALCULI (IN PER CENT OF ALL NUTRITIONALLY SICK CATTLE) COMPARED TO OTHER NUTRITIONAL DISEASES AND AILMENTS, BY REGIONS IN 1954

| Disease               | Western States<br>Except Great Plains | Great<br>Plains | Southern<br>States |
|-----------------------|---------------------------------------|-----------------|--------------------|
| Bloat-pasture         | 8.25                                  | 22.94           | 52.85              |
| Vitamin A             | 42.24                                 | 15.33           | 12.29              |
| Bloat-feed-lot        | 14.68                                 | 17.43           | 6.18               |
| Poisonous plants      | 8.70                                  | 4.46            | 4.11               |
| URINARY CALCULI       | 6.11 (5th)                            | 18.61 (2nd)     | 1.48 (7th)         |
| Grass staggers        | 4.10                                  | 4.19            | 2.97               |
| Flourine poison       | 4.20                                  | .39             | 0.59               |
| Pine needle abortion  | 3.14                                  | 0.00            | 0.17               |
| White muscle disease  | 2.39                                  | 0.92            | 0.07               |
| Iodine deficiency     | 1.03                                  | 1.44            | 1.11               |
| Phosphorus deficiency | 0.45                                  | 3.28            | 1.14               |
| Sweet clover disease  | 0.16                                  | 0.39            | 1.80               |
| X disease             | 0.01                                  | 1.05            | 1.31               |
| Oat hay poisoning     | 0.23                                  | 0.00            | 0.69               |
| Oak poisoning         | 0.48                                  | 0.00            | 0.07               |
| Anemia                | 0.16                                  | 0.26            | 0.59               |
| Rickets               | 0.23                                  | 0.52            | 0.24               |
| Acetonemia            | 0.16                                  | 0.26            | 0.48               |
| Milk fever            | 0.16                                  | 0.39            | 0.03               |
| Disease not diagnosed | 0.68                                  | 0.00            | 0.24               |
| Disease not listed    | 0.81                                  | 1.57            | 5.26               |

References in literature to the relationships between the various characteristics of range and urolithiasis are very limited. A few authors have speculated on the possibility that certain grasses are responsible for high incidence of urinary calculi in cattle from certain areas. Mathams and Sutherland (1951) observed cows coming to an Australian abattoir from the Gympie-Eumundi district and having considerable amount of kidney stone. These two workers examined kidney specimens from aged dairy cows from that district and found that "one or several lobes of each kidney were shrunken and fibrosed. Capillary ducts of these lobes were occluded by calculi - ". Two of these calculi measured about five millimeters in diameter. Analysis showed these calculi to be composed almost entirely of silica. It was stated that the shape, hardness, and composition of the calculi suggested that they had as a nucleus a crystal of calcium oxalate (an octahedron), upon which the silica was deposited in layers.

In the presence of Mathams and Southerland, a slaughterhouse inspector of the Australian Department of Agriculture and Stock stated that similar calculi occurred occasionally in cattle from this district (Gympie-Eumundi district) but only rarely from other districts. In addition, he indicated that pastures in the Gympie-Eumundi district have a great deal of "blady grass", (Imperata cylindrica variety major), in the pastures in which they grazed. It was further indicated that this grass, which has a high content of silica, would contribute to the formation of the siliceous renal calculi.

Jones, Black, Ellis, and Keating of Texas A. and M. Agricultural Experiment Station (1949) recognized that renal calculi condition of steers in feed-lots was probably not due entirely to feed-lot environment. They

cited the fact that cattlemen in the area had attributed losses among range steers to urinary calculi. This was confirmed when eight steers were selected at random out of fifty and slaughtered immediately following delivery from range in 1941. Seven of the eight showed traces to small amounts of urinary calculi. Again in the similar tests (1948 and 1949), ten steer calves from a group of 46 were similarly selected for slaughter shortly after delivery from the range. Eight of the ten urinary bladders showed traces to small amounts of calculi.

The Texas work cited above has been carried out in cooperation with the United States Department of Agriculture, Agricultural Research Service. An administrative officer in charge of beef cattle research for that agency (Madsen, 1954) stated that analytical work on harvested feeds and some range forage samples from Texas and New Mexico, from areas where trouble from urinary calculi has been encountered, "continues to show that silicon content is often high, but variable". However, the amount of silicon contained in the range forage was not given. These workers also speculated on the presence of a relationship between the high silicon intake from range forage and the incidence of urolithiasis later on in steers on fattening rations. Madsen also noted a number of cases of urinary calculi in wintering steers, particularly in Colorado and Nebraska (Sandhills country) during early 1954. The personal experience of the writer during the period 1943 to 1951 in eastern Colorado in the mixed grass and ponderosa pine savannahs of El Paso, Elbert and Kiowa Counties of Colorado parallels Madsen's observations. Urinary calculi is a very common problem in that particular area where the soils are classed as sands to fine sandy

loams and where the snow cover is sufficiently light that steers may winter out on the range. Conversely, it was observed that cattlemen running steers on desert shrub type range in Utah encountered very little trouble from urolithiasis.

In a later experiment, Jones, et. al., (1951) found that both limestone and bone meal supplements increased the amount of calculi in range steers when placed in the feed-lot and fed a fattening ration. There was less tendency toward calculi formation in steers on a ration containing cotton seed hulls than on a similar ration containing corn silage. Steers which were lost from calculi had small amounts of sharp, small calculi in their bladders. Tiny perforations of the bladder had apparently allowed the urine to seep out into the body cavity causing (uremic) poisoning before external symptoms were actually observed.

In a follow-up project, Jones, et. al., (1953) concluded that sorghum silage which is rather high in silica is more conducive to urinary calculi formation than is cotton seed hulls. They observed the possibility that silica in the silage plays a major role in the formation of calculi.

Newsom, (1937) discussed possible contributing factors of urolithiasis in livestock. He pointed out the possibility of low water intake, vitamin A deficiency, mineral imbalance, reaction, hyperparathyroidism, infection, and urinary irritation as being possible causes of urolithiasis.

In subsequent feed-lot experiments, Newsom and co-workers (1943) produced a higher incidence of urinary calculi in sheep on a cane fodder, bran, and white corn ration than on alfalfa-beet top ration. Some interesting facts came out of the urine analyses conducted in these trials.

The total urine solids, in grams per liter, were found to be high from the sheep fed a ration of alfalfa, intermediate from those fed beet tops, and low from those fed cane fodder. Conversely the incidence of urinary calculi in the same sheep was high in those on cane fodder, intermediate in those on beet tops, and low in those on alfalfa. It was pointed out that the sheep on the alfalfa and beet top rations drank much more water and passed more urine than those on cane fodder. Insoluble precipitates formed while standing in a refrigerator were highest in the urine from sheep in the cane fodder lots. Potassium and magnesium were higher in the alfalfa and beet top rations than in the cane fodder rations. From these trials, it was concluded that alfalfa and beet tops were protective and that cane fodder, bran, and white corn were suspected of causing urinary calculi in sheep. These workers reached the following conclusions:

"A ration composed of cane fodder, bran and white corn seems more likely to produce urinary calculi in lambs than one containing alfalfa or beet tops and yellow corn.

Such a cane fodder-bran-white corn ration is low in vitamin A, has a narrow Ca-P ratio, required little water consumption, and results in a small urine output.

The urine from animals on this ration is more nearly neutral, is low in total solids and specific gravity, and on standing precipitates out a large proportion of insoluble matter.

There is some indication that calculi may develop in the presence of adequate amounts of alfalfa when excessive amounts of calcium carbonate and magnesium carbonate are fed in the form of a mineral supplement."

The interesting points in these conclusions are that grass plants (sorghum and corn) produced a higher incidence of urinary calculi than the broad-leaved type plants (alfalfa and sugar beets). It should be pointed out also that the grass plants produced a smaller flow of urine with a higher content of insoluble solids, whereas the forb type or legume plants

produced a greater volume with a higher percentage of soluble solids. Force feeding of excessive amounts of calcium carbonate and magnesium carbonate produced calculi, even in the presence of adequate amounts of alfalfa hay.

A similar experience was had by Elam and co-workers (1955). These workers added 48.3 pounds of potassium acid phosphate per ton of ration to a ration for fifteen lambs; this addition resulted in the production of eleven cases of urinary calculi. A very interesting and possibly significant innovation was introduced in connection with this experiment. When ten pounds of salt (sodium chloride) was added to the same ration at the rate of ten per cent, clinical cases of urinary calculi were entirely prevented. No decrease in feed consumption could be observed in lambs receiving this relatively high level of salt. A similar ration containing 0.5 per cent salt seemed to have little tendency to resist formation of calculi.

This project and previous work by these workers demonstrated that an increase in calculi incidence would occur when the calcium-phosphorous ratio was shifted (excessively) in the direction of phosphorous. Their most recent work indicates that the presence of a high level of potassium, as furnished by the potassium acid phosphate might be offset, in some manner not understood, by the increased level of salt (sodium chloride). The potassium-sodium balance might be a determining factor.

As early as 1909 Law (1909) of the USDA Bureau of Animal Industry reported the incidence of urinary calculi in cattle and described eight types, one of which was siliceous calculi.

Blount (1931) listed several types of stones found in cattle suffering from urolithiasis: xanthine, calcium and magnesium carbonates, calcium oxalates, calcium and magnesium phosphates, triple phosphates, iron carbonate, and silicates.

Newsom, Tobiska, and Osborn (1943) reported finding silica in stones from sheep during a urinary calculi experiment previously referred to. Percentages varied greatly, running from 0.17 per cent silica to 81.0 per cent silica.

Swingle (1953) analyzed stones from 63 steers collected over a period of six years. He excluded any stones from feed-lot animals, from female cattle, from bulls, from animals known to be suffering from other disease, and from slaughter animals not suffering from urethral occlusions. All the stones contained silica.

Silica is one of the most abundant single minerals of the soil. It comprises more than three-fifths of the crust of the earth (Byers, et al., 1938). It comprises three-fourths of horizons "A" and "B".

The following table is a listing by Byers of the amount of important minerals contained in a representative soil profile.

| A Horizon         |       | B Horizon         |       |
|-------------------|-------|-------------------|-------|
| Aluminum Oxide    | 9.97  | Aluminum Oxide    | 11.77 |
| Iron Oxide        | 3.59  | Iron Oxide        | 5.74  |
| Calcium Oxide     | 1.04  | Calcium Oxide     | 1.01  |
| Magnesium Oxide   | .60   | Magnesium Oxide   | .85   |
| Potassium Oxide   | 1.73  | Potassium Oxide   | 2.06  |
| Sodium Oxide      | .82   | Sodium Oxide      | .83   |
| Manganese Oxide   | .14   | Manganese Oxide   | .14   |
| Titanium Oxide    | .90   | Titanium Oxide    | .90   |
| Phosphorous Oxide | .14   | Phosphorous Oxide | .14   |
| Sulphur Oxide     | .09   | Sulphur Oxide     | .09   |
| Silicon Oxide     | 76.46 | Silicon Oxide     | 76.46 |

The silicate minerals constitute the most important class of soil-forming minerals. Feldspars, a common kind of silicate mineral, are essentially anhydrous aluminosilicates.

Plants apparently have the ability to absorb silica from the soil in varying amounts. (Aaron, et al., 1939). Tobiska, et al., (1937) found that the silica ( $\text{SiO}_2$ ) content of ash of redtop grass (Agrostis alba) was 62 per cent, timothy (Phleum pratense), 50 per cent and beaked sedge (Carex rostrata) 64 per cent. The ash of alsike clover (Trifolium hybridum) contained only five per cent silica. In general, it was found that legumes were lowest, grasses (and certain grasslike plants) were intermediate, and certain sedges and rushes were highest in silica. It is common knowledge that heavy, continuous irrigation plus late cutting and heavy grazing of aftermath favors certain water-loving sedges (Carex sp) and rushes (Juncus sp). The same workers stated that "hay plants cited show an increase in  $\text{SiO}_2$  during a dry season". The exceptions were hairgrass (Deschampsia caespitosa), an "upland hay composite" sample and, most notably, alsike clover (Trifolium hybridum), a widely different genus which normally contained much less silica than the grasses and sedges studied. In summary, these workers stated, "The descending order of mineral ingredients in hay plants is  $\text{SiO}_2$ ,  $\text{K}_2\text{O}$ ,  $\text{CaO}$ ,  $\text{P}_2\text{O}_5$ ,  $\text{SO}_3$ ,  $\text{MgO}$ ,  $\text{CO}_2$ ,  $\text{Cl}$ ,  $\text{Na}_2\text{O}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{Mn}_3\text{O}_4$ ,  $\text{Al}_2\text{O}_3$ , while for alfalfa and alsike clover the (descending) order is  $\text{K}_2\text{O}$ ,  $\text{CaO}$ ,  $\text{CO}_2$ ,  $\text{SO}_3$ ,  $\text{P}_2\text{O}_5$ ,  $\text{MgO}$ ,  $\text{SiO}_2$ ,  $\text{Cl}$ ,  $\text{Na}_2\text{O}$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Mn}_3\text{O}_4$ ".

A similar grouping of range plants as to mineral content was derived in a California study by Gordon and Sampson (1939). In addition, relation-

ship of site to mineral composition of the plants was suggested. Low soil phosphorus resulted in low phosphorus content of the plants. Under the same condition, a higher than usual potassium content resulted. More fertile soil produced higher protein and phosphorus and lower crude fiber.

#### Animal Silicon Metabolism

The actual metabolic changes undergone by silicon compounds after they are ingested and digested by farm animals is not well understood.

It has been shown that silica is plentiful in plant species eaten by livestock and that it is associated with the occluding stones of urolithiasis.

Animals get most of their food from plants and have access to plentiful, if not burdensome supplies of silica.

A mineral balance type of metabolism experiment was conducted by Forbes and Beegle (1915) of Ohio. These workers conducted a similar study the following year with similar results. The principal purpose of these studies was to determine the influence of protein and roughages on digestibility of minerals and the whole ration.

They used three-to five-year-old Holstein cows in lactation. Intake and outgo of the several classes of nutrients and eight minerals were measured. The project was apparently very carefully planned and carried out.

It should be noted that six cows were used in these trials. There were three feed periods of 20 days each. During a ten-day interval between periods, the cows were started on the ration which was to follow. This ten-day interval on the new ration allowed time for emptying the

digestive tract of the previous ration.

In the three rations of interest in connection with silicon metabolism, the following rations were fed:

Corn, cotton seed meal, timothy hay, corn silage

Corn, cotton seed meal, clover hay

Corn, cotton seed meal, clover hay, corn silage

The amounts of each ingredient, the nutrients, and dry matter furnished by these rations have been calculated from tables on chemical analyses of feeds given in their bulletin and are shown in Table II of this thesis.

Table III shows the average silicon content of the daily ration, the amounts excreted in feces and urine, the silicon balance, the cubic centimeters of normal solution of silicon in the feed, and the excess base or acid (total) for all minerals in the ration. It is not clear how the acid and base normalities were calculated.

Incidental to the experiment Forbs and Beegle discovered "an extensive metabolism of silicon -". The retention of silicon from rations containing timothy hay and corn silage was surprisingly large.

In some instances the silicon intake was as great as the total for chlorine, sodium, and phosphorus. Most of the silicon was recovered in the feces. The smallest amount was in the urine. The feces were the principal means of excretion. Balances showed some retention of silicon on all rations - as much as five grams daily.

The computations of mineral acids and bases of the foodstuffs to cubic centimeters of normal solution of the respective elements, sodium, potassium, chlorine, magnesium, calcium, and silicon showed a marked predominance of

acids in ration number 1 containing timothy hay. In the ration containing clover hay (and low silicon balance), there was a definite base balance.

The excess acidity of the ash of ration number 1 was attributed largely to the high silicon content of the timothy hay. The following digestion coefficients were calculated by the writer for the silicon in the various rations.

Ration no. 1    23.31

Ration no. 2    9.0

Ration no. 3    13.6

The digestion coefficient for silica given by Frapps (1918) was 22.2.

Another item worthy of note in regard to these experiments is seen in the reported absence of silicon in the milk produced, regardless of the amount in the ration.

TABLE II. INGREDIENTS IN RATIONS FED AND NUTRIENTS FURNISHED  
TO COWS ON A SILICON METABOLISM EXPERIMENT (FORBES AND BEEGLE, 1915)

| Feed<br>Per-<br>iod                                  | Cow<br>No. | Ra-<br>tion<br>No. | Daily Feeds Consumed - Kg |           |               |                  |                |       |         | Digestible Nutrients Furnished - Grams |                  |       |               |         |
|------------------------------------------------------|------------|--------------------|---------------------------|-----------|---------------|------------------|----------------|-------|---------|----------------------------------------|------------------|-------|---------------|---------|
|                                                      |            |                    | Cotton<br>Corn            | Seed Meal | Clover<br>Hay | Timot-<br>hy Hay | Corn<br>Silage | Salt  | Protein | N.F.E.                                 | Ether<br>Extract | Fiber | Dry<br>Matter |         |
| 1                                                    | 1          |                    | 4.25                      | 1.60      |               |                  | 3.62           | 11.34 | .0239   | 923.9                                  | 4627.0           | 321.0 | 890.2         | 11533.7 |
| 1                                                    | 2          | 1                  | 4.3                       | 1.24      |               |                  | 3.62           | 13.60 | .0280   | 995.2                                  | 5104.1           | 347.9 | 1143.9        | 12315.8 |
| 1                                                    | 3          |                    | 4.78                      | 1.24      |               |                  | 3.44           | 11.34 | .0233   | 920.8                                  | 4892.8           | 286.0 | 1272.8        | 12868.8 |
| 1                                                    | 4          |                    | 4.32                      | .82       | 4.08          |                  | -              | -     | .0254   | 831.8                                  | 3940.3           | 270.0 | 794.9         | 8342.2  |
| 1                                                    | 5          | 2                  | 4.51                      | .82       | 4.08          |                  | -              | -     | .0254   | 811.7                                  | 4085.1           | 277.7 | 766.7         | 8511.8  |
| 1                                                    | 6          |                    | 4.31                      | .81       | 4.08          |                  | -              | -     | .0253   | 812.1                                  | 3859.4           | 255.3 | 726.7         | 8326.0  |
| 2                                                    | 1          |                    | 3.0                       | 1.00      | 4.54          |                  | -              | 11.34 | .0280   | 975.3                                  | 4581.2           | 307.8 | 1066.9        | 11053.9 |
| 2                                                    | 2          | 3                  | 3.0                       | 1.00      | 4.54          |                  | -              | 11.34 | .0280   | 964.9                                  | 4742.7           | 316.4 | 1212.7        | 11053.9 |
| 2                                                    | 3          |                    | 3.0                       | 1.00      | 4.54          |                  | -              | 11.34 | .0280   | 968.3                                  | 4659.4           | 307.7 | 1215.7        | 11053.9 |
| *Calculated: Coef. of dig. x content of daily ration |            |                    |                           |           |               |                  |                |       |         |                                        |                  |       |               |         |

TABLE III. SILICON METABOLISM OF COWS ON RATIONS 1, 2 AND 3 (ABOVE)

| Feed<br>Period | Cow<br>No. | Ration<br>No. | Ave. Silicon                     | Silicon Excret-   |             | Daily<br>Balance<br>Grams | CC. N Sol.<br>Of Silicon<br>In Ration | Excess - for all           |         |
|----------------|------------|---------------|----------------------------------|-------------------|-------------|---------------------------|---------------------------------------|----------------------------|---------|
|                |            |               | Content Of Daily<br>Ration-Grams | ed Grams<br>Urine | In<br>Feces |                           |                                       | Minerals In Ration<br>Base | Acid    |
| 1              | 1          |               | 63.004                           | .554              | 46.833      | +15.617                   | 4452.59                               | -                          | 2684.98 |
| 1              | 2          | 1             | 70.007                           | .780              | 49.968      | +19.259                   | 4947.48                               | -                          | 2954.77 |
| 1              | 3          |               | 76.412                           | .548              | 50.939      | +24.925                   | 5400.13                               | -                          | 2934.60 |
| 1              | 4          |               | 4.918                            | .163              | 4.710       | + 0.045                   | 347.53                                | 3151.85                    | -       |
| 1              | 5          | 2             | 4.955                            | .062              | 3.740       | + 1.153                   | 350.15                                | 3140.27                    | -       |
| 1              | 6          |               | 4.914                            | .000              | 5.016       | + 0.102                   | 347.27                                | 3152.55                    | -       |
| 2              | 1          |               | 36.797                           | .512              | 31.001      | + 5.284                   | 2600.47                               | 2467.34                    | -       |
| 2              | 2          | 3             | 36.797                           | .435              | 31.631      | + 4.731                   | 2600.47                               | 2467.34                    | -       |
| 2              | 3          |               | 36.797                           | .252              | 31.586      | + 4.959                   | 2600.47                               | 2467.34                    | -       |

## METHODS AND PROCEDURE

### The Study Area

This study was conducted principally in the southeastern one-fourth of Montana. The ranches studied were located in Rosebud, Musselshell, Carter, Carbon, and Wheatland Counties.

The study area was well adapted to work on this problem. Most of it is considered to be within the mixed prairie association of the grassland formation. This association or type alternates with the desert shrub and salt desert shrub type. The latter type occupies a much smaller percentage of the study area than does the former.

TABLE IV. AVERAGE ANNUAL PRECIPITATION, DEPARTURE FROM NORMAL AND AVERAGE ANNUAL TEMPERATURES AT SOME STATIONS IN THE STUDY AREA, IN SOUTHEASTERN MONTANA

| County      | Weather Station | Average Annual Precipitation Inches |                |       | Average Annual Temperature |           |
|-------------|-----------------|-------------------------------------|----------------|-------|----------------------------|-----------|
|             |                 |                                     | Departure From |       | Departure From             | Degree F. |
|             |                 | 1954                                | Normal         | 1955  | Normal                     |           |
| Carbon      | Bridger         | 8.83                                | - 2.11         | 10.01 | - .93                      | 46.8      |
| Carter      | Ekalaka         | 12.64                               | - .75          | 15.73 | 2.34                       | 44.0      |
| Musselshell | Melstone        | 13.33                               | 1.05           | 14.07 | 1.79                       | 46.7      |
|             | Roundup         | 9.29                                | - 3.16         | 14.59 | 2.14                       | 46.7      |
| Rosebud     | Colstrip        | 11.31                               | - 4.13         | 17.51 | 2.01                       | 46.2      |
|             | Forsyth         | 9.78                                | - 3.61         | 12.82 | - .57                      | 46.5      |
| Wheatland   | Harlowton       | 8.49                                | - 3.58         | 10.62 | - 1.45                     | 41.5      |

Precipitation in the study area was below normal in November and December of 1954, but above normal for the same months in 1955. In November 1955, precipitation was 170 per cent of normal for the state of Montana as a whole - - "the coldest November in Montana since 1896" (U.S. Weather Bureau, 1956).

Most of the study area is in the 10 to 14 inch rainfall belt. South Rosebud County is in the 15 to 19 inch rainfall belt.

Average annual temperatures, range from 41.5 to 46.8 degrees Fahrenheit.

#### Ranch Unit Pairs

This project is based upon the proposition that a study of practical range units might reveal facts and principles upon which can be based some preliminary conclusions regarding the range cattle urolithiasis problem.

In order to permit clear expression of actual animal-soil-vegetation-water relationships, ranch units were studied in pairs. Individual ranch units to be paired for the purpose of this study were selected for comparable size, kind of cattle, climatic conditions, and management. At the same time, units were selected to provide a degree of contrast in their experience with incidence of urolithiasis.

The term "unit" and "ranch unit" as used in this thesis mean a ranch or part of a ranch on which the livestock are handled separately and on which separate records are kept, regardless of ownership.

It was hoped that by studying pairs of ranch units salient features of management, range sites, vegetational types, range condition or mineral composition of plants could be identified positively or negatively with incidence of urolithiasis.

Prospective study units were located with the assistance of practicing veterinarians, county extension agents, and cooperating ranchers. By selecting units known to veterinarians, it was possible to obtain for study

a considerable number of units which had experienced urolithiasis incidence on which positive diagnosis had been made by veterinarians.

Ranch visits were made personally by the author. In all but a few exceptions, it was necessary to visit the ranch units more than once. Ranch visits were made during the months of February and March in the winters of 1954-55 and 1955-56.

Field notes were kept on prepared forms for each ranch unit.

Where feasible, ranchers' written records were consulted in obtaining information not actually obtained by the author through range and livestock inspection.

The following information was obtained for each ranch unit visited:<sup>1/</sup>

|                                                           |                                  |                                                                                                                |
|-----------------------------------------------------------|----------------------------------|----------------------------------------------------------------------------------------------------------------|
| Owner's Name                                              | Address                          | Location                                                                                                       |
| Size of Unit                                              | Pasture Numbers                  | Site Numbers                                                                                                   |
| Soils<br>Group<br>Type<br>Parent materials                | Slope                            | Permeability                                                                                                   |
| Vegetation Inventory                                      | Range Condition                  | Cattle Inventory, particularly steer cattle and their ages.<br>Kind and breed<br>Ages, and condition and dates |
| Incidence of Urolithiasis<br>Diagnosed by<br>Confirmed by | Samples Taken<br>Forage<br>Water | Narrative Record of important information on the unit                                                          |

A range condition (Dyksterhuis, 1949) and range utilization table was prepared for each site on each unit. Each plant species was listed with the per cent of volume of total forage yield contributed by that species.

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<sup>1/</sup> Complete data are shown in the appendix of this thesis.

Technicians' range condition guides prepared by the Soil Conservation Service for the Missouri Basin in Montana were used as a basis for range condition determinations. Maximum per cent in climax for a few plant species were adjusted to more nearly fit the particular site under study.

Utilization of species was recorded on the basis of percentage volume removed by livestock. In judging utilization, care was taken to segregate, as nearly as possible, grazing by wild animals and other animals not under study.

Range condition data were recorded in a manner as to serve also as an inventory of vegetation.

Forage samples taken for the purpose of chemical analysis for minerals, protein, and moisture were obtained in a manner to represent as nearly as possible the intake of forage by grazing cattle during the season of high incidence of urolithiasis. All grazing samples were taken during the months of January and February. Species for each site or site complex were composited and were bagged in a paper bag. Grazing samples were clipped by hand, using nine-inch lawn shears in a manner shown in Figure 1.



Figure 1. Illustration of method used in clipping.

Grazing samples for both years of this study were stored and then submitted at once to the Montana State College Agricultural Experiment Station, Department of Chemistry Research, for analysis for moisture, protein, phosphorus, calcium, magnesium, potassium, and silica.

The forage samples taken November 13, 1955, were each separated by hand into two equal portions. One of these sample portions for each species was analyzed by the chemistry laboratory in the usual manner. The other portion of each sample was washed under a jet of tap water, dried, and then submitted for analysis.

A portion of the soil residue washed from these grass samples was recovered from the wash water and also submitted for analysis for silica.

One-quart water samples were taken in glass jars from each unit, in a manner that would represent as nearly as possible the water consumed by the animals under study. Samples taken during the winter of 1954-55 were

stored until after all of the 1955-56 samples were accumulated. All water samples from all units were submitted about the same time to the chemistry laboratory for analysis. Water samples were analyzed for calcium, phosphorus, and silica.

The methods used in securing rancher information were conceived to eliminate as far as possible bias and prejudices on the part of all concerned. Interviews with ranchers and others concerned were designed to obtain actual dates, amounts, materials, and incidence of urolithiasis without excessive use of personal opinion. However, observations of ranch operators of long experience and eminent personal qualifications are invaluable. Creditable observations by ranchers and others qualified are recorded in hopes that they may offer some basis for further investigation into this problem.

#### Preparatory Study

Because an extensive area was covered in connection with this study, it was necessary to make range utilization and condition studies on the basis of ocular estimates. In order to obtain reasonable accuracy in these estimates, the author established a set of six clip quadrats on a ranch near Ashland, Montana. Wire cages of the type shown in Figure 1 were used for this purpose. Cages were fastened to the ground with iron stakes at each corner. Although animals rubbed on these cages occasionally, none of the cages were moved enough to interfere with their purpose. This study site was visited by the author once or twice each month during the year.

Careful observations were made and recorded on each of the important range forage species. Records kept included dates, stage of growth, and percentage utilization of plant species, weather observations, and grazing habits of livestock.

After one year of such observations, all exclosure quadrats were clipped. Each species was placed in a paper bag, separately, and weighed air dry after storage in a room at approximately room temperature (76° F.) for a period of nine months. A grazed quadrat near and outside each exclosure was clipped and the yield weighed and recorded in a similar manner.

In establishing the clip quadrat in the grazed area near each of the exclosures, care was taken to avoid trampled areas. Also, in order to reduce the number of quadrats needed for this purpose in the grazed vegetation, they were selected as nearly as possible to duplicate the species and volume of species in the corresponding exclosure.

The difference in yield of protected and unprotected clip quadrats was recorded as percentage utilization.

Estimates of utilization made previous to the clipping operation were compared with utilization data obtained by clipping. This gave a basis for visual estimates of forage, volume, and utilization to be made during ranch visits.



Figure.2. Clip quadrats of the preparatory study on yield of important range species. Grazed clip quadrat in foreground and exclosure cage in background.

#### Mineral Content of Some Range Plants

A corollary study to obtain information on the mineral composition and the trend in mineral composition of the important range species was conducted in connection with the utilization study on a ranch near Ashland, Montana. Samples of the important species were taken at two-week intervals from May to January inclusive and once a month during each February, March, and April. Sampling was carried out for a period of one year.

Species sampled included western wheatgrass (Agropyron smithii), bluebunch wheat grass (Agropyron spicatum), blue grama (Bouteloua gracilis), threadleaf sedge (Carex filifolia), junegrass (Koleria cristata), sandberg bluegrass (Poa secunda), needle-and-thread grass (Stipa comata),

and green needlegrass (Stipa viridula).

Forage samples were analyzed by the Montana State College, Department of Chemistry Research. Samples were analyzed for moisture, protein, calcium, phosphorus, magnesium, silica, and for potassium part of the year.

#### Incidence Of Urolithiasis In The Desert Shrub Formation Of Central Utah

A mail survey including 24 ranches in the northern desert shrub-salt-bush type of central Utah was conducted. Questionnaires were sent to selected ranchers. Ranch units were selected with the aid of range research workers, a veterinarian, and the Extension Livestock Specialist in the state of Utah.

It was found that there were few ranches in this area wintering steers on range thus the necessity for careful selection of units. Information was obtained from eight ranches, aggregating a total of 876 steer cattle grazed.

#### The Seasonal Incidence of Urolithiasis In Range Steers

Records of the occurrence of urolithiasis on ranches were compiled in connection with the study of pairs of ranch units. Accuracy of information was strengthened by consulting practicing veterinarians and by examining written records of the ranch operators.

## RESULTS AND DISCUSSION

### Vegetational Types And The Incidence Of Urolithiasis

Six vegetational types were encountered on range lands in this phase of the study. All are more or less closely related to the basic vegetational types described earlier in this thesis. A listing of the types found appear in Table V. A description of vegetational types on each unit is given in range condition tables in the Appendix. Estimated volume of each species is also given.

It was rather uncommon to find a substantial number of cattle grazing on a single uniform vegetational type. In only three units were cattle confined to a single vegetational type. More commonly, they grazed a complex of types. Thus, it was necessary to base this study on complexes and transitions of type rather than on pure vegetational types.

Twenty-one ranch units were included under this study phase. A majority of these units were studied for two different years. Each unit carried a different set of cattle each year and was treated separately in this study.

There were a total of 3,451 cattle on the ranch units studied during the winters of 1954-55 and 1955-56. The minimum number grazed on any one of the six vegetational types was 198; the maximum number in any one site was 978. There was a wide spread in the percentage incidence of urolithiasis in these vegetational types.

A summary of data obtained is shown in the following table.

TABLE V. RANGE VEGETATIONAL TYPES IN RELATION TO THE INCIDENCE OF UROLITHIASIS ON SELECTED RANCH UNITS IN SOUTHEASTERN MONTANA - WINTERS OF 1954-55 AND 1955-56

|                                                 | Number Of<br>Ranch Units<br>In Which<br>Type<br>Occurred | Uro-<br>lithiasis<br>Number Of<br>Cases | Total<br>Cattle<br>In Herds<br>Head | Uro-<br>lithiasis<br>Incidence<br>% |
|-------------------------------------------------|----------------------------------------------------------|-----------------------------------------|-------------------------------------|-------------------------------------|
| 1. Desert shrub-mixed<br>grass transition       | 2                                                        | 15                                      | 367                                 | 4.09                                |
| 2. Desert shrub-mixed<br>grass-saltbush complex | 5                                                        | 3                                       | 400                                 | 0.75                                |
| 3. Mixed grassland                              | 3                                                        | 58                                      | 987                                 | 5.88                                |
| 4. Ponderosa pine<br>savannah-mixed grass       | 6                                                        | 49                                      | 880                                 | 5.57                                |
| 5. Mixed grass-desert<br>shrub complex          | 3                                                        | 42                                      | 619                                 | 6.78                                |
| 6. Mixed grass-savannah<br>(deciduous)          | 2                                                        | 1                                       | 198                                 | 0.51                                |
| Total                                           | 21                                                       | 168                                     | 3451                                | xx                                  |

Incidence of urolithiasis in the vegetational types containing a substantial amount of palatable shrubs was approximately one-tenth that of the vegetational types containing only grasses or grasses and unpalatable shrubs.

Four additional ranch units which wintered steer cattle on cultivated crops, including cultivated hays and aftermath of legumes and small grains, were included in this study. These units had a zero incidence of urolithiasis among 541 steer cattle. One ranch unit wintered sixty head of steers on a combination of oat hay and native range. This unit had nine cases or 15 per cent incidence of urolithiasis. During the previous

winter, this same unit experienced a 16 per cent incidence of urolithiasis in a similar number of steer cattle wintered on a ponderosa pine savannah-mixed grass vegetational type.

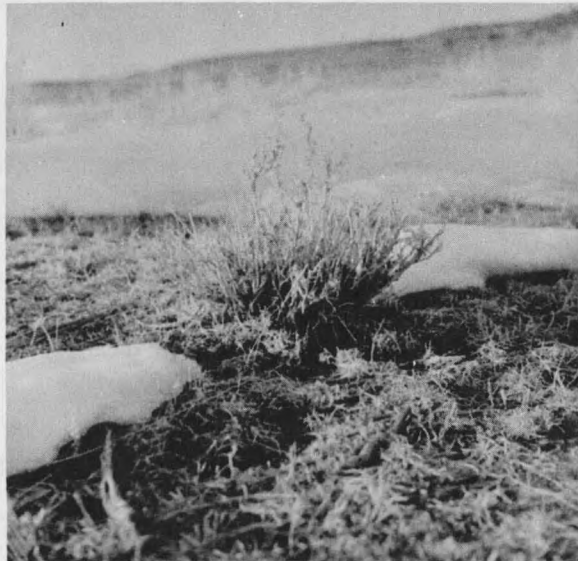


Figure 3. Silver sagebrush, showing heavy use. Incidence of urolithiasis was low on this ranch.



Figure 4. Cattle on unit H fed on accumulations of silver sagebrush leaves beneath the plants. They also grazed the twig growth of this shrub and on greasewood. Incidence of urolithiasis was very low.

#### Corollary Study In Northern Desert Shrub Formation

Urolithiasis is only a minor problem, at most, among cattle in the northern desert shrub formation in Utah, according to public officials closely associated with the livestock industry in Utah (George R. Henderson, Dr. C. Wayne Cook and Dr. Wayne Binns - Utah State Agricultural College. Private correspondence.)

One of these workers, (Henderson) stated that, in twelve years of work with stockmen in Utah, no cases have come to his attention. During a similar period while working in eastern Colorado (grasslands formation), urolithiasis was "abundant". The author has made similar observations

in these two areas.

Questionnaires on urolithiasis incidence were sent to twenty-four cattlemen in the desert shrub formation of Utah. Eight questionnaires were completed and returned which gave congruent information on steer cattle wintering substantially on desert shrub vegetation. The data obtained have been tabulated in Table VI.

Typically, ranchers in this vegetational type state that they "have never seen a case of water-belly in cattle".

TABLE VI. INCIDENCE OF UROLITHIASIS ON EIGHT RANCHES IN THE GREAT BASIN  
NORTHERN DESERT SHRUB-SALTBUSH RANGE OF UTAH  
DETERMINED BY A MAIL SURVEY, 1956

| Unit No. | Vegetational Type<br>(Rancher's Description)*                                                  | Number Steers | Number Urolith-<br>iasis Cases |
|----------|------------------------------------------------------------------------------------------------|---------------|--------------------------------|
| Utah 1   | White sage, brown sage, shadscale, salt sage, giant wildrye, squirrel tail                     | 50            |                                |
| Utah 2   | Fourwing saltbush, winterfat, sand dropseed, indian ricegrass, curly grama, stipa (70% grass)  | 135           |                                |
| Utah 3   | Sages, shadscale, saltgrass, sandgrass, crested wheatgrass, bunchgrass                         | 30            |                                |
| Utah 4   | White sage, fourwing saltbush, greasewood, ricegrass, trampgrass, and tumbleweeds              | 200           |                                |
| Utah 5   | White sage, fourwing saltbush, shadscale, some grass                                           | 75            |                                |
| Utah 6   | (Not given. Ranch located in type similar to above)                                            | 350           |                                |
| Utah 7   | White sage, bud sage, sagebrush, greasewood, western wheatgrass, tall wildrye, russian thistle | 70            |                                |
| Utah 8   | White sage - saltgrass                                                                         | 16            |                                |
| Total    |                                                                                                | 876           | None                           |

\* Common names of plants given by ranches are reported as such. In the general area of this study Eurotia lanata is called "white sage"; Atriplex nuttallii - "salt sage"; Atriplex confertifolia - "shadscale"; Atriplex canescens - "fourwing saltbush"; and Artemisia spinescens - "brown sage".

# Range Condition And Urolithiasis Incidence

Range condition in relation to the incidence of urolithiasis was studied on 19 different units. The study was continued through the second year on 10 of these units. For practical purposes then, the study covered 29 unit-years.

The data obtained in connection with this study are presented in condensed form in Table VII.

TABLE VII. RANGE CONDITION IN RELATION TO UROLITHIASIS  
ON SELECTED RANCH UNITS IN SOUTHEASTERN MONTANA

| Unit  | 1954-55          |              |      |                         | 1955-56          |              |      |                         |
|-------|------------------|--------------|------|-------------------------|------------------|--------------|------|-------------------------|
|       | Number<br>Cattle | Urolithiasis |      | Range<br>Condi-<br>tion | Number<br>Cattle | Urolithiasis |      | Range<br>Condi-<br>tion |
|       |                  | Cases        | %    |                         |                  | Cases        | %    |                         |
| A     | 70               | 8            | 11.4 | 60                      | 90               | 2            | 2.2  | 60                      |
| B     | 40               | 0            | 0    | 52                      | 100              | 2            | 2.0  | 52                      |
| C     | 212              | 20           | 9.4  | 81                      | -                | -            | -    | -                       |
| D     | 90               | 1            | 1.1  | 51                      | -                | -            | -    | -                       |
| E     | 175              | 22           | 12.6 | 73                      | -                | -            | -    | -                       |
| F     | 150              | 0            | 0    | 53                      | 150              | 1            | 0.7  | 53                      |
| G     | 30               | 7            | 23.0 | 55                      | 30               | 3            | 10.0 | 55                      |
| H     | 16               | 0            | 0    | 53                      | -                | -            | -    | -                       |
| I     | 65               | 11           | 16.9 | 91                      | -                | -            | -    | -                       |
| K     | -                | -            | -    | -                       | 55               | 14           | 25.5 | 66                      |
| L     | -                | -            | -    | -                       | 60               | 0            | 0    | 57                      |
| M     | 500              | 9            | 1.8  | 83                      | -                | -            | -    | -                       |
| N     | 104              | 0            | 0    | 59                      | -                | -            | -    | -                       |
| O     | 106              | 9            | 8.5  | 75                      | 106              | 3            | 2.8  | 75                      |
| P     | 75               | 1            | 1.3  | 60                      | 75               | 0            | 0    | 60                      |
| Q     | 60               | 6            | 10.0 | 84                      | 60               | 0            | 0    | 84                      |
| S     | 21               | 6            | 28.6 | 87                      | 15               | 2            | 13.3 | 87                      |
| U     | 70               | 0            | 0    | 85                      | 70               | 1            | 1.4  | 85                      |
| V     | 48               | 0            | 0    | 28                      | 48               | 0            | 0    | 28                      |
| Total | 1832*            | 100          | 4.37 | -                       | 859*             | 28           | 3.26 | -                       |

\* A total of 2,691 steer calves were included in this phase of this study.

Table VII shows that a predominance of the units studied were in range condition class good (50 to 75% condition). Sixteen or more than

half of the units studied, were in this range condition class. Range condition on nine units was excellent (75 to 100% condition). Two cases were on the dividing line between good and excellent range condition. Two units were in the fair condition class (25 to 50% condition). There were no units in the poor range condition class (0 to 25% condition). An effort was made to obtain units for study in the poor range condition class. None could be found where steers were kept on range during the season of high incidence of urolithiasis.

Ranch units having zero incidence of urolithiasis occurred in the ratio of 2-5-2 in the fair, good, and excellent range condition classes, respectively. Ranch units with an incidence of urolithiasis of zero to five per cent of the steer cattle occurred in the ratio of 0-5-2 in the fair, good, and excellent range condition classes, respectively. Units with an incidence of urolithiasis of over five per cent occurred in the ratio of 0-5-5 in the fair, good, and excellent range condition classes, respectively.

The per cent of urolithiasis incidence was slightly lower among cattle wintering on good condition range than on excellent condition range. There were a total of 61 cases of urolithiasis, or 4.66 per cent incidence among 1,310 steer cattle grazing on good condition range. On excellent condition range, there were 55 cases, or 5.13 per cent among 1,073 steer cattle.

It was noted that where steer cattle were wintered on range and where factors of management and range condition were rather constant, there were wide variations in the percentage of incidence of urolithiasis on

a given ranch unit from one year to the next. This suggests influence by factors other than range condition.

# Range Sites And Urolithiasis Incidence

This phase of this study attempted to ascertain the relationship of range cattle urolithiasis to range sites. All sites recognized under the range condition system used were not available for study.

TABLE VIII. INCIDENCE OF UROLITHIASIS IN THE WINTERS OF 1954-55 AND 1955-56 ON SELECTED SOUTHEASTERN MONTANA RANCHES STUDIED BY RANGE SITES

| Sites and Site Complexes         | No. Ranch Units On Which Site Occurs | Urolithiasis No. Cases | Number Cattle | Urolithiasis % Incidence |
|----------------------------------|--------------------------------------|------------------------|---------------|--------------------------|
| Overflow                         | 1                                    | 0                      | 98            | 0                        |
| Clayey                           | 11                                   | 126                    | 3469          | 3.34                     |
| Thin breaks, clayey and overflow | 1                                    | 0                      | 16            | 0                        |
| Saline upland and clayey         | 1                                    | 0                      | 110           | 0                        |
| Savannah                         | 3                                    | 16                     | 398           | 4.07                     |
| Clayey and overflow land         | 2                                    | 11                     | 235           | 4.66                     |
| Clayey, savannah and overflow    | 1                                    | 24                     | 345           | 6.96                     |
| Clayey and saline lowland        | 1                                    | 5                      | 144           | 3.47                     |

It was not practicable to isolate and identify the disease directly with certain sites in enough instances to permit clear expression of relationships (see "Overflow" site in Table VIII above). The occurrence of site classes of the kind that appeared to be less conducive to urolithiasis were quite limited.

Where overflow and saline upland sites were grazed independently of clayey and savannah sites, there was low incidence of urolithiasis (Table VIII). On the other hand, where cattle grazed on clayey and savannah (pine) sites continuously in the fall and winter, urolithiasis

was common.

Experience of ranchers indicated that where limited areas of saline and overflow sites occur in the same pasture with clayey sites the incidence of urolithiasis varied considerably from year to year.

Sites which supported a rather homogeneous cover of grasses or grasses and trees to the exclusion of palatable shrubs and forbs showed a higher incidence of urolithiasis during the study period of two years.

Seasonal fluctuations in rainfall seemed to be associated with variations in the amount of urolithiasis among steers in areas of intermingled sites. Fluctuations in rainfall are known to change the aspects of plant cover noticeably. Because cattle graze selectively, changes of this nature could possibly modify or change the intake of herbage by cattle and consequently effect the health of the stock.

Cattlemen cooperating in this study generally believed that the incidence varied with the weather. Opinions as to the nature of these variations were not entirely consistent. A majority, however, contended that dry autumns resulted in higher incidence. Incidence of urolithiasis in sites supporting only a few shrub and forb species seemed to fluctuate in a manner similar to that noted in clayey and savannah sites. An example of this was seen in the clayey-saline lowland site complex. Fluctuations in incidence was even greater there than in the clayey and savannah sites. In the latter, urolithiasis is common almost every year, whereas in the clayey-saline lowland complex it occurred only following extremely droughty falls. The frequency of such occurrences appears to depend upon the extent of sites in the site complex. Site complexes

with extensive overflow, saline lowland, and saline uplands were associated to a lesser degree with outbreaks of urolithiasis following dry autumns than those with proportionally smaller areas in these site classes.



Figure 5. Cattle grazing nuttall saltbush (arrow). Darker plants in foreground are big sagebrush which was seldom grazed by cattle. Incidence of urolithiasis is low except following very droughty autumns.

Cropland sites were not surveyed in detail, but it was observed that incidence of urolithiasis in cattle on diversified cropland (alfalfa, small grains, irrigated pasture, sugar beets, etc.) was very low compared to range savannah and clayey sites.

# Yearly And Seasonal Incidence Of Urolithiasis In Cattle Studied

In conjunction with this study of range condition, range site, and range vegetational types in relation to the incidence of urolithiasis, information on the seasonal incidence of urolithiasis was obtained.

During the two winters of this study, a record was kept of the chronological incidence of urolithiasis. These data are reported in Table IX.

TABLE IX. YEARLY AND SEASONAL INCIDENCE OF UROLITHIASIS  
IN CATTLE ON RANCHES STUDIED IN SOUTHEASTERN MONTANA  
DURING THE WINTERS OF 1954-55 AND 1955-56

|              | Urolithiasis Cases |         | Number Steer Cattle In Affected Herds |         | Per Cent Incidence Of Urolithiasis |         |
|--------------|--------------------|---------|---------------------------------------|---------|------------------------------------|---------|
|              | 1954-55            | 1955-56 | 1954-55                               | 1955-56 | 1954-55                            | 1955-56 |
| Oct. 1 - 15  | 0                  | 1       |                                       |         |                                    |         |
| Oct. 16 - 31 | 1                  | 1       |                                       |         |                                    |         |
| Nov. 1 - 15  | 3                  | 1       |                                       |         |                                    |         |
| Nov. 16 - 30 | 8                  | 11      |                                       |         |                                    |         |
| Dec. 1 - 15  | 12                 | 17      |                                       |         |                                    |         |
| Dec. 16 - 31 | 17                 | 8       |                                       |         |                                    |         |
| Jan. 1 - 15  | 22                 | 1       |                                       |         |                                    |         |
| Jan. 16 - 31 | 29                 | 0       |                                       |         |                                    |         |
| Feb. 1 - 15  | 21                 | 2       |                                       |         |                                    |         |
| Feb. 16 - 29 | 9                  | 2       |                                       |         |                                    |         |
| Mar. 1 - 15  | 7                  | 0       |                                       |         |                                    |         |
| Mar. 16 - 31 | 2                  | 0       |                                       |         |                                    |         |
| Apr. 1 - 15  | 1                  | 0       |                                       |         |                                    |         |
|              | 132                | 44      | 2350                                  | 3140    | 5.62                               | 1.40    |

There were 2350 cattle included in the study during the winter of 1954-55 and 3140 cattle during the winter of 1955-56. There were 132 cases or a 5.62 per cent incidence the first year as contrasted to 44 cases of urolithiasis or 1.40 per cent incidence during the second year.

Figure 6 shows the trend of urolithiasis during the period September through January to April during the winter of 1954-55 and 1955-56.

The trend in incidence of urolithiasis from September to December 1 of each year was similar. In the winter of 1954-55, this trend continued upward while in the winter of 1955-56 the trend went downward until late January. The low point in the incidence of urolithiasis in the winter of 1955-56 occurred at about the same date as the high point during the previous year.

Because this phase is a by-product of this research project it was not practicable to explore or consider all factors involved nor to reach any final conclusions in this regard. However, observations and tentative conclusions in regard to this information are reported herein for their value as a possible guide in establishment of future research on this problem.

It is well known to the residents and particularly to stockmen in the study area that the winter of 1955-56 was more severe than the winter of 1954-55. This suggests consideration of two factors which are commonly associated with the urolithiasis problem: they are (1) water, and (2) feed as affected by snow cover.

The quantity and quality of water consumed by livestock during the two winters might have been influenced by the weather. It was not possible in this study to obtain information in this regard.

The snow cover had a marked affect on the kind of feed available to cattle during the two winters. During the winter of 1954-55, snow fall

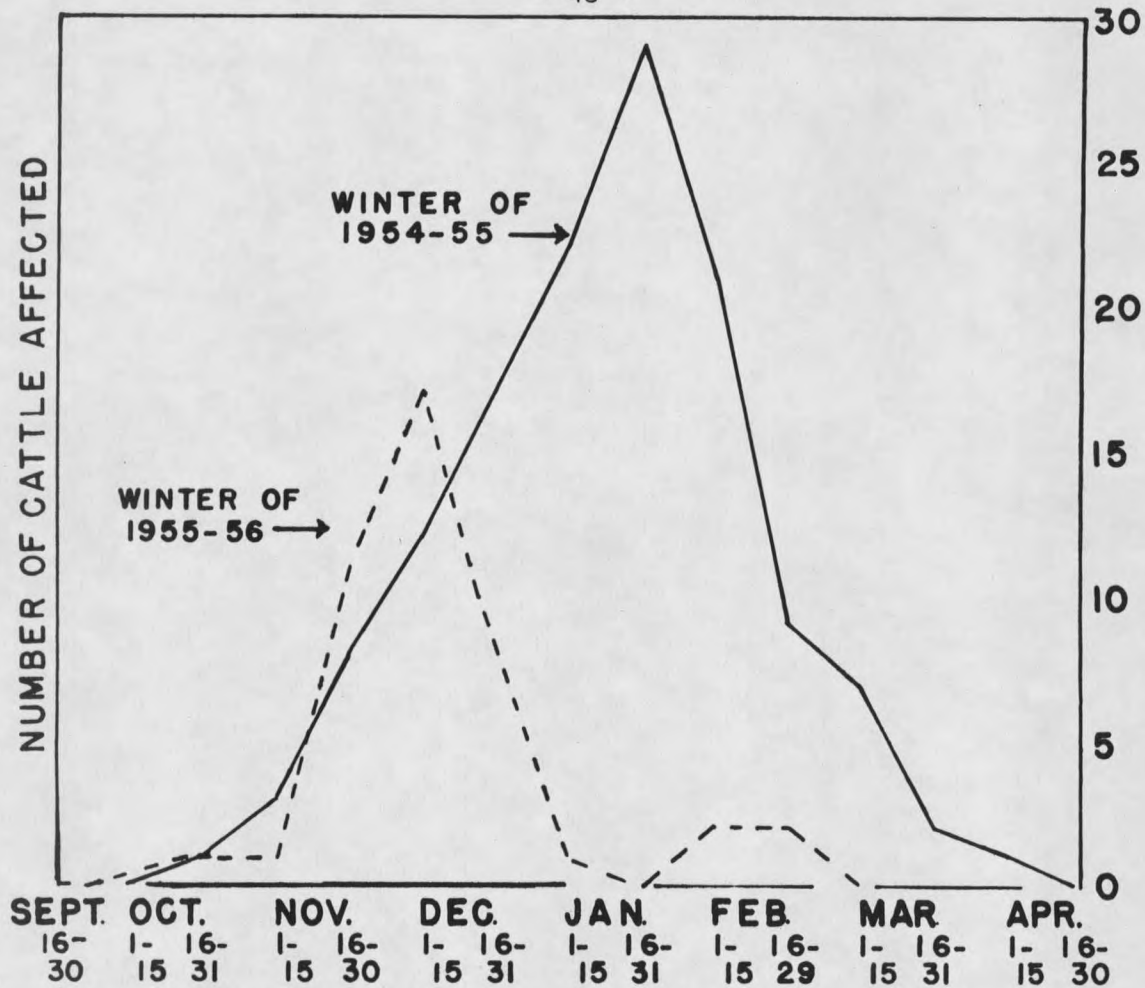


Figure 6. Yearly and seasonal incidence of urolithiasis in cattle on ranches studied in southeastern Montana during the winters of 1954-55 and 1955-56.

was light during the period of November through January. Cattle could graze on range and even on "short grasses". Mild weather reduced the normal supplemental feed requirement for this period of the year, and cattle were permitted to graze out on range during much of the winter. Supplemental feeding of roughages did not become necessary until February.



Figure 7. Steers grazed high benches, selecting threadleaf sedge, largely, during December, January and February of the winter of 1954-55. Urolithiasis incidence 28.6 per cent.

The situation was quite different in the winter of 1955-56. A general snow cover fell on the range in the study area during the early part of November. "Heavy feeding was necessary following the cold wave of the 11th (Nov. 1955) and was continuous through the 30th "(U. S. Weather Bureau, 1956).

In a few areas, the snow cover melted off, permitting limited grazing on the taller grasses until the middle of December. Grazing on short grasses was greatly restricted on practically all units from November 11 until March 1 of 1955-56. Most range was again covered by snow by the 20th of December, precluding grazing and remained covered until late

January.



Figure 8. Snow and ice kept "short grasses" inaccessible to cattle most of the 1955-56 winter.

Most ranches had an abundant supply of supplemental forage, much of which was alfalfa or mixed alfalfa and grass hay. Consequently, many of the cattle were moved into ranch headquarters and given full feeding of supplemental forage.

These observations suggest strongly a relationship between range forage obtained by livestock in grazing, particularly "short grasses" and the incidence of urolithiasis.

Five practicing veterinarians in southeastern Montana were circularized in regard to the incidence of urolithiasis during the 1954-55 and 1955-56 winters. Three responded, reporting a total of 403 cases for

1954-55 and 307 cases for 1955-56 appertaining to their practices. One veterinarian suggested two explanations for the difference.

1. More hay was fed (in 1955-56 winter) "eliminating intake of range grasses and browse".
2. More ranchers, because of economic conditions, treated the animals themselves, thus, reducing the number of cases brought to his (the veterinarian's) attention.



Figure 9. Snow and unusually low temperature in November, December and January of the 1955-56 winter necessitated earlier and heavier feeding than the previous winter. Less urolithiasis occurred this winter.

Observations on ranches made by the author partly supports the first point. However, seldom were snow depths sufficient to eliminate intake of browse. Snow cover on low growth of grasses actually forced more grazing on higher growing browse plants. Browse or shrub forage is intermediate in quality

of minerals, vitamins, and protein to cured range grasses and good quality hays.

The second point (above) cannot be evaluated adequately here. Ranchers are more inclined, during economic recessions, to perform operations normally submitted to veterinarians. Little evidence of such was observed in connection with ranch visits by the author.



Figure 10. Rabbitbrush used heavily on unit F, 1955.

The Incidence Of Urolithiasis In Relation To Minerals  
Of Forage And Water Sampled

The mineral content of forage samples taken during the urolithiasis season in connection with the study of paired ranches varied considerably in the content of phosphorus, calcium, magnesium, potassium and silica (Table X). The manner in which they vary in relation to the incidence of urolithiasis may hold some clues as to further research into management practices or feeding practices which would reduce losses due to urolithiasis in steers.

Scatter charts (Figures 12, 13, 14, 15 and 16) in which the incidence of urolithiasis is plotted as the Y axis and the per cent of the mineral is plotted on the X axis shows some relationships as they occurred in this study.

Because of the doubt of the accuracy of values of four samples, two separate statistical analyses have been conducted 1/, one including and one excluding these samples.

There was a highly significant linear relationship between the amount of phosphorus, calcium, magnesium and silica and the incidence of urolithiasis in steers. A highly significant curvilinear relationship was shown between the incidence of urolithiasis and phosphorus and calcium in forage.

In the analysis of these same data with the four questionable samples excluded, a distinct departure from linearity was shown in all cases except one. In that one case (silica in relation to incidence of urolithiasis)

1/ Statistical analysis was conducted by the Statistical Laboratory, Montana State College

a highly significant linear relationship was show.

From these data (Tables XVIII and XIX ) it appears that there was a highly significant negative correlation between the amount of phosphorus, calcium, magnesium, and potassium in the forage and the incidence of urolithiasis. It appears that there is a highly significant positive correlation between the amount of silica in forage of range livestock and the incidence of urolithiasis in range steers in this study.

Stock water analyzed for calcium, phosphorus, and silica showed that contribution of these minerals to the grazing animal's diet would be very small compared to the contribution furnished by range and other forages.



Figure 11. Threadleaf sedge grazed by steers during the winter to a height of one-half inch (see pocket knife for height comparison). Urolithiasis incidence - 28.6 per cent.

Scatter charts prepared in which calcium, phosphorus, and silica in water were plotted against the incidence of urolithiasis in steers showed no particular relationships.

Data obtained in connection with this phase of this study are shown in Table X.

TABLE X. INCIDENCE OF UROLITHIASIS IN RELATION TO MINERAL CONTENT OF FORAGE ON SELECTED RANCH UNITS IN SOUTHEASTERN MONTANA - 1954-56

| Unit | Year    | Sample                         | Phos-<br>phorus | Cal-<br>cium | Mag-<br>nesium | Pot-<br>assium | Silica  | Urolithiasis<br>Incidence<br>% |
|------|---------|--------------------------------|-----------------|--------------|----------------|----------------|---------|--------------------------------|
| A    | 1954-55 | Range composite                | .06             | .77          | .45            | .29            | 12.901/ | 11.4                           |
| A    | 1955-56 | Range composite                | .06             | .77          | .45            | .29            | 12.901/ | 2.2                            |
| B    | 1954-55 | Range composite                | .09             | .55          | .29            | .57            | 5.61    | 0                              |
| B    | 1955-56 | Range composite                | .09             | .55          | .29            | .57            | 5.61    | 2.0                            |
| C    | 1954-55 | Range composite                | .06             | .40          | .23            | .28            | 7.22    | 9.4                            |
| C    | 1955-56 | Range & hay                    | .09             | .63          | .26            | 1.12           | 3.90    | 1.3                            |
| D    | 1954-55 | Range composite                | .09             | .46          | .20            | .49            | 4.16    | 1.1                            |
| D    | 1955-56 | Alfalfa hay                    | .13             | 1.28         | .44            | 2.42           | 0.33    | 0                              |
| E    | 1954-55 | Range composite                | .05             | .30          | .16            | .11            | 6.16    | 12.6                           |
| F    | 1954-55 | Range composite                | .09             | .50          | .25            | .80            | 2.42    | 0                              |
| F    | 1955-56 | Range composite                | .09             | .50          | .25            | .80            | 2.42    | .7                             |
| G    | 1954-55 | Range composite                | .06             | .24          | .17            | .22            | 5.71    | 23.0                           |
| G    | 1955-56 | Range composite                | .06             | .24          | .17            | .22            | 5.71    | 10.0                           |
| H    | 1954-55 | Range composite                | .09             | .41          | .19            | .67            | 2.73    | 0                              |
| I    | 1954-55 | Range composite                | .04             | .34          | .18            | .17            | 6.23    | 16.9                           |
| I    | 1955-56 | Range & oat hay                | .07             | .67          | .41            | 1.15           | 5.281/  | 15.0                           |
| J    | 1954-55 | Alfalfa hay and<br>corn silage | .14             | .61          | .43            | 2.00           | 1.96    | 0                              |
| J    | 1955-56 | Alfalfa hay and<br>corn silage | .14             | .61          | .43            | 2.00           | 1.96    | 0                              |
| K    | 1955-56 | Range composite                | .03             | .27          | .18            | .12            | 3.72    | 25.5                           |
| L    | 1955-56 | Range composite                | .09             | 1.18         | .55            | 1.03           | 3.23    | 0                              |
| M    | 1954-55 | Range composite                | .05             | .32          | .14            | .17            | 5.30    | 1.8                            |
| M    | 1955-56 | Alfalfa hay                    | .13             | 1.28         | .44            | 2.42           | 0.33    | 0                              |
| N    | 1954-55 | Range composite                | .09             | .86          | .54            | .74            | 2.82    | 0                              |
| O    | 1954-55 | Range composite                | .12             | .32          | .18            | .79            | 4.46    | 8.5                            |
| O    | 1955-56 | Range composite                | .12             | .32          | .18            | .79            | 4.46    | 2.8                            |
| P    | 1954-55 | Range composite                | .10             | .61          | .22            | .96            | 1.43    | 1.3                            |
| P    | 1955-56 | Range composite                | .10             | .61          | .22            | .96            | 1.43    | 0                              |
| R    | 1954-55 | Grass-alfalfa                  | .18             | 1.09         | .39            | .20            | 0.21    | 0                              |
| R    | 1955-56 | Grass-alfalfa                  | .18             | 1.09         | .39            | .20            | 0.21    | 0                              |
| S    | 1954-55 | Range composite                | .07             | .27          | .14            | .22            | 4.78    | 28.6                           |
| S    | 1955-56 | Range composite                | .07             | .27          | .14            | .22            | 4.78    | 13.3                           |
| T    | 1954-55 | Alfalfa hay                    | .17             | 2.11         | .58            | 2.62           | 0.09    | 0                              |
| T    | 1955-56 | Alfalfa hay                    | .17             | 2.11         | .58            | 2.62           | 0.09    | 0                              |
| U    | 1954-55 | Range and mixed<br>silage      | .11             | 1.32         | .45            | 2.71           | 2.56    | 0                              |
| U    | 1955-56 | Range and mixed<br>silage      | .11             | 1.32         | .45            | 2.71           | 2.56    | 1.4                            |
| V    | 1954-55 | Range composite                | .06             | .59          | .34            | .63            | 2.71    | 0                              |
| V    | 1955-56 | Range composite                | .06             | .59          | .34            | .63            | 2.71    | 0                              |
| No.1 | 1954-55 | Meadow (timothy)               | .19             | .53          | .34            | 2.00           | 5.371/  | 17.3                           |

1/ Validity of these samples problematical. See statistical Table XVIII.

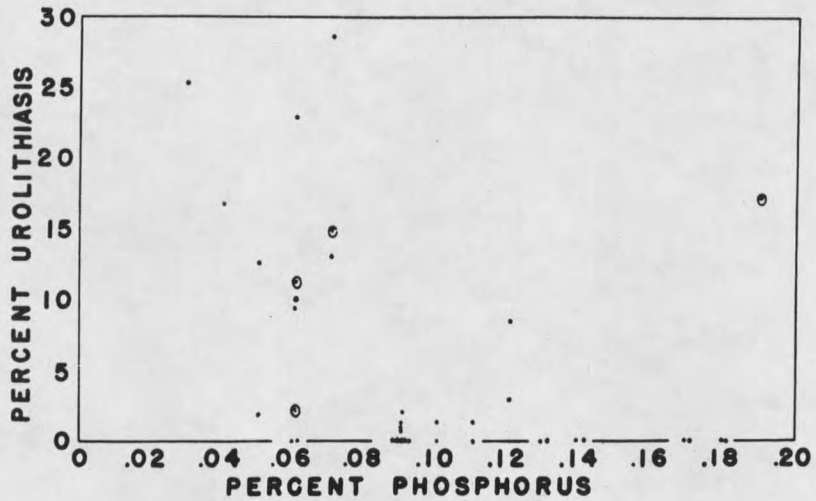


Figure 12. Phosphorus content of forage from study units, in relation to incidence of urolithiasis.

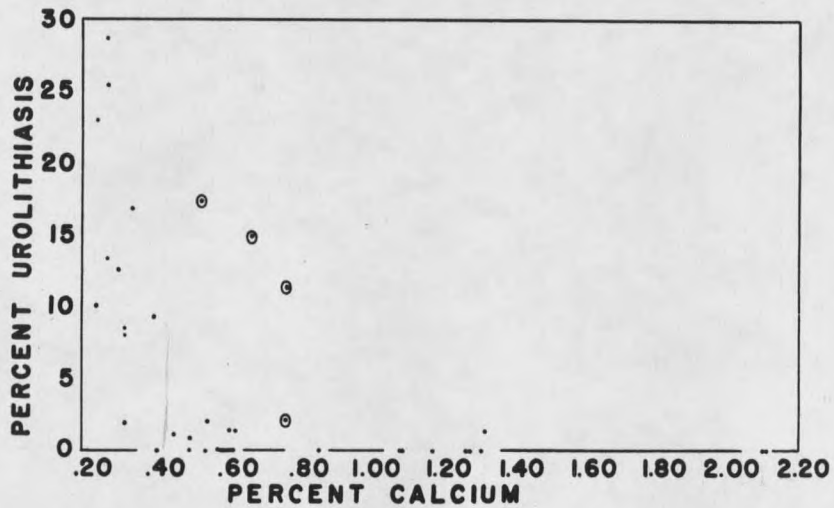


Figure 13. Calcium content of forage from study units in relation to incidence of urolithiasis.

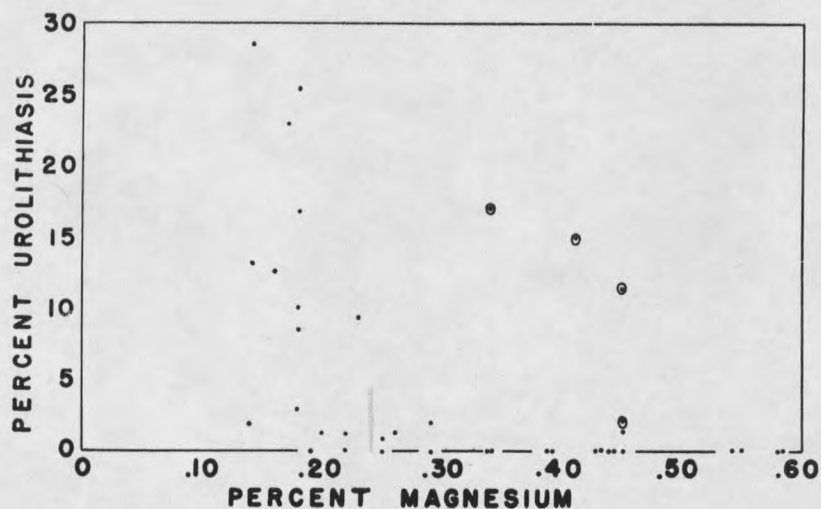


Figure 14. Magnesium content of forage from study units, in relation to incidence of urolithiasis.

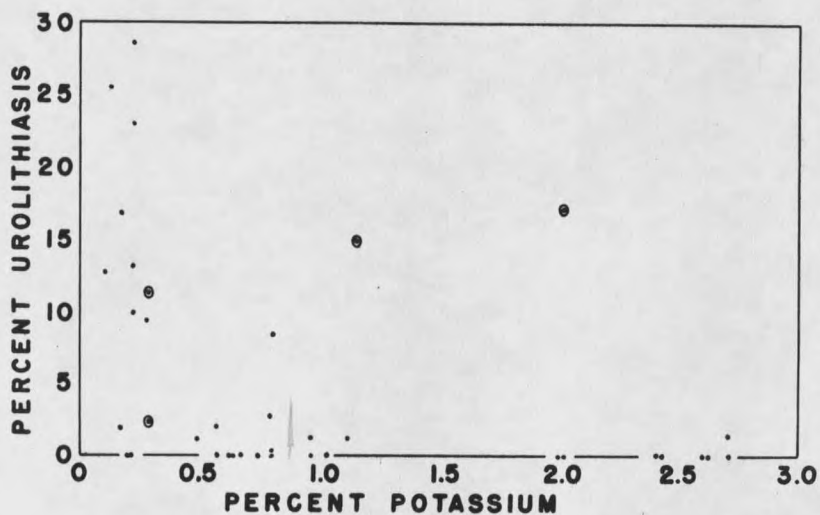


Figure 15. Potassium content of forage from study units, in relation to incidence of urolithiasis.

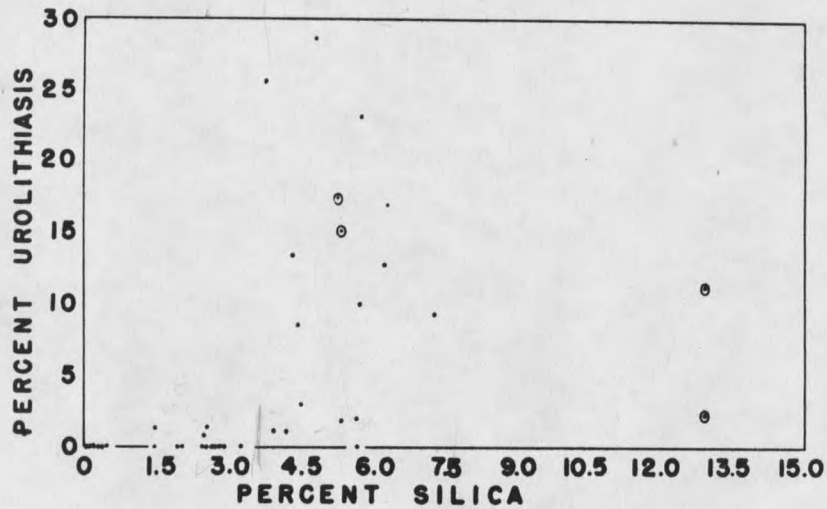


Figure 16. Silica content of forage from study units, in relation to incidence of urolithiasis.

TABLE XI. THE INCIDENCE OF UROLITHIASIS IN RELATION TO MINERALS  
IN WATER SAMPLED ON RANCH UNITS  
IN SOUTHEASTERN MONTANA - 1955-56

| Unit | Year | Calcium<br>% | Phos-<br>phorus<br>% | Silica<br>% | Number<br>Of<br>Cattle |         | Incidence<br>Of<br>Urolithiasis |              |
|------|------|--------------|----------------------|-------------|------------------------|---------|---------------------------------|--------------|
|      |      |              |                      |             | 1954-55                | 1955-56 | 1954-55<br>%                    | 1955-56<br>% |
| A-1  | 1955 | .0105        | .000014              | .00022      | 70                     | 90      | 11.4                            | 2.2          |
| A-2  | 1955 | .0062        | .000064              | .00100      | -                      | -       | -                               | -            |
| B    | 1955 | .0050        | .000002              | .00071      | 40                     | 100     | 0                               | 2.0          |
| C    | 1956 | .0035        | .000003              | .00138      | 212                    | -       | 9.4                             | -            |
| D    | 1955 | .0105        | .000016              | .00085      | 90                     | -       | 1.1                             | -            |
| E-1  | 1955 | .0265        | .000058              | .00170      | 175                    | -       | 12.6                            | -            |
| E-2  | 1955 | .0125        | .000005              | .00160      | 175                    | -       | -                               | -            |
| F    | 1956 | .0062        | .000058              | .00058      | 150                    | 150     | 0                               | 0.7          |
| G    | 1956 | .0065        | .000003              | .00140      | 30                     | 30      | 23.0                            | 10.0         |
| H    | 1956 | .0020        | .000025              | .00042      | 16                     | -       | 0                               | -            |
| I*   | 1956 | .0185        | .000036              | .00112      | -                      | 60      | -                               | 15.0         |
| I-1  | 1955 | .0062        | .000002              | .00073      | 65                     | -       | 16.9                            | -            |
| J    | 1956 | .0020        | .000026              | .00034      | 83                     | 83      | 0                               | 0            |
| K    | 1956 | .0030        | .000005              | .00086      | -                      | 55      | -                               | 25.5         |
| L    | 1956 | .0020        | .000019              | .00028      | -                      | 60      | -                               | 0            |
| M    | 1955 | .0030        | .000006              | .00092      | 500                    | -       | 1.8                             | -            |
| N    | 1955 | .0095        | .000028              | .00093      | 104                    | -       | 0                               | -            |
| O-1  | 1955 | .0090        | .000054              | .00080      | 106                    | 106     | 8.5                             | 2.8          |
| O-2  | 1955 | .0060        | .000002              | .00084      | -                      | -       | -                               | -            |
| P    | 1956 | .0360        | .000005              | .00086      | 75                     | 75      | 1.3                             | 0            |
| R    | 1955 | .0065        | .000003              | .00180      | 55                     | 130     | 0                               | 0            |
| U    | 1956 | .0170        | .000002              | .00038      | 70                     | 70      | 0                               | 1.4          |
| U    | 1956 | .0070        | .000027              | .00093      | -                      | -       | -                               | -            |

\* Well

Mineral Content And Trend In Seven Important  
Range Grasses And One Sedge

The mineral silica was the most abundant mineral found in samples of seven range grasses and one sedge that were analyzed for calcium, potassium, phosphorus, magnesium, and silica. Frequently, the amount of silica more than exceeded the total per cent of all the other minerals. (Tables XII, XIII, XIV, XV, and XVI).

Potassium ranked second to silica in abundance, followed by calcium, magnesium, and phosphorus. This agrees with the findings of Tobiska et al., (1937), except that in their study, the phosphorus exceeded the magnesium.

Grass samples were collected once every two weeks except during February, March, and April when monthly samples were taken. It should be pointed out in this connection that the analysis for potassium was not included in the procedure for the April 24 through the August 3 samples. For that reason the potassium trend line in Figure 17 is a broken line.

#### Silica

The content of silica, in species studied, declined steadily during the early growth stages to the blossom stage (Figure 17). There was an increase in this mineral content from the blossom stage until the seeds were ripe; then there was a decline until the height of the fall regrowth period. Next, there was an upward trend in the silica content which continued into the middle of the winter, reaching a high during December and January.

This trend was most accentuated in the more important "short grasses"

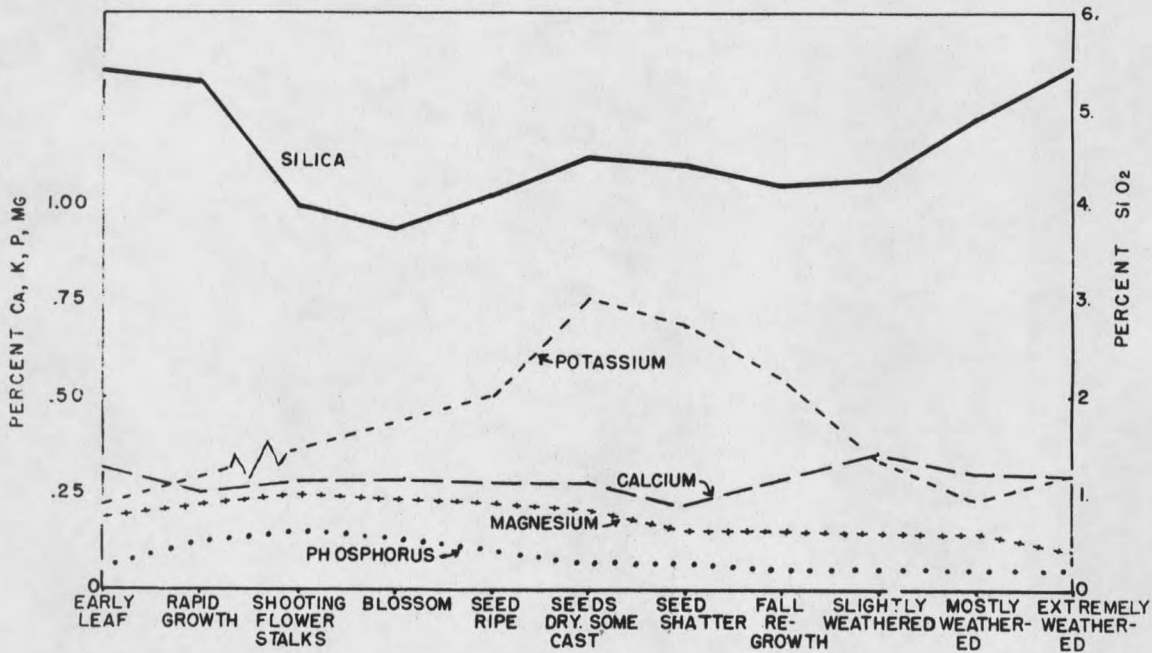


Figure 17. Minerals in seven grasses and one sedge, by growth stages for one year. Western wheatgrass, bluebunch wheatgrass, blue grama, threadleaf sedge, junegrass, sandberg bluegrass, needle-and thread and green needlegrass. Samples collected near Ashland, Montana, 1954-55.

(blue grama and threadleaf sedge). The silica content of threadleaf sedge followed a rather distinct seasonal trend reaching a high point in late January at 11.73 per cent. This per cent exceeds the silica content of any other species in this study. The low points in silica in threadleaf sedge occurred at blossom stage and again during the fall regrowth period. The content and trend of minerals in blue grama and threadleaf sedge were also combined and plotted in Figure 18.

The silica content of blue grama followed somewhat the same trend as that of threadleaf sedge, reaching a high point at 9.11 in early December and a low point at 3.92 during the blossom stage July 7.

The silica content and trends in the important mid-grasses (western wheatgrass, bluebunch wheatgrass, needle-and-thread and junegrass) were very similar, although generally lower and not so extreme. The data on the first three of these species were consolidated into Figure 19.

Junegrass was not included because of lack of four samples in April, May, and early June.

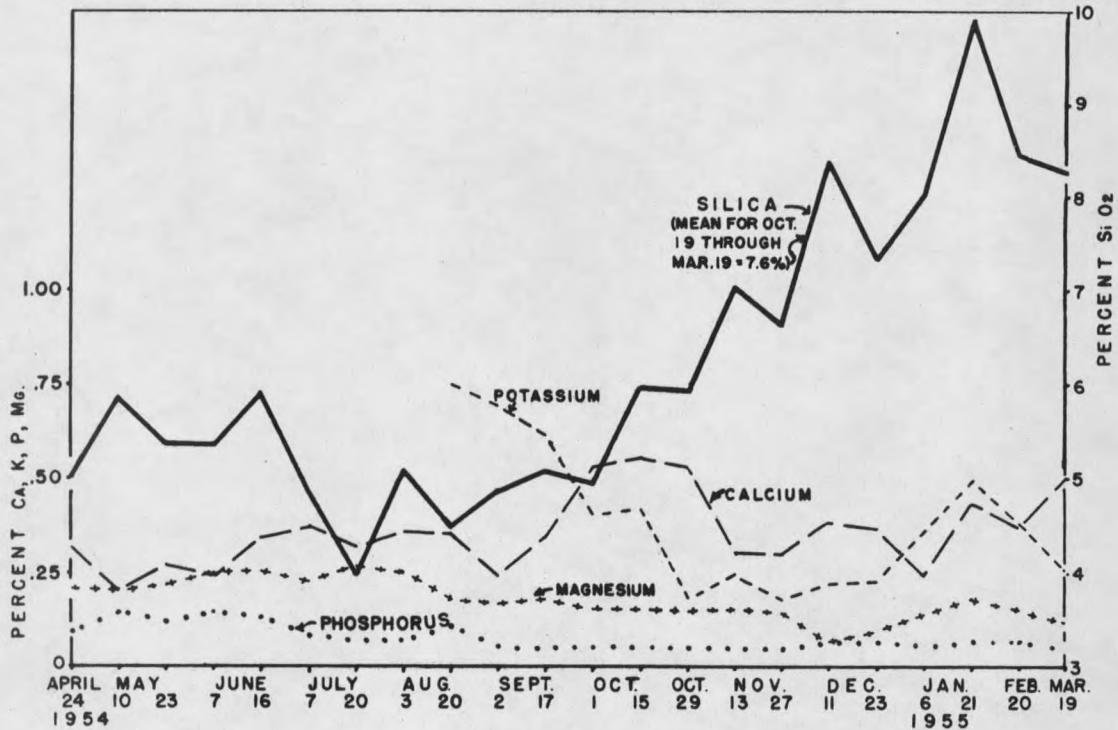


Figure 18. Minerals in two "short grasses"-blue grama and thread-leaf sedge, one year, 1954-55. Sampled near Ashland, Montana,

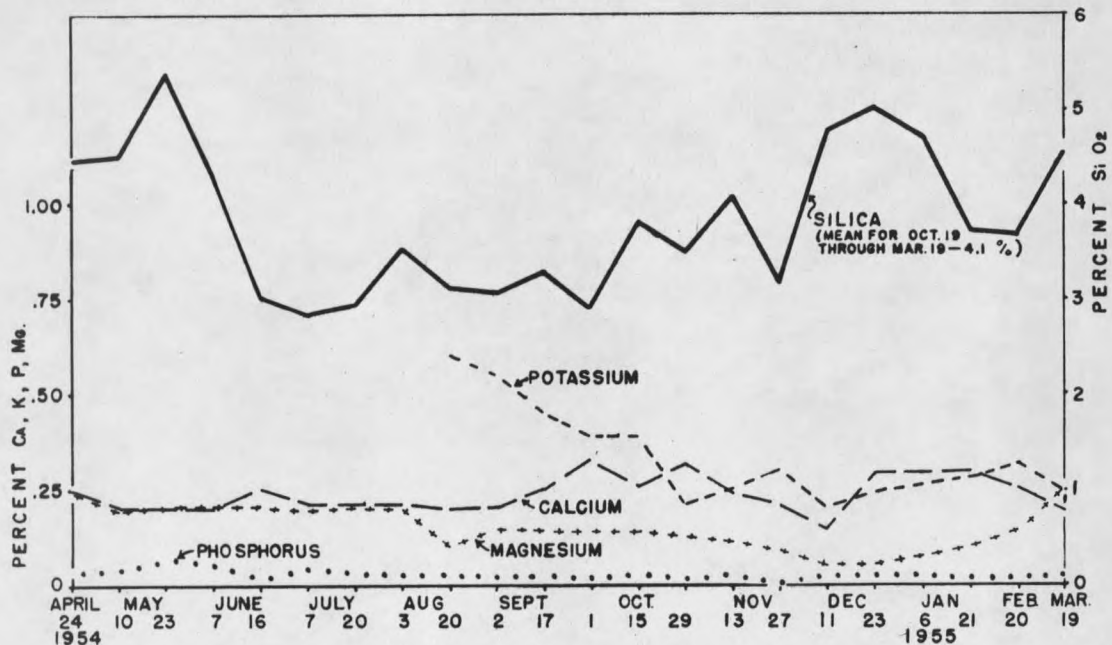


Figure 19. Minerals in three mid-grasses-western wheatgrass, needle-and-thread and green needlegrass, one year, 1954-55. Sampled near Ashland, Montana.

The silica content of the grass species and the one sedge, during the spring and summer of this one year study, followed rather closely the trend in range grasses in California as described by Gordon and Sampson (1939).

A hailstorm in the middle of September severely damaged sandberg bluegrass, making regular sampling of this species impracticable for the remainder of the year.

#### Other Minerals

The average potassium content of all species was highest August 3, at the time of the first analysis for this mineral, and decreased steadily as the plants matured and weathered. There was a slight uptrend in potassium in the very early spring. As it was pointed out earlier, forage samples were not analyzed for this mineral during the rapid growth, shooting flower stalks, and blossom stages.

The per cent of calcium in plants, analyzed in connection with this study, decreased during the early growth stages, increased slightly during the maturation process, and decreased during the time seeds were dropping. There was a varied trend in calcium during the winter.

Magnesium and phosphorus content of range forage samples increased during the early growth stages up to the time the flower stalks were forming. Following this increase there was a general decline through the maturing and weathering seasons. In most species, an uptrend in magnesium occurred slightly earlier in the spring than the uptrend in phosphorus.

In general, it should be noted that the rise in per cent of silica and calcium and the decrease in potassium, phosphorus, and magnesium coincides chronologically with the rise in incidence of urolithiasis in the steers studied.

#### Samples Washed

Duplicates of the November 13 samples of all species except sandberg bluegrass were washed in a jet of water for the purpose of removing the superficial soil silica burden. Analysis showed a reduction in silica of about one-twentieth, or 5.5 per cent. The residue washed from the samples contained 48.0 per cent silica.

#### Protein In Range Forage

Protein analysis is also included in Tables XII to XVI for general purposes. It serves as an approximate index to palatability and general nutritional value.

TABLE XII. MINERAL AND PROTEIN CONTENT OF THREE MID-GRASSES AND TWO "SHORT GRASSES"

1954-55 (MOISTURE FREE BASIS)

Rangeland 9 Miles Northwest of Ashland, Montana

| Date     | Important Mid-grass Species                                    |     |     |     |     |        | Important "Short grass" Species |     |     |     |     |        |
|----------|----------------------------------------------------------------|-----|-----|-----|-----|--------|---------------------------------|-----|-----|-----|-----|--------|
|          | Western wheatgrass, Needle-and thread and Bluebunch wheatgrass |     |     |     |     |        | Blue grama and Threadleaf Sedge |     |     |     |     |        |
|          | Prot.                                                          | Ca  | K   | P   | Mg  | Silica | Prot.                           | Ca  | K   | P   | Mg  | Silica |
|          | %                                                              | %   | %   | %   | %   | %      | %                               | %   | %   | %   | %   | %      |
| 1954     |                                                                |     |     |     |     |        |                                 |     |     |     |     |        |
| Apr. 24  | 6.9                                                            | .25 | -   | .07 | .24 | 4.47   | 8.8                             | .32 | -   | .09 | .21 | 5.02   |
| May 10   | 8.6                                                            | .21 | -   | .08 | .19 | 4.51   | 8.1                             | .21 | -   | .14 | .20 | 5.87   |
| May 23   | 10.6                                                           | .21 | -   | .14 | .21 | 5.39   | 10.2                            | .27 | -   | .12 | .22 | 5.38   |
| June 7   | 11.1                                                           | .21 | -   | .11 | .21 | 4.30   | 10.9                            | .24 | -   | .14 | .25 | 5.37   |
| June 16  | 10.5                                                           | .26 | -   | .04 | .22 | 3.03   | 10.5                            | .34 | -   | .13 | .26 | 5.90   |
| July 7   | 7.0                                                            | .23 | -   | .08 | .20 | 2.86   | 9.0                             | .37 | -   | .08 | .23 | 4.86   |
| July 20  | 6.0                                                            | .23 | -   | .07 | .22 | 2.95   | 6.1                             | .32 | -   | .07 | .27 | 3.98   |
| Aug. 3   | 5.6                                                            | .24 | -   | .06 | .21 | 3.54   | 7.5                             | .36 | -   | .07 | .25 | 5.08   |
| Aug. 20  | 5.5                                                            | .21 | .61 | .06 | .11 | 3.13   | 6.8                             | .35 | .75 | .11 | .18 | 4.49   |
| Sept. 2  | 5.7                                                            | .22 | .56 | .05 | .15 | 3.09   | 6.9                             | .24 | .69 | .06 | .17 | 4.86   |
| Sept. 17 | 5.1                                                            | .26 | .46 | .06 | .14 | 3.30   | 6.7                             | .34 | .62 | .05 | .18 | 5.07   |
| Oct. 1   | 4.7                                                            | .36 | .38 | .04 | .14 | 2.91   | 6.5                             | .53 | .40 | .06 | .16 | 4.95   |
| Oct. 15  | 4.5                                                            | .27 | .38 | .07 | .14 | 3.81   | 6.2                             | .56 | .42 | .06 | .16 | 5.97   |
| Oct. 29  | 4.4                                                            | .34 | .23 | .04 | .13 | 3.50   | 5.8                             | .53 | .18 | .05 | .15 | 5.93   |
| Nov. 13  | 4.1                                                            | .24 | .27 | .06 | .12 | 4.08   | 6.4                             | .31 | .24 | .05 | .16 | 7.03   |
| Nov. 27  | 3.2                                                            | .23 | .31 | .02 | .09 | 3.16   | 6.5                             | .30 | .18 | .05 | .14 | 6.63   |
| Dec. 11  | 2.3                                                            | .15 | .22 | .05 | .06 | 4.78   | 6.7                             | .38 | .22 | .07 | .07 | 8.39   |
| Dec. 23  | 1.4                                                            | .28 | .24 | .05 | .06 | 5.02   | 4.6                             | .37 | .23 | .07 | .09 | 7.32   |
| 1955     |                                                                |     |     |     |     |        |                                 |     |     |     |     |        |
| Jan. 6   | 4.1                                                            | .28 | -   | .05 | -   | 4.72   | 5.9                             | .24 | -   | .06 | -   | 8.03   |
| Jan. 21  | 3.5                                                            | .30 | .27 | .04 | .11 | 3.73   | 6.0                             | .43 | .49 | .07 | .18 | 9.92   |
| Feb. 20  | 3.6                                                            | .27 | .33 | .04 | .14 | 3.69   | 5.4                             | .37 | .38 | .07 | .15 | 8.45   |
| Mar. 19  | 3.9                                                            | .21 | .25 | .05 | .25 | 4.56   | 5.8                             | .49 | .26 | .05 | .12 | 8.28   |

TABLE XIII. MINERAL AND PROTEIN CONTENT OF BLUE GRAMA AND THREADLEAF SEDGE  
1954-55 (MOISTURE FREE BASIS)

Rangeland 9 Miles Northwest of Ashland, Montana

| Date     | Blue Grama |     |     |     |     |                   | Threadleaf Sedge |     |      |     |     |        | Plant Growth Stage                |
|----------|------------|-----|-----|-----|-----|-------------------|------------------|-----|------|-----|-----|--------|-----------------------------------|
|          | Prot.      | Ca  | K   | P   | Mg  | Silica            | Prot.            | Ca  | K    | P   | Mg  | Silica |                                   |
| 1954     | %          | %   | %   | %   | %   | %                 | %                | %   | %    | %   | %   | %      | Early leaf                        |
| Apr. 24  | 3.9        | .26 | -   | .05 | .21 | 6.85 <sup>1</sup> | 13.8             | .38 | -    | .14 | .21 | 3.19   | Rapid growth                      |
| May 10   | 4.1        | .14 | -   | .14 | .19 | 7.63              | 12.1             | .28 | -    | .15 | .21 | 4.11   | Shooting flower stalks            |
| May 23   | 7.9        | .21 | -   | .11 | .20 | 6.54              | 12.6             | .33 | -    | .14 | .24 | 4.23   | Blossom                           |
| June 7   | 9.1        | .15 | -   | .13 | .23 | 6.98              | 12.8             | .34 | -    | .15 | .28 | 3.76   |                                   |
| June 16  | 9.7        | .30 | -   | .13 | .25 | 7.62              | 11.4             | .39 | -    | .13 | .27 | 4.19   | Seed ripe                         |
| July 7   | 9.3        | .30 | -   | .11 | .23 | 4.98              | 8.7              | .44 | -    | .07 | .23 | 4.74   |                                   |
| July 20  | 5.2        | .25 | -   | .10 | .25 | 3.92              | 7.1              | .40 | -    | .04 | .29 | 4.05   | Seeds dry-some<br>cast            |
| Aug. 3   | 7.7        | .31 | -   | .09 | .26 | 5.56              | 7.3              | .41 | -    | .06 | .24 | 4.61   |                                   |
| Aug. 20  | 6.3        | .30 | .50 | .15 | .19 | 5.24              | 7.4              | .40 | 1.01 | .06 | .17 | 3.74   | Seed shatter                      |
| Sept. 2  | 6.4        | .28 | .50 | .06 | .18 | 5.77              | 7.5              | .21 | .89  | .06 | .17 | 3.96   |                                   |
| Sept. 17 | 6.2        | .29 | .48 | .04 | .19 | 5.67              | 7.2              | .40 | .77  | .07 | .17 | 4.47   | Fall regrowth                     |
| Oct. 1   | 5.6        | .40 | .35 | .06 | .16 | 5.58              | 7.5              | .67 | .46  | .06 | .16 | 4.32   | Slightly weathered                |
| Oct. 15  | 5.1        | .48 | .35 | .06 | .17 | 7.13              | 7.3              | .64 | .49  | .07 | .16 | 4.81   |                                   |
| Oct. 29  | 4.9        | .40 | .18 | .05 | .17 | 6.55              | 6.7              | .67 | .19  | .05 | .14 | 5.32   | Mostly weathered                  |
| Nov. 13  | 5.1        | .28 | .20 | .05 | .15 | 8.18*             | 7.7              | .35 | .28  | .05 | .17 | 5.88*  |                                   |
| Nov. 27  | 4.4        | .24 | .18 | .05 | .15 | 7.76              | 8.7              | .37 | .18  | .05 | .13 | 5.50   | Extremely weathered <sup>1/</sup> |
| Dec. 11  | 6.1        | .27 | .22 | .07 | .08 | 9.11              | 7.4              | .50 | .22  | .07 | .07 | 7.67   |                                   |
| Dec. 23  | 4.0        | .27 | .25 | .08 | .08 | 8.27              | 5.2              | .48 | .22  | .06 | .10 | 6.37   |                                   |
| 1955     |            |     |     |     |     |                   |                  |     |      |     |     |        |                                   |
| Jan. 6   | 5.2        | .25 |     | .06 |     | 8.33              | 6.6              | .23 |      | .06 |     | 7.73   | Rapid growth                      |
| Jan. 21  | 5.5        | .26 | .50 | .07 | .15 | 8.12              | 6.5              | .60 | .49  | .07 | .22 | 11.72  |                                   |
| Feb. 20  | 5.7        | .25 | .41 | .11 | .17 | 7.92              | 5.1              | .49 | .35  | .04 | .14 | 8.99   |                                   |
| Mar. 19  | 4.9        | .34 | .23 | .06 | .12 | 8.76              | 6.8              | .64 | .30  | .05 | .12 | 7.81   |                                   |
|          |            |     |     |     |     | 7.56*             |                  |     |      |     |     | 5.74*  |                                   |

\* November 13 samples were split -- one-half was washed and analyzed for silica. The silica in washed samples is the last item in the silica columns.

TABLE XIV. MINERAL AND PROTEIN CONTENT OF WESTERN WHEATGRASS AND BLUEBUNCH WHEATGRASS  
1954-55 (MOISTURE FREE BASIS)

Rangeland 9 Miles Northwest of Ashland, Montana

| Date     | Western Wheatgrass |     |      |     |     |        | Bluebunch Wheatgrass |     |     |     |     |        | Plant Growth Stage     |
|----------|--------------------|-----|------|-----|-----|--------|----------------------|-----|-----|-----|-----|--------|------------------------|
|          | Prot.              | Ca  | K    | P   | Mg  | Silica | Prot.                | Ca  | K   | P   | Mg  | Silica |                        |
| 1954     | %                  | %   | %    | %   | %   | %      | %                    | %   | %   | %   | %   | %      |                        |
| Apr. 24  | 8.8                | .24 | -    | .08 | .27 | 4.73   | 3.9                  | .25 | -   | .06 | .15 | 4.82   | Early leaf stage       |
| May 10   | 12.10              | .20 | -    | .08 | .27 | 3.72   | 6.2                  | .19 | -   | .07 | .15 | 5.17   | Rapid growth           |
| May 23   | 14.1               | .20 | -    | .13 | .25 | 4.25   | 8.9                  | .24 | -   | .12 | .19 | 4.65   |                        |
| June 7   | 16.1               | .24 | -    | .04 | .29 | 2.86   | 7.6                  | .17 | -   | .13 | .15 | 4.45   | Shooting flower stalks |
| June 16  | 13.6               | .29 | -    | .14 | .29 | 2.35   |                      |     |     |     |     |        |                        |
| June 16  |                    |     |      |     |     |        | 8.7                  | .30 | -   | .10 | .18 | 3.77   | Blossom                |
| July 7   | 8.6                | .34 | -    | .10 | .28 | 3.50   | 4.9                  | .20 | -   | .05 | .11 | 2.85   |                        |
| July 20  | 8.1                | .27 | -    | .09 | .28 | 3.87   | 3.4                  | .19 | -   | .03 | .15 | 2.33   | Seed ripe              |
| Aug. 3   | 8.3                | .30 | -    | .08 | .28 | 3.64   | 3.2                  | .19 | -   | .03 | .14 | 3.76   | Seeds dry-some cast    |
| Aug. 20  | 8.2                | .23 | 1.04 | .09 | .14 | 2.77   | 3.3                  | .17 | .31 | .03 | .07 | 3.52   | Seeds shattered        |
| Sept. 2  | 8.7                | .24 | .80  | .07 | .19 | 2.88   | 3.1                  | .16 | .42 | .03 | .11 | 3.21   | Fall regrowth          |
| Sept. 17 | 7.0                | .27 | .63  | .08 | .13 | 3.51   | 3.2                  | .22 | .36 | .04 | .12 | 3.39   |                        |
| Oct. 1   | 6.6                | .40 | .56  | .06 | .14 | 3.17   | 2.7                  | .30 | .33 | .03 | .13 | 2.42   | Slightly weathered     |
| Oct. 15  | 6.5                | .35 | .41  | .05 | .14 | 3.62   | 2.5                  | .25 | .22 | .03 | .09 | 4.12   |                        |
| Oct. 29  | 5.0                | .20 | .35  | .08 | .15 | 4.02   | 2.6                  | .29 | .20 | .02 | .11 | 2.77   | Mostly weathered       |
| Nov. 13  | 5.0                | .25 | .46  | .08 | .15 | 3.19*  | 2.7                  | .19 | .18 | .02 | .08 | 4.23*  |                        |
| Nov. 27  | 3.6                | .19 | .52  | .03 | .13 | 3.49   | 2.4                  | .18 | .23 | .01 | .06 | 3.01   | Extremely weathered    |
| Dec. 11  | 4.4                | .27 | .36  | .07 | .09 | 6.53   | 0.7                  | .12 | .17 | .02 | .05 | 3.86   |                        |
| Dec. 23  | 2.2                | .28 | .42  | .06 | .07 | 4.08   | 0.3                  | .25 | .14 | .04 | .05 | 6.48   |                        |
| 1955     |                    |     |      |     |     |        |                      |     |     |     |     |        |                        |
| Jan. 6   | 5.9                | .29 |      | .07 |     | 5.01   | 2.8                  | .22 |     | .03 |     | 4.68   |                        |
| Jan. 21  | 4.7                | .29 | .23  | .06 | .12 | 4.35   | 2.5                  | .28 | .35 | .02 | .08 | 3.48   |                        |
| Feb. 20  | 4.9                | .25 | .44  | .07 | .15 | 3.91   | 2.6                  | .24 | .38 | .02 | .11 | 3.58   |                        |
| Mar. 19  | 5.1                | .19 | .35  | .06 | .16 | 4.53   | 2.6                  | .14 | .20 | .03 | .12 | 4.52   |                        |
|          |                    |     |      |     |     | 3.12*  |                      |     |     |     |     | 4.13*  |                        |

\* November 13 samples were split -- one-half was washed and analyzed for silica. The silica in washed samples is the last item in the silica columns.

TABLE XV. MINERAL AND PROTEIN CONTENT OF NEEDLE-AND-THREAD AND GREEN NEEDLEGRASS  
1954-55 (MOISTURE FREE BASIS)

Rangeland 9 Miles Northwest of Ashland, Montana

| Date     | Needle-and-thread |     |     |     |     |        | Green Needlegrass |     |     |     |     |        | Plant Growth Stage     |
|----------|-------------------|-----|-----|-----|-----|--------|-------------------|-----|-----|-----|-----|--------|------------------------|
|          | Prot.             | Ca  | K   | P   | Mg  | Silica | Prot.             | Ca  | K   | P   | Mg  | Silica |                        |
| 1954     | %                 | %   | %   | %   | %   | %      | %                 | %   | %   | %   | %   | %      |                        |
| Apr. 24  | 8.1               | .26 | -   | .06 | .30 | 3.88   | 4.7               | .25 | -   | .05 | .18 | 5.08   | Early leaf stage       |
| May 10   | 7.5               | .25 | -   | .09 | .16 | 4.64   | 6.4               | .18 | -   | .11 | .21 | 7.27   | Rapid growth           |
| May 23   | 8.8               | .20 | -   | .16 | .20 | 7.26   | 11.0              | .33 | -   | .13 | .24 | 6.57   |                        |
| June 7   | 9.6               | .22 | -   | .16 | .19 | 5.60   | 10.3              | .30 | -   | .20 | .25 | 5.02   | Shooting flower stalks |
| June 16  | 9.2               | .20 | -   | .08 | .20 | 2.96   | 8.5               | .26 | -   | .11 | .21 | 4.60   |                        |
| July 7   | 7.5               | .24 | -   | .10 | .22 | 2.22   | 6.6               | .26 | -   | .14 | .20 | 6.59   | Blossom                |
| July 20  | 6.5               | .22 | -   | .10 | .23 | 2.06   | 5.6               | .22 | -   | .07 | .22 | 4.38   | Seed ripe              |
| Aug. 3   | 5.2               | .22 | -   | .07 | .21 | 3.21   | 4.8               | .25 | -   | .06 | .20 | 5.78   | Seeds dry-some cast    |
| Aug. 20  | 4.9               | .23 | .47 | .07 | .13 | 3.09   | 4.1               | .23 | .88 | .06 | .14 | 6.19   | Seeds shattered        |
| Sept. 2  | 5.2               | .26 | .47 | .05 | .15 | 3.19   | 4.6               | .23 | .91 | .05 | .19 | 5.65   | Fall growth            |
| Sept. 17 | 5.0               | .29 | .38 | .05 | .17 | 3.00   | 5.2               | .29 | .77 | .08 | .15 | 6.14   |                        |
| Oct. 1   | 4.7               | .39 | .26 | .04 | .15 | 3.15   | 4.1               | .47 | .66 | .08 | .16 | 7.48   | Slightly weathered     |
| Oct. 15  | 4.4               | .22 | .52 | .14 | .19 | 3.70   | 3.3               | .34 | .49 | .07 | .14 | 5.50   |                        |
| Oct. 29  | 5.7               | .34 | .14 | .03 | .14 | 3.70   | 3.4               | .40 | .19 | .08 | .14 | 5.70   | Mostly weathered       |
| Nov. 13  | 4.5               | .28 | .18 | .07 | .13 | 4.81*  | 3.4               | .28 | .38 | .04 | .14 | 5.91*  |                        |
| Nov. 27  | 3.6               | .32 | .18 | .03 | .08 | 2.98   | 2.9               | .24 | .28 | .05 | .13 | 5.22   | Extremely weathered    |
| Dec. 11  | 1.8               | .32 | .14 | .06 | .05 | 3.96   | 1.5               | .43 | .34 | .06 | .05 | 8.05   |                        |
| Dec. 23  | 1.8               | .32 | .17 | .05 | .07 | 4.50   | 1.3               | .27 | .35 | .05 | .09 | 6.81   |                        |
| 1955     |                   |     |     |     |     |        |                   |     |     |     |     |        |                        |
| Jan. 6   | 3.6               | .32 | -   | .06 | -   | 4.48   | 3.2               | .35 | -   | .03 | -   | 6.90   |                        |
| Jan. 21  | 3.3               | .33 | .23 | .03 | .14 | 3.37   | 3.1               | .33 | .30 | .04 | .14 | 6.12   |                        |
| Feb. 20  | 3.4               | .31 | .18 | .03 | .15 | 3.58   | 2.6               | .33 | .35 | .05 | .14 | 7.91   |                        |
| Mar. 19  | 4.0               | .29 | .19 | .07 | .48 | 4.62   | 3.0               | .20 | .19 | .03 | .14 | 4.63   | Early leaf stage       |
|          |                   |     |     |     |     | 4.08*  |                   |     |     |     |     | 6.19*  |                        |

\* November 13 samples were split -- one-half was washed and analyzed for silica. The silica in washed samples is the last item in the silica columns.

TABLE XVI. MINERAL AND PROTEIN CONTENT OF JUNEGRASS AND SANDBERG BLUEGRASS  
1954-55 (MOISTURE FREE BASIS)  
Rangeland 9 Miles Northwest of Ashland, Montana

| Date     | Junegrass |     |     |     |     |        | Sandberg bluegrass |     |     |     |     |        | Plant Growth Stage     |
|----------|-----------|-----|-----|-----|-----|--------|--------------------|-----|-----|-----|-----|--------|------------------------|
|          | Prot.     | Ca  | K   | P   | Mg  | Silica | Prot.              | Ca  | K   | P   | Mg  | Silica |                        |
| 1954     | %         | %   | %   | %   | %   | %      | %                  | %   | %   | %   | %   | %      |                        |
| Apr. 24  | -         | -   | -   | -   | -   | -      | 23.4               | .34 | -   | .32 | .40 | 2.16   | Shooting flower stalks |
| May 10   | -         | -   | -   | -   | -   | -      | 20.6               | .24 | -   | .31 | .35 | 3.10   |                        |
| May 23   | -         | -   | -   | -   | -   | -      | 14.1               | .23 | -   | .24 | .34 | 2.22   |                        |
| June 7   | -         | -   | -   | -   | -   | -      | 11.4               | .17 | -   | .29 | .24 | 2.44   | Blossom                |
| June 16  | 8.6       | .26 | -   | .15 | .21 | 3.84   | 9.0                | .22 | -   | .15 | .22 | 3.02   | Seed ripe              |
| July 7   | 5.7       | .23 | -   | .17 | .18 | 6.47   | 7.7                | .23 | -   | .10 | .22 | 5.60   | Seeds dry-some cast    |
| July 20  | 5.7       | .22 | -   | .08 | .22 | 3.72   | 7.6                | .20 | -   | .17 | .22 | 1.90   | Seed shatter           |
| Aug. 3   | 5.4       | .28 | -   | .08 | .21 | 4.39   | 7.4                | .24 | -   | .10 | .23 | 3.54   |                        |
| Aug. 20  | 4.8       | .19 | .60 | .06 | .11 | 5.97   | 6.2                | .19 | .45 | .06 | .12 | 3.21   | Fall regrowth          |
| Sept. 2  | 4.2       | .24 | .48 | .04 | .14 | 4.10   | 8.1                | .22 | .29 | .12 | .15 | 4.47   | Slightly weathered     |
| Sept. 17 | 3.8       | .18 | .47 | .05 | .12 | 5.20   | 4.0                | .17 | .30 | .06 | .10 | 3.00   |                        |
| Oct. 1   | 1.9       | .24 | .13 | .02 | .08 | 2.11   | -                  | -   | -   | -   | -   | -      | Mostly weathered       |
| Oct. 15  | 3.6       | .18 | .34 | .05 | .14 | 2.37   | -                  | -   | -   | -   | -   | -      |                        |
| Oct. 29  | 2.4       | .30 | .08 | .02 | .19 | 2.64   | -                  | -   | -   | -   | -   | -      |                        |
| Nov. 13  | 3.8       | .26 | .24 | .03 | .13 | 7.04*  | 4.4                | .28 | .23 | .08 | .13 | 3.59   | Extremely weathered    |
| Nov. 27  | 2.8       | .19 | .20 | .02 | .08 | 3.12   | -                  | -   | -   | -   | -   | -      |                        |
| Dec. 11  | 0.7       | .22 | .20 | .04 | .05 | 5.02   | -                  | .33 | .27 | .09 | .07 | 2.83   |                        |
| Dec. 23  | 0.5       | .23 | .12 | .04 | .05 | 3.56   | -                  | -   | -   | -   | -   | -      |                        |
| 1955     |           |     |     |     |     |        |                    |     |     |     |     |        |                        |
| Jan. 6   | 3.7       | .32 | -   | .03 | -   | 5.85   | -                  | -   | -   | -   | -   | -      | Early leaf growth      |
| Jan. 21  | 2.9       | .27 | .52 | .03 | .12 | 6.76   | -                  | -   | -   | -   | -   | -      |                        |
| Feb. 20  | 2.7       | .24 | .31 | .03 | .08 | 4.00   | -                  | -   | -   | -   | -   | -      | Rapid growth           |
| Mar. 19  | 3.3       | .33 | .23 | .03 | .07 | 4.52   | -                  | -   | -   | -   | -   | -      |                        |
|          |           |     |     |     |     | 6.68*  |                    |     |     |     |     |        |                        |

\* November 13 samples were split -- one-half was washed and analyzed for silica. The silica in washed samples is the last item in the silica columns.

### CONCLUSIONS

1. Little information was available on the relationship of important characteristics of range to the incidence of urolithiasis in range steers.
2. There was a wide spread in the percentage incidence of urolithiasis in steers grazing on six important vegetational types studied. Incidence of urolithiasis in vegetational types containing a substantial amount of palatable shrubs was approximately one-tenth that of the vegetational types containing only grasses or grasses and unpalatable shrubs.
3. On the ranches in this study, there was a ten per cent higher incidence of urolithiasis in range among 1073 steers on "excellent" condition range than in 1310 steers grazing on range in "good" condition. Not enough "fair" and "poor" condition range could be sampled in this study to serve as a basis for even tentative conclusions in regard to those classes.
4. Where overflow and saline upland sites were grazed independently of clayey and savannah sites, there was a low incidence of urolithiasis. Incidence of the disease was high in savannah (pine) sites.
5. A complicated set of factors operate in relationships between range site and urolithiasis. Not all recognized sites were sampled in this study. Therefore, no general conclusion regarding site-urolithiasis relationships can be stated.
6. During each of the two years of this study, the seasonal incidence of urolithiasis varied markedly. Nearly all cases occurred between October 1 and April 15 (during the winter). Occurrence of urolithiasis reached a peak in January during the first year of this study and in late November and early December of the second year. There was a 5.66 per cent

incidence among 2350 cattle the first year and 1.40 per cent among 3140 cattle the second year. A theory is offered that snow cover on range reduced the incidence of urolithiasis in the winter of 1955-56. Intake of cured range grass, particularly short plants, together with increased feeding of good quality hay, was effective in reducing the incidence from the previous winter.

7. There was a highly significant correlation between the amount of phosphorus, calcium, potassium, magnesium, and silica in range forage samples and urolithiasis in steers on ranches studied. The relationship was positive in the case of silica and negative in the case of the other minerals.

8. A distinct annual trend in the amount of silica in seven range grasses and one sedge was traced. It was highest during December and January and lowest during the rapid growth stages in June and July. Blue grama and threadleaf sedge were higher in silica and showed a more extreme trend than the mid-grasses. Silica exceeded the combined amounts of all other minerals in the plants. Seasonal trends in silica coincided with the seasonal trends in urolithiasis.

9. Calcium followed a modified trend to that of silica but occurred in much lesser amounts in range grasses and the one sedge studied.

Potassium, magnesium, and phosphorus were higher in the summer and lower in the fall and winter.

10. Additional research on this problem is needed.

11. Based on this preliminary study the following plants are tentatively grouped as to influence in urolithiasis incidence.

| Protective        | Intermediate          | Conducive                                   |
|-------------------|-----------------------|---------------------------------------------|
| Native plants     | Early cut native hays | Weathered mature native grasses and a sedge |
| Silver sagebrush  |                       | Blue grama                                  |
| Nuttall saltbush  |                       | Threadleaf sedge                            |
| Winterfat         |                       | Needle-and-thread                           |
| Willow            |                       | Western wheatgrass                          |
| Greasewood        |                       | Green needlegrass                           |
|                   |                       | Others                                      |
| Introduced Plants | Smooth Bromegrass     | Mature timothy                              |
| Alfalfa           |                       | Dirty oat hay                               |
| Sweet Clover      |                       |                                             |



Figure 20. Greasewood heavily grazed. Cattle on this ranch received supplemental roughage (alfalfa-grass hay) in the late fall. Had no urolithiasis.

### SUMMARY

Practical cattlemen and research workers have ranked urolithiasis as one of the great nutritional disease problems of the cattle industry in the Great Plains.

This exploratory study was conducted for the purpose of developing a better understanding of the factors in range lands which surround the urolithiasis (water-belly) problem in range cattle and was conducted in such a manner as to give rise to as many sound bases as possible for more intensive research into the problem. This study explored the relationships of range vegetational types, range condition, and range sites to the incidence of urolithiasis in range steers.

Ranches were studied in pairs. The two ranch units in a pair were selected for contrasting experiences with urolithiasis and also for as much comparability as possible as to size, kind of cattle, climatic conditions, management, etc. Information was obtained by actual visits to ranch units over a period of two years.

Twenty-five ranches were included in this study. Twenty-two were studied in pairs and three singly.

In a corollary study on range forage mineral content, samples of important grasses and one sedge were taken at two-week intervals May through January and at monthly intervals February through April. All samples for this part of the study were taken from one ranch and in the same location, nine miles northwest of Ashland, Montana. They were analyzed for minerals and protein.

Information on the seasonal incidence of urolithiasis, mineral

content of typical range forage consumed by livestock on south central and southeastern Montaña ranches, and mineral content of water consumed by range livestock was obtained.

The paired-ranch study revealed a wide spread in the percentage of incidence of urolithiasis in six vegetational types encountered. Incidence of urolithiasis in vegetational types containing a substantial amount of palatable shrubs was approximately one-tenth that of the vegetational types containing only grasses or grasses and unpalatable shrubs.

There appeared to be no strong relationship between the incidence of urolithiasis and range condition. However, there were several instances where ranches in a higher state of range condition had a higher incidence of urolithiasis than units with much lower range condition. The urolithiasis incidence was 4.66 per cent in good condition range and 5.13 per cent in steers on excellent range.

A complicated set of factors operate in relationships between range site and urolithiasis. Seasonal fluctuations in rainfall and lack in uniformity and size of range sites on ranches in this study prevented establishment of absolutely clear relationships.

Where overflow and saline upland sites were grazed independently of clayey and savannah sites, there was a low incidence of urolithiasis.

During each of the two years of this study, the seasonal incidence of urolithiasis varied markedly. Nearly all cases occurred between October 1 and April 15 (during the winter). Occurrence of urolithiasis reached a peak in January during the first year of this study (1954-55). In the

second year of the study, a peak in the incidence was reached in late November and early December. There was a 5.62 per cent incidence among 2350 cattle the first year and 1.40 per cent among 3140 cattle the second year. The difference in the seasonal incidence in these two years and the difference in the percentage incidence was attributed to a difference in snow cover on range forage. Below normal precipitation in November and December the first year permitted the cattle to graze out most of the winter. Higher than normal precipitation (snow) during the second November and December forced ranchers to take the cattle off range and place them on supplemental feed in many cases. Even in areas where snow cover was shallow enough to permit grazing on range during the winter of 1955-56, short plants such as blue grama and threadleaf sedge were inaccessible to livestock because of snow cover. It is theorized that a reduced intake of these and other short plants and the feeding of good quality hays may have played a part in reducing the incidence of urolithiasis during the second winter.

The study of minerals in range forage during the urolithiasis season revealed a highly significant relationship between the amount of phosphorus, calcium, magnesium, and silica and urolithiasis. The relationship was positive in the case of silica and negative in the case of the other minerals.

A distinct seasonal trend in the amount of silica in seven range grasses and one sedge was discovered. According to these analyses, silica was highest during December and January and lowest during the rapid growth stages in June and July. "Short grasses" were higher in

silica and showed a more extreme trend than the mid-grasses. Content of silica in species sampled ranged from approximately three per cent in the early summer to over 11 per cent in the winter. Silica exceeded the combined amounts of all other minerals in the plants.

Seasonal trends in silica coincided with the seasonal trends in urolithiasis.

Calcium followed a modified trend to that of silica but seldom exceeded .25 per cent. Potassium, magnesium, and phosphorus were higher in the summer and lower in the winter.

Additional research is needed to find the tolerance of steers to silica in forages, the relationship of other minerals to such tolerance, and to develop range management practices which will enable ranchers to reduce the losses caused by urolithiasis in cattle.

### RECOMMENDED RESEARCH

These recommendations for research into the range urolithiasis problem are based upon information gained and conclusions reached as a result of several years of formal and informal study of this problem in Montana, Colorado, and Utah.

The order in which these recommendations are presented is not intended as a rating of suggested priority.

1. Joint range and nutrition studies

- A. Develop methods and materials for protective feeding of range steers in the mixed grass vegetational type, the mixed grass-desert shrub transition, and the ponderosa pine-bunchgrass type range in Montana.

- B. Feeding alfalfa pellets to calves on grass range in the fall and winter.

2. Range Management

- A. Development of all and winter urolithiasis protective pastures.

- (1) Temporary fall pastures

- (2) Permanent pastures

- B. Development of native range with a desirable population of palatable range shrubs through management and mechanical seeding of saltbushes, winterfat, caragana, etc. on adaptable sites.

- C. Establish a comprehensive study of mineral content of all important range plants of Montana, including native and introduced plants adapted to Montana.
- D. Establish a project designed to re-evaluate the place of palatable shrubs in climax range.

3. Nutritional studies

Through feeding trials attempt to establish the relationship of sodium, potassium, and calcium absorption and resorption to solubility of urine solids as a means of establishing nutritional mineral balances conducive to high continuous solubility of silica in the urine of cattle and sheep.



Figure 21. Roadside general view of same area shown in Figure 20. (See ungrazed greasewood plants in foreground outside the pasture.)

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## A P P E N D I X

TABLE XVII. UNIT COMPARISONS AND SINGLE UNIT DESCRIPTIONS; A STUDY OF CHARACTERISTICS OF RANGELAND IN RELATION TO INCIDENCE OF UROLITHIASIS

PAIR 1

Unit A

Unit B

Location

20 miles northwest of Roundup,  
Montana

20 miles northwest of Roundup,  
Montana

A fence divides these two units.

Urolithiasis Incidence

Winter of 1954-55

Eight cases. Six occurred Dec.  
15 to Dec. 27, 1954, and two  
cases Dec. 27, 1954 to Jan. 28,  
1955.

Winter of 1954-55

None

Winter of 1955-56

Two cases about Dec. 10, 1955.

Winter of 1955-56

Two cases. One Nov. 18 and  
another Nov. 30.

Cattle

Herefords. 70 steer calves Oct.  
1 to Dec. 20, 1954 when weaned. 90  
steer calves Oct. 1 to Nov. 18, 1955.  
Stock generally in good condition.

Herefords. 40 steers Nov. 20 to  
Dec. 20, 1954 when weaned. 100  
steer calves Oct. 1 to Dec. 8, 1955.  
General condition of cattle is  
slightly better than on Unit A.

Size of Unit

3,200 acres.

3,200 acres.

Soils

Zonal brown, alluviated residual from  
shale and sandstone. Fine sandy clay.

Zonal brown, alluviated residual  
from shale and sandstone. Sandy  
clay.

Rainfall Belt

10 to 14 inches

10 to 14 inches

Sites

1. Overflow (10% of pasture)  
Slope - 3%  
Permeability - 2
2. Clayey (90% of area pasture)  
Slope - 8 to 25%  
Permeability - 3

1. Clayey (80% of area)  
Slope - 5 to 25%  
Permeability - 3
2. Clayey (20% of area)

Vegetational Type

Mixed grass - Desert shrub complex

Desert shrub-mixed grass  
saltbush complex.

Range Condition

Site 1 - 54 (good)  
Site 2 - 65 (good)  
Pasture - 60 (good)

Site 1 - 47 (fair)  
Site 2 - 55 (good)  
Pasture - 52 (fair)

PAIR 1 (continued)

Unit A

Unit B

Utilization

Cattle grazed "short-grass" forb cover 80% of time. Small areas of silver sagebrush grazed moderately (20-30%)

Cattle grazed sagebrush mixed grass type 60% of time. Remaining 40% divided between short-grass and crested wheat-grass. Saltbush and winterfat were grazed.

Supplemental Feed

None Oct. 1 to Dec. 20, 1954. Alfalfa hay 90%, grass hay 10% beginning Dec. 20, 1954. 2nd year (1955-56) calves were weaned Nov. 18 and moved to feed yards (alfalfa hay 7.5 pounds and rolled barley 2.5 pounds per day). 25 steer calves were removed to alfalfa meadow Oct. 1, 1955. No urinary calculi in these 25.

None in fall up to Dec. 20, 1954, when they were put on alfalfa hay - 90%, grass-10% ration. 2nd year they were fed 3 to 4 pounds hay per day after Nov. 24 to Dec. 8, 1956, when removed to feed yards and fed 7.5 pounds alfalfa hay and 2.5 pounds rolled barley per day.

Forage Analysis (per cent)

|            | Unit A       |        | Unit B |        |
|------------|--------------|--------|--------|--------|
|            | Site 1 and 2 | Site 1 | Site 1 | Site 2 |
| Protein    | 3.9          | 6.9    |        | 4.5    |
| Phosphorus | .06          | .10    |        | .08    |
| Calcium    | .77          | .59    |        | .38    |
| Magnesium  | .45          | .32    |        | .18    |
| Potassium  | .29          | .63    |        | .32    |
| Silica     | 12.90        | 4.98   |        | 8.15   |

Water Analysis (per cent)

|            | Unit A  |         | Unit B       |
|------------|---------|---------|--------------|
|            | Site 1  | Site 2  | Site 1 and 2 |
| Calcium    | .0105   | .0062   | .0050        |
| Phosphorus | .000014 | .000064 | .000002      |
| Silica     | .00022  | .00100  | .00071       |

PAIR 1 (continued)

Range Condition and Utilization:

|                                                       | Volume In<br>Range-% | Maximum In<br>Climax-% | Condition<br>Score-% | Utiliza-<br>tion-% |
|-------------------------------------------------------|----------------------|------------------------|----------------------|--------------------|
| Unit A-site 1. Overflow (one tenth of area of Unit A) |                      |                        |                      |                    |
| Western wheatgrass                                    | 20                   | 30                     | 20                   | 35                 |
| Big sagebrush                                         | 30                   | 5                      | 5                    | -                  |
| Silver sagebrush                                      | 20                   | 5                      | 5                    | 15                 |
| Needle-and-thread                                     | 10                   | 20                     | 10                   | 50                 |
| Threadleaf sedge                                      | 6                    | 5                      | 5                    | 65                 |
| Sandberg bluegrass                                    | 4                    | 5                      | 4                    | 50                 |
| Blue grama                                            | 5                    | 10                     | 5                    | 35                 |
| Saltgrass ( <i>Distichilis stricta</i> )              | 5                    | -                      | -                    | 10                 |
| Total                                                 | 100                  | xxx                    | 54                   | xxx                |
| Unit A-site 2. Clayey (nine-tenths of area of Unit A) |                      |                        |                      |                    |
| Western wheatgrass                                    | 25                   | 30                     | 25                   | 35                 |
| Needle-and-thread                                     | 25                   | 20                     | 20                   | 50                 |
| Blue grama                                            | 15                   | 10                     | 10                   | 35                 |
| Threadleaf sedge                                      | 10                   | 5                      | 5                    | 65                 |
| Forbs (increasers)                                    | 10                   | 5                      | 5                    | 15                 |
| Cactus ( <i>Opuntia</i> spp)                          | 10                   | -                      | -                    | -                  |
| Needleleaf sedge                                      | 5                    | -                      | -                    | 10                 |
| Total                                                 | 100                  | xxx                    | 65                   | xxx                |
| Unit B-site 1. Clayey (80 per cent of area of Unit B) |                      |                        |                      |                    |
| Big sagebrush                                         | 60                   | 5                      | 5                    | 1                  |
| Needle-and-thread                                     | 9                    | 20                     | 9                    | 30                 |
| Western wheatgrass                                    | 12                   | 30                     | 12                   | 35                 |
| Threadleaf sedge                                      | 5                    | 5                      | 5                    | 30                 |
| Blue grama                                            | 3                    | 10                     | 3                    | 20                 |
| Sandberg bluegrass                                    | 3                    | 5                      | 3                    | 35                 |
| Winterfat                                             | 2                    | 5                      | 2                    | 45                 |
| Nuttall saltbush                                      | 2                    | 5                      | 2                    | 45                 |
| Canby bluegrass ( <i>Poa canbii</i> )                 | 2                    | D*                     | 2                    | 50                 |
| Green needlegrass                                     | 2                    | D                      | 2                    | 30                 |
| Cactus                                                | 2                    | -                      | -                    | -                  |
| Total                                                 | 100                  | xxx                    | 47                   | xxx                |
| Unit B-site 2. Clay (20 per cent of area of Unit B)   |                      |                        |                      |                    |
| Blue grama                                            | 35                   | 10                     | 10                   | 20                 |
| Western wheatgrass                                    | 25                   | 30                     | 25                   | 30                 |
| Threadleaf sedge                                      | 15                   | 5                      | 5                    | 30                 |
| Needle-and-thread                                     | 12                   | 20                     | 12                   | 30                 |
| Cactus                                                | 7                    | -                      | -                    | -                  |
| Green needlegrass                                     | 3                    | D                      | 3                    | 35                 |
| Forbs                                                 | 3                    | -                      | -                    | -                  |
| Total                                                 | 100                  | xxx                    | 55                   | xxx                |

\* D = Decreaser. All is counted toward range condition score.

PAIR 2

Unit C

Unit D

Location

10 miles south and three miles west of Sumatra, Montana. 15 miles northeast of Melstone, Montana.

Urolithiasis Incidence

Winter of 1954-55

Twenty cases. Eight cases appeared in late Nov. and up to Dec. 28. The remaining 12 cases occurred intermittently until Feb. 5.

Winter of 1954-55

One case in February

Winter of 1955-56

None

Winter of 1955-56

Two cases. Feb. 2 and Feb. 29 respectively.

Cattle

Winter of 1954-55

Herefords - 212 steer calves.

All but 53 of these summered on site 1 of this Unit. 53 calves summered on Unit D of this pair until Nov. 20 when they were moved to site 1 of this Unit.

Calves were castrated at about 2 months of age.

Cattle in fair to good condition.

Winter of 1955-56

151 Hereford steer calves.

Winter of 1954-55

90 head of Hereford steer calves.

Winter of 1955-56

120 head of Hereford steer calves generally castrated at about 2 months of age. Cows naturally wean calves in Feb. Condition of cattle quite similar to that of Unit C of this pair.

Size of Unit

3,250 acres

14,720 acres

Soils

Zonal brown, alluviated residual from shale and sandstone. Fine sandy clay to sandy clay.

Azonal grey to light brown, immature alluviated residual from shale and sandstone. Sandy clay to dense clay.

Rainfall Belt

10 to 14 inches

10 to 14 inches

Sites

1. Clayey

Slope - 0 to 25%

Permeability - Slow to moderately slow.

1. Clayey

Slope - 4 to 20%

Permeability-Slow, some evidence of salt accumulation and alkali.

2. Clayey

Slope 3 to 10%

Permeability-Moderately slow. Very slight salt and alkali accumulation.

PAIR 2 (continued)

Unit C

Unit D

Vegetational Type

Mixed grass-Desert shrub transition      Desert shrub-mixed grass-saltbush complex.

Range Condition

Site 1 - 81 (excellent)      Site 1 - 53 (good)  
Site 2 - 43 (fair)  
Pasture - 51 (good)

Utilization

Cattle grazed mostly on grasses.      Extensive utilization of grease-  
Utilization of silver sagebrush in the wood, saltbush, silver sagebrush  
1954-55 winter was light. The small and western wheatgrass.  
amount of saltbush in this pasture  
was probably grazed off before the  
fall season. In the winter of 1955-  
56, there was a noticeable increase  
in the grazing of silver sagebrush.

Supplemental Feed

Winter of 1954-55

Calves received 1.3 pounds of oats  
and .33 pounds of pellets apiece  
beginning Dec. 28. Crested wheat-  
grass hay was fed at 6 pounds per  
head per day beginning Feb. 1.

Winter of 1955-56

Cattle received monosodium  
phosphate and trace mineralized  
salt mixed at the ratio of 40 to  
60, along with 150 pounds of bran  
self fed on summer range. Consump-  
tion was good. The first 70 head of  
steers were weaned and brought in  
from summer pasture Nov. 29 and fed  
5 pounds of alfalfa hay, 5 pounds  
of crested wheatgrass hay, 1 pound  
of oats and a commercial mineral.  
The second group of approximately  
80 were brought in from range Jan. 11  
and given the same feed. Both calculi  
cases were in the 80 head. None in  
the early weaned group.

Winter of 1954-55

Calves received 1 1/2 pounds of  
cottonseed cake per day per  
head and free access to mineral-  
ized block salt. Calves re-  
mained on cows until Feb. 1.

Winter of 1955-56

Wintered calves on alfalfa hay  
at 5 pounds per day plus 2  
pounds of cottonseed cake per  
head per day with free access  
to rock salt. Watered on  
Musselshell River.

PAIR 2 (continued)

|            | <u>Forage Analysis (per cent)</u> |      |        |        |         |
|------------|-----------------------------------|------|--------|--------|---------|
|            | Unit C                            |      |        | Unit D |         |
|            | Site 1                            | Hay  | Site 1 | Site 2 | Alfalfa |
| Protein    | 4.5                               | 9.5  | 5.6    | 5.7    | 12.7    |
| Phosphorus | .06                               | .12  | .08    | .11    | .13     |
| Calcium    | .40                               | .87  | .48    | .45    | 1.28    |
| Magnesium  | .23                               | .29  | .22    | .18    | .44     |
| Potassium  | .28                               | 1.96 | .51    | .48    | 2.42    |
| Silica     | 7.22                              | 0.68 | 4.51   | 3.84   | 0.33    |

|            | <u>Water Analysis (per cent)</u> |         |
|------------|----------------------------------|---------|
|            | Unit C                           | Unit D  |
| Calcium    | .0035                            | .0105   |
| Phosphorus | .000003                          | .000016 |
| Silica     | .00138                           | .00085  |

PAIR 2 (continued)

Range Condition and Utilization:

|                      | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utiliza-</u><br><u>tion-%</u> |
|----------------------|------------------------------------|--------------------------------------|------------------------------------|----------------------------------|
| Unit C               |                                    |                                      |                                    |                                  |
| Western wheatgrass   | 29                                 | 30                                   | 29                                 | 25                               |
| Needle-and-thread    | 22                                 | 20                                   | 22                                 | 25                               |
| Big sagebrush        | 13                                 | 5                                    | 5                                  | -                                |
| Threadleaf sedge     | 7                                  | 5                                    | 5                                  | 40                               |
| Junegrass            | 5                                  | 15                                   | 5                                  | 25                               |
| Fringed sagewort 1/  | 4                                  | -                                    | -                                  | -                                |
| Bluebunch wheatgrass | 4                                  | D                                    | 4                                  | 20                               |
| Silver sagebrush     | 6                                  | 5                                    | 5                                  | 3-5% in<br>1955-56               |
| Blue grama           | 3                                  | 5                                    | 3                                  | 20                               |
| Little bluestem 2/   | 3                                  | D                                    | 3                                  | 5                                |
| Broom snakeweed      | 2                                  | -                                    | -                                  | -                                |
| Plains muhly 3/      | 2                                  | -                                    | -                                  | -                                |
| Total                | 100                                | xxx                                  | 81                                 | xxx                              |

Unit D - site 1

|                      |     |     |    |     |
|----------------------|-----|-----|----|-----|
| Big sagebrush        | 30  | 5   | 5  | -   |
| Western wheatgrass   | 24  | 25  | 24 | 40  |
| Cactus               | 15  | -   | -  | -   |
| Needle-and-thread    | 8   | 20  | 8  | 35  |
| Sandberg bluegrass   | 3   | 5   | 3  | 40  |
| Blue grama           | 3   | 10  | 3  | 25  |
| Fringed sagewort     | 3   | -   | -  | -   |
| Greasewood           | 5   | 5   | 5  | 35  |
| Threadleaf sedge     | 2   | 5   | 2  | 40  |
| Plains muhly         | 2   | -   | -  | -   |
| Saltbush             | 2   | -   | 2  | 60  |
| Forbs                | 2   | -   | -  | -   |
| Bluebunch wheatgrass | 1   | D   | 1  | 35  |
| Total                | 100 | xxx | 53 | xxx |

Unit D - site 2 (one-twentieth of entire pasture)

|                    |     |     |    |     |
|--------------------|-----|-----|----|-----|
| Silver sagebrush   | 45  | 10  | 10 | 1   |
| Western wheatgrass | 25  | 20  | 20 | 50  |
| Big sagebrush      | 9   | -   | -  | 1   |
| Cactus             | 5   | -   | -  | -   |
| Needle-and-thread  | 5   | D   | 5  | 40  |
| Sandberg bluegrass | 3   | 5   | 3  | 30  |
| Greasewood         | 2   | 5   | 2  | 40  |
| Fringed sagewort   | 2   | -   | -  | 5   |
| Green needlegrass  | 2   | D   | 2  | 30  |
| Alkali bluegrass   | 1   | D   | 1  | 35  |
| Kentucky bluegrass | 1   | -   | -  | 45  |
| Total              | 100 | xxx | 43 | xxx |

1/ Artemisia frigida. 2/ Andropogon scoparius. 3/ Muhlenburgia cuspidata

PAIR 3

Unit E

Unit F

30 miles southeast of Forsyth, Montana.      Location      20 miles southeast of Bridger, Montana.

Urolithiasis Incidence

Winter of 1954-55

Twenty-two cases. Two cases appeared between Dec. 1 and Dec. 20, twelve cases between Dec. 20 and Jan. 20, seven cases between Jan. 20 and Mar. 5 and one case between Mar. 5 and Mar. 20.

Winter of 1954-55

None

Winter of 1955-56

One case Dec. 5, none since. Water-belly rare on this ranch.

Winter of 1955-56

Two cases (all but sixteen head were sold and moved out by Nov. 3).

Cattle

Winter of 1954-55

Herefords-175 steer calves of good quality and thriftiness.

Winter of 1954-55 (and previous Years)

Usually has about 150 steers.

Winter of 1955-56

170 Hereford steer calves (all but sixteen sold and moved off the place by Nov. 3).

Winter of 1955-56

150 steers, all grade Hereford calves. Calving date Mar. 10 and castration date about May 1.

Size of Unit

Approximately 13,000 acres

8,700 acres (Indian Reservation, Bowler Flat).

Soils

Brown soils of shale and sandstone materials. Sandy clay to sandy clay loam.

Most of pasture grazed by livestock is large, flat, alluvial fan of residual, sedimentary materials largely originating from sandstone and shale. Some igneous materials in soil. Fine sandy clay loams to clay loam.

Rainfall Belt

15 to 19 inches

10 to 14 inches

Sites

1. Overflow

Slope - great variations

Permeability - moderate to slow.

1. Clayey

2. Intermingled clayey and savannah site.

Slope - extreme variations

Permeability - moderate

Vegetational Type

Mixed grassland

Desert shrub-mixed grass transition.

PAIR 3 (continued)

Unit E

Unit F

Range Condition

|                         |           |
|-------------------------|-----------|
| Site 1 - 55 (good)      | 53 (good) |
| Site 2 - 75 (high good) |           |
| Pasture- 73 (high good) |           |

Utilization

Winter of 1954-55

Site 1 was utilized moderately heavy.

Site 2 was grazed lightly with the exception of threadleaf sedge which was grazed moderately to heavy.

Cattle apparently grazed Bowler Flat and toes of ridges once cake feeding started in fall. Most grasses grazed moderately. Needle-and-thread heavy. Spotted heavy grazing on silver sagebrush, heavy grazing on rabbitbrush. Big sagebrush grazed heavier than usual.

Supplemental Feed

Winter of 1954-55

Calves received 1/2 to 1 pound of cottonseed cake per day.

Cattle were brought off range Dec. 1, calves weaned and fed corn silage and alfalfa hay.

Winter of 1955-56

Sixteen calves were fed good quality alfalfa and grass hay.

Forage Analysis (per cent)

|            | Unit E |        | Unit F |
|------------|--------|--------|--------|
|            | Site 1 | Site 2 | Site 1 |
| Protein    | 4.4    | 5.4    | 5.5    |
| Phosphorus | .04    | .06    | .09    |
| Calcium    | .42    | .28    | .50    |
| Magnesium  | .18    | .14    | .25    |
| Potassium  | .14    | .08    | .80    |
| Silica     | 6.59   | 5.73   | 2.42   |

Water Analysis (per cent)

|            | Unit E  |         | Unit F  |
|------------|---------|---------|---------|
|            | Site 1  | Site 2  | Site 1  |
| Calcium    | .0265   | .0125   | .0062   |
| Phosphorus | .000058 | .000005 | .000058 |
| Silica     | .00170  | .00160  | .00058  |

PAIR 3 (continued)

Range Condition and Utilization:

|                      | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utiliza-</u><br><u>tion-%</u> |
|----------------------|------------------------------------|--------------------------------------|------------------------------------|----------------------------------|
| Unit E - site 1      |                                    |                                      |                                    |                                  |
| Western wheatgrass   | 60                                 | 30                                   | 30                                 | 65                               |
| Saltgrass            | 10                                 | 5                                    | 5                                  | 10                               |
| Needle-and-thread    | 5                                  | 10                                   | 5                                  | 60                               |
| Alkali sacation 1/   | 10                                 | D                                    | 10                                 | 40                               |
| Forb (increasers)    | 10                                 | 5                                    | 5                                  | 5                                |
| Forb (invaders)      | 5                                  | -                                    | -                                  | 5                                |
| Total                | 100                                | xxx                                  | 55                                 | xxx                              |
| Unit E - site 2      |                                    |                                      |                                    |                                  |
| Needle-and-thread    | 35                                 | 25                                   | 25                                 | 25                               |
| Western wheatgrass   | 15                                 | 35                                   | 15                                 | 35                               |
| Bluebunch wheatgrass | 15                                 | D                                    | 15                                 | 20                               |
| Cheatgrass brome 2/  | 10                                 | -                                    | -                                  | 15                               |
| Plains muhly         | 5                                  | 5                                    | 5                                  | 5                                |
| Little bluestem      | 5                                  | D                                    | 5                                  | 10                               |
| Blue grama           | 5                                  | -                                    | -                                  | 5                                |
| Prairie sandreed 3/  | 5                                  | D                                    | 5                                  | 15                               |
| Threadleaf sedge     | 5                                  | 10                                   | 5                                  | 50                               |
| Total                | 100                                | xxx                                  | 75                                 | xxx                              |
| Unit F               |                                    |                                      |                                    |                                  |
| Big sagebrush        | 50                                 | 10                                   | 10                                 | 3                                |
| Needle-and-thread    | 15                                 | D                                    | 15                                 | 60                               |
| Western wheatgrass   | 8                                  | 50                                   | 8                                  | 40                               |
| Silver sagebrush     | 8                                  | 5                                    | 5                                  | 35                               |
| Blue grama           | 5                                  | 20                                   | 5                                  | 30                               |
| Fringed sagewort     | 5                                  | 5                                    | 5                                  | 35                               |
| Rabbitbrush          | 4                                  | -                                    | -                                  | 75                               |
| Green needlegrass    | 3                                  | D                                    | 3                                  | 40                               |
| Junegrass            | 2                                  | 15                                   | 2                                  | 40                               |
| Total                | 100                                | xx                                   | 53                                 | xxx                              |

1/ Sporobus cryptandrus

2/ Bromus tectorum

3/ Calamovilfa longifolia

PAIR 4

Unit G

Unit H

Location

20 miles southwest of Ekalaka, Montana on Chalk Buttes road.

10 miles northwest of Forsyth, Montana on the Vananda road.

Urolithiasis Incidence

Winter of 1954-55

Seven cases. Started in Nov. and last case occurred Feb. 15.

None (except one head, a steer calf bought from Colstrip area, Montana for the son's 4H project).

Winter of 1955-56

Three cases. Two of these were Dec. 2 and one more Feb. 20

Cattle

Hereford steer calves, 30 head, fair condition. Usually brought in each year off summer range to winter range Oct. 15 and weaned about Christmas time. Calves Mar. to May and castrates about mid-June.

Winter of 1954-55

Sixteen head of Aberdeen Angus and Aberdeen Angus-Brahman cross steer calves.

Winter of 1955-56

Rancher sold all yearling steers in Sept. and all steer calves Nov. 10. No symptoms of water-belly to that date.

Size of Unit

1,250 acres in addition to several thousand acres of Title III land grazed in common with other ranchers.

Approximately 2,500 acres.

Soils

Grey to brown. Parent material sedimentary. Residual from shale and sandstone. Fine sandy clay with clay loam in coulees.

Parent materials-shale and sandstone. Soils mostly sandy clays to sandy clay loam, with dense clays in coulee bottoms.

Rainfall Belt

10 to 14 inches

10 to 14 inches

Sites

1. Clayey

Slope - general 5 to 8%  
Permeability - slow to moderately slow.

1. Clayey

Slope - rolling to abrupt slopes  
Permeability - slow

2. Clayey

Even sloping bottom land  
Permeability-slow to moderate slow.

3. Thin breaks

Slope - 8 to 60%  
Permeability - slow

4. Overflow

Slope - 3 to 5% southwest  
Permeability-slow to moderately slow.

PAIR 4 (continued)

Unit G

Unit H

Mixed grass-Desert shrub complex      Desert shrub-mixed grass, saltbush complex

Range Condition

Site 1 - 55 (good)      Site 1 - 60 (good)  
                                  Site 2 - 45 (fair)  
                                  Site 3 - 60 (good)  
                                  Site 4 - 40 (fair)  
                                  Pastures - 53 (good)

Utilization

Heaviest use made of western wheat-grass and needle-and-thread. Moderate use of short grasses. Coarse mixed grasses (prairie sandreed and alkali sacaton heavily used.)      Light to moderate use of short grasses and mixed grasses, moderate to heavy use on silver sagebrush, greasewood, canby bluegrass and threadleaf sedge. Cattle were photographed eating silver sagebrush leaves off ground beneath plants.

Supplemental Feed

Winter of 1954-55

This winter was open and cattle could pick extensively on range. Fed 1/2 pound barley, 1/2 pound oats, 1/2 pound cottonseed cake and white granulated salt.

Winter of 1954-55

Feeds yellow corn at 1 pound per head per day during Nov. and Dec. Cattle given supplemental forage, alfalfa hay at 5 pounds per head per day when range is snow covered.

Winter of 1955-56

Steer calves brought in from range about Christmas time and grazed on grain stubble, alfalfa, and fed prairie hay for one month and then fed straight alfalfa hay. No mineral supplement fed either above years.

Forage Analysis (per cent)

|            | Unit G | Unit H                                     |
|------------|--------|--------------------------------------------|
|            | Site 1 | Site 1      Site 2      Site 3      Site 4 |
| Protein    | 4.0    | 4.1      6.4      4.4      6.5             |
| Phosphorus | .06    | .07      .11      .07      .09             |
| Calcium    | .24    | .22      .53      .45      .45             |
| Magnesium  | .17    | .14      .24      .19      .22             |
| Potassium  | .22    | .26      .69      .76      .96             |
| Silica     | 5.71   | 3.02      2.62      4.08      2.21         |

Water Analysis (per cent)

|            | Unit G  | Unit H  |
|------------|---------|---------|
| Calcium    | .0065   | .0020   |
| Phosphorus | .000003 | .000025 |
| Silica     | .00140  | .00042  |

PAIR 4 (continued)

Range Condition and Utilization:

|                                         | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utiliza-</u><br><u>tion-%</u> |
|-----------------------------------------|------------------------------------|--------------------------------------|------------------------------------|----------------------------------|
| Unit G                                  |                                    |                                      |                                    |                                  |
| Big sagebrush                           | 25                                 | 5                                    | 5                                  | -                                |
| Western wheatgrass                      | 20                                 | 35                                   | 20                                 | 35                               |
| Blue grama                              | 10                                 | 10                                   | 10                                 | 30                               |
| Needle-and-thread                       | 10                                 | D                                    | 10                                 | 35                               |
| Saltgrass                               | 5                                  | -                                    | -                                  | 15                               |
| Junegrass                               | 5                                  | 15                                   | 5                                  | 40                               |
| Sageworts ( <u>Artemesia</u> spp)       | 5                                  | -                                    | -                                  | 5                                |
| Curlycup gumweed <u>1/</u>              | 5                                  | -                                    | -                                  | 5                                |
| Grass-Forbs invaders                    | 5                                  | -                                    | -                                  | 5                                |
| Prairie sandreed and alkali<br>sacation | 5                                  | D                                    | 5                                  | 75                               |
| Total                                   | 100                                | xxx                                  | 55                                 | xxx                              |
| Unit H - site 1                         |                                    |                                      |                                    |                                  |
| Western wheatgrass                      | 25                                 | 35                                   | 25                                 | 25                               |
| Big sagebrush                           | 20                                 | 5                                    | 5                                  | -                                |
| Silver sagebrush                        | 5                                  | 5                                    | 5                                  | 8                                |
| Needle-and-thread                       | 5                                  | D                                    | 5                                  | 25                               |
| Greasewood                              | 10                                 | -                                    | -                                  | 25                               |
| Blue grama                              | 10                                 | 10                                   | 10                                 | 15                               |
| Sandberg bluegrass                      | 10                                 | 5                                    | 5                                  | 20                               |
| Cactus                                  | 8                                  | -                                    | -                                  | -                                |
| Green needlegrass                       | 5                                  | D                                    | 5                                  | 25                               |
| Invaders                                | 2                                  | -                                    | -                                  | 5                                |
| Total                                   | 100                                | xxx                                  | 60                                 | xxx                              |
| Unit H - site 2                         |                                    |                                      |                                    |                                  |
| Big sagebrush                           | 40                                 | 5                                    | 5                                  | 1                                |
| Silver sagebrush                        | 15                                 | 5                                    | 5                                  | 5                                |
| Greasewood                              | 15                                 | -                                    | 5                                  | 25                               |
| Western wheatgrass                      | 15                                 | 35                                   | 15                                 | 30                               |
| Blue grama                              | 10                                 | 10                                   | 10                                 | 10                               |
| Canby bluegrass                         | 5                                  | D                                    | 5                                  | 30                               |
| Total                                   | 100                                | xxx                                  | 45                                 | xxx                              |

1/ Grindelia squarrosa

PAIR 4 (continued)

Range Condition and Utilization:

|                              | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utiliza-</u><br><u>tion-%</u> |
|------------------------------|------------------------------------|--------------------------------------|------------------------------------|----------------------------------|
| Unit H - site 3              |                                    |                                      |                                    |                                  |
| Big sagebrush                | 25                                 | 5                                    | 5                                  | -                                |
| Bluebunch wheatgrass         | 15                                 | D                                    | 15                                 | 5                                |
| Western wheatgrass           | 10                                 | D                                    | 10                                 | 20                               |
| Greasewood                   | 5                                  | -                                    | -                                  | 25                               |
| Blue grama                   | 5                                  | 10                                   | 5                                  | 5                                |
| Prairie sandreed             | 5                                  | D                                    | 5                                  | 30                               |
| Canby bluegrass              | 5                                  | D                                    | 5                                  | 20                               |
| Sandberg bluegrass           | 5                                  | 5                                    | 5                                  | 10                               |
| Saltgrass                    | 5                                  | -                                    | -                                  | 5                                |
| Junegrass                    | 5                                  | 10                                   | 5                                  | 20                               |
| Cactus                       | 5                                  | -                                    | -                                  | -                                |
| Phlox and clubmoss <u>1/</u> | 5                                  | -                                    | -                                  | -                                |
| Needle-and-thread            | 3                                  | D                                    | 3                                  | 40                               |
| Threadleaf sedge             | <u>2</u>                           | <u>20</u>                            | <u>2</u>                           | <u>70</u>                        |
| Total                        | 100                                | xxx                                  | 60                                 | xxx                              |
| Unit H - site 4              |                                    |                                      |                                    |                                  |
| Greasewood                   | 65                                 | 10                                   | 10                                 | 20                               |
| Western wheatgrass           | 15                                 | D                                    | 15                                 | 45                               |
| Canby bluegrass              | 5                                  | D                                    | 5                                  | 35                               |
| Silver sagebrush             | 5                                  | 5                                    | 5                                  | 5                                |
| Sandberg bluegrass           | 5                                  | -                                    | -                                  | 10                               |
| Green needlegrass            | <u>5</u>                           | <u>D</u>                             | <u>5</u>                           | <u>20</u>                        |
| Total                        | 100                                | xxx                                  | 40                                 | xxx                              |

1/ Phlox spp and Selaginelli densa respectively

PAIR 5

Unit I

Unit J

Location

10 miles south of Melstone, Montana      5 miles west of melstone, Montana

Urolithiasis Incidence

Winter of 1954-55

Eleven cases including one bull.      No urinary calculi during the last  
First case occurred Nov. 15.      five years (1951 through 1956  
Three cases Nov. 15 to Dec. 15.      winter).  
Six cases Dec. 15 to Mar. 15.  
One bull Jan. 28, 1955

Winter of 1955-56

Nine cases. First case (a  
yearling steer) in late October.  
One calf Nov. 15 and seven  
more Nov. 25 to Dec. 10

Cattle

1954-55.

55 Hereford steer calves and  
10 registered Hereford bulls  
all in good condition.  
Calves weaned Nov. 15

1954-55-56

Keeps an average of 73 steer  
calves and 8 to 10 yearling  
steers. Cattle generally in  
good to excellent condition.

1955-56

Wintered 60 steer calves.

Size of Unit

2,140 acres

Approximately 2,500 acres

Soils

Brown. Residual from shale and  
sandstone. Sandy clay to sandy  
clay loam.

Brown. Residual from shale and  
sandstone. Sandy clay.

Rainfall Belt

10 to 14 inches

10 to 14 inches

Sites

1. Clayey

Slope-3% to steep breaks  
Permeability-slow to moderate

1. Clayey

Slope-3% to steep breaks  
Permeability-slow to  
moderately slow

2. Clayey

Slope-3% to steep breaks  
Permeability-slow to moderately  
slow

Vegetational Type

Ponderosa pine grasslands savannah-  
mixed grass

Ponderosa pine savannah-mixed  
grass

Range Condition

Site 1 - 91 (excellent)

Site 2 - 87 (excellent)

Range condition not checked be-  
cause of snow cover

PAIR 5

Unit I

Unit J

Utilization

Light particularly in summer pasture (site 2). Moderate in site 1 (winter pasture). About the same as Unit I except greater availability and use of silver sagebrush. Cattle usually removed from range about middle of Nov. and placed on alfalfa hay and corn silage feed.

Supplemental Feed

Winter of 1954-55

Calves received one pound per day of soy bean pellets Dec. 1 through the winter. A mineral mix consisting of half trace mineralized salt and half monosodium phosphate was self fed on winter range. Soil is phosphorus deficient. Cattle brought in off range normally about mid-Nov. and grazed on hay and grain aftermath. Winter of 1954-55 Cattle received alfalfa hay, and corn silage at the rate of 7 pounds per day and 14 pounds per day respectively.

Calves were on native range until Nov. 8, then on oat hay and native pasture. Snow kept most of the grass covered beginning Nov. 11. It melted off Nov. 18 and covered again Dec. 23. Oat hay fed while range was snow covered at the rate of 7 pounds of oat hay per day. Salt was force fed at about 2% of the ration for a short time about Dec. 1. Winter of 1955-56 Cattle received 20 pounds of alfalfa silage and 6 pounds of alfalfa hay per day. Water was short on late summer range but ample during winter feed period (Musselshell River water).

Forage Analysis (per cent)

|            | Unit I |        |               | Unit J               |             |             |
|------------|--------|--------|---------------|----------------------|-------------|-------------|
|            | Site 1 | Site 2 | dirty oat Hay | Site 1               | alfalfa hay | corn silage |
| Protein    | 3.5    | 3.6    | 8.0           | (no forage analysis) | 11.7        | 8.2         |
| Phosphorus | .04    | .05    | .10           |                      | .11         | .18         |
| Calcium    | .34    | .30    | 1.00          |                      | .86         | .36         |
| Magnesium  | .18    | .17    | .64           |                      | .44         | .42         |
| Potassium  | .17    | .11    | 2.13          |                      | 2.67        | 1.43        |
| Silica     | 6.26   | 5.25   | 4.31          |                      | 0.23        | 3.70        |

Water Analysis (per cent)

|            | Unit I  |            | Unit J  |
|------------|---------|------------|---------|
|            | Site 1  | well water | Site 1  |
| Calcium    | .0062   | .0185      | .0020   |
| Phosphorus | .000002 | .000036    | .000026 |
| Silica     | .00073  | .00112     | .00034  |

PAIR 5 (continued)

Range Condition and Utilization:

|                                | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utiliza-</u><br><u>tion-%</u><br>Est. |
|--------------------------------|------------------------------------|--------------------------------------|------------------------------------|------------------------------------------|
| Unit I - site 1                |                                    |                                      |                                    |                                          |
| Western wheatgrass             | 21                                 | D                                    | 21                                 | 25                                       |
| Needle-and-thread              | 20                                 | D                                    | 20                                 | 20                                       |
| Threadleaf sedge               | 10                                 | 15                                   | 10                                 | 45                                       |
| Blue grama                     | 7                                  | 5                                    | 5                                  | 20                                       |
| Fringed sagewort               | 7                                  | 5                                    | 5                                  | -                                        |
| Junegrass                      | 6                                  | 10                                   | 10                                 | 15                                       |
| Sandberg bluegrass             | 5                                  | 5                                    | 5                                  | 10                                       |
| Bluebunch wheatgrass           | 5                                  | D                                    | 5                                  | 15                                       |
| Little bluestem                | 5                                  | D                                    | 5                                  | 10                                       |
| Prairie sandreed               | 3                                  | D                                    | 3                                  | 25                                       |
| Phlox                          | 2                                  | 5                                    | 2                                  | -                                        |
| Forbs                          | 9                                  | -                                    | -                                  | 3                                        |
| Total                          | 100                                | xxx                                  | 91                                 | xxx                                      |
| Unit I - site 2 (summer range) |                                    |                                      |                                    |                                          |
| Needle-and-thread              | 32                                 | D                                    | 32                                 | 25                                       |
| Western wheatgrass             | 15                                 | D                                    | 15                                 | 35                                       |
| Bluebunch wheatgrass           | 8                                  | 15                                   | 8                                  | 20                                       |
| Blue grama                     | 6                                  | 5                                    | 5                                  | 10                                       |
| Fringed sagewort               | 6                                  | 5                                    | 5                                  | -                                        |
| Junegrass                      | 5                                  | 10                                   | 5                                  | 25                                       |
| Big sagebrush                  | 4                                  | -                                    | -                                  | -                                        |
| Canby bluegrass                | 3                                  | D                                    | 3                                  | 30                                       |
| Sandberg bluegrass             | 3                                  | 5                                    | 3                                  | 20                                       |
| Green needlegrass              | 3                                  | D                                    | 3                                  | 35                                       |
| Little bluestem                | 3                                  | D                                    | 3                                  | 30                                       |
| Silver sagebrush               | 1                                  | -                                    | -                                  | 5                                        |
| Forb increasers                | 6                                  | -                                    | -                                  | 10                                       |
| Total                          | 100                                | xxx                                  | 87                                 | xxx                                      |

## PAIR 6

## Unit K

## Unit L

30 miles south of Hysham, Montana

Location

4 miles northeast of Warren, Montana (Sage Creek).

Urolithiasis Incidence

Winter of 1955-56

Fourteen cases. First case occurred about Nov. 28 while the calves were still nursing cows. Practically all these cases occurred before the first of the year, 1956. Six died. Eight survived.

None. A previous owner stated that he had run cattle on Sage Creek as early as 1891 and has seen no cases of urinary calculi there. Careful count of calves kept. No serious losses of any kind.

Cattle

55 Hereford steer calves in good general condition.

50 head of Hereford yearling steers and 60 head of steer calves. Condition good.

Size of Unit

6,000 acres

Cattle range over one entire township or approximately 23,000 acres.

Soils

Grey to brown. Residual from shale and sandstone. Mostly sandy clay loam to fine sandy clay loam.

The immature grey soil ranging from heavy clay to sandy clay loam. Some igneous materials in soil along east side of valley.

Rainfall Belt

10 to 14 inches

10 to 14 inches (actually 9 inches average).

Sites

1. Clayey

Slope - 3 to 25%

Permeability-slow to moderately slow.

1. Saline upland

Slope - 3 to 40%

Permeability - slow

2. Clayey

Slope - 2 to 10%

Permeability - slow

Vegetational Type

Ponderosa pine savannah-Mixed grass

Site 1 - Desert shrub-saltbush

Site 2 - Mixed grass-desert shrub "deteriorated" to desert shrub cover.

Range Condition

Site 1 - 66 (good)

Site 1 - 60 (good)

Site 2 - 55 (good)

Pasture - 57 (good)

PAIR 6 (continued)

Unit K

Unit L

Utilization

Livestock apparently grazed to moderate extent the mixed grasses including western wheatgrass and needle-and-thread. Rather heavy grazing on threadleaf sedge and blue grama.

Site 1 - moderate to heavy utilization on most grass species which contributed a small part of the herbage. Grazing on salt-bushes, greasewood and minor species was moderate to heavy. These species contributed a substantial part of the herbage in this site.

Site 2 - moderate to heavy use on grasses and greasewood. Light utilization on big sagebrush and "brown sage".

Supplemental Feed

Cattle were put on a ten pound per day feed of a alfalfa, brome grass, hay mixture of good quality Dec. 18. No more cases up to Mar. 15, 1956.

Yearling steers were removed from range Oct. 1 and placed on alfalfa grass hay feed. Steer calves were removed from range Dec. 15 and placed on alfalfa grass hay feed.

Forage Analysis (per cent)

|            | Unit K |                                | Unit L       |
|------------|--------|--------------------------------|--------------|
|            | Site 1 | Hay, alfalfa, brome, bluegrass | Site 1 and 2 |
| Protein    | 2.8    | 13.5                           | 6.7          |
| Phosphorus | .03    | .16                            | .09          |
| Calcium    | .27    | .59                            | 1.18         |
| Magnesium  | .18    | .41                            | .55          |
| Potassium  | .12    | 1.22                           | 1.03         |
| Silica     | 3.72   | 0.49                           | 3.23         |

Water Analysis (per cent)

|            | Unit K  | Unit L  |
|------------|---------|---------|
| Calcium    | .0030   | .0020   |
| Phosphorus | .000005 | .000019 |
| Silica     | .00086  | .00028  |

PAIR 6 (continued)

Range Condition and Utilization:

|                                   | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utiliza-</u><br><u>tion-%</u><br><u>Est.</u> |
|-----------------------------------|------------------------------------|--------------------------------------|------------------------------------|-------------------------------------------------|
| Unit K                            |                                    |                                      |                                    |                                                 |
| Big sagebrush                     | 30                                 | 5                                    | 5                                  | -                                               |
| Needle-and-thread                 | 20                                 | D                                    | 20                                 | 35                                              |
| Western wheatgrass                | 12                                 | 40                                   | 12                                 | 40                                              |
| Blue grama                        | 9                                  | 10                                   | 9                                  | 20                                              |
| Threadleaf sedge                  | 8                                  | 5                                    | 5                                  | 55                                              |
| Green needlegrass                 | 5                                  | D                                    | 5                                  | 30                                              |
| Bluebunch wheatgrass              | 7                                  | D                                    | 7                                  | 20                                              |
| Red three-awn <u>1/</u>           | 4                                  | -                                    | -                                  | -                                               |
| Cheatgrass brome                  | 3                                  | -                                    | -                                  | 20                                              |
| Forb increasers                   | <u>2</u>                           | <u>-</u>                             | <u>-</u>                           | <u>5</u>                                        |
| Total                             | 100                                | xxx                                  | 63                                 | xxx                                             |
| Unit L - site 1                   |                                    |                                      |                                    |                                                 |
| Big sagebrush                     | 40                                 | 10                                   | 10                                 | 3                                               |
| Nuttall saltbush                  | 15                                 | 20                                   | 15                                 | 60                                              |
| Greasewood                        | 10                                 | 5                                    | 5                                  | 50                                              |
| Indian ricegrass <u>2/</u>        | 5                                  | D                                    | 5                                  | 60                                              |
| Alkali sacaton                    | 5                                  | D                                    | 5                                  | 75                                              |
| Western wheatgrass                | 5                                  | D                                    | 5                                  | 35                                              |
| Plains reedgrass <u>3/</u>        | 5                                  | D                                    | 5                                  | 10                                              |
| Junegrass                         | 5                                  | D                                    | 5                                  | 30                                              |
| Saltgrass                         | 5                                  | 10                                   | 5                                  | 10                                              |
| Rabbitbrush <u>4/</u>             | <u>5</u>                           | <u>-</u>                             | <u>-</u>                           | <u>25</u>                                       |
| Total                             | 100                                | xxx                                  | 60                                 | xxx                                             |
| Unit L - site 2                   |                                    |                                      |                                    |                                                 |
| Big Sagebrush                     | 50                                 | 15                                   | 15                                 | 3                                               |
| Bluebunch wheatgrass              | 10                                 | D                                    | 10                                 | 55                                              |
| Needle-and-thread                 | 10                                 | D                                    | 10                                 | 60                                              |
| Indian ricegrass                  | 5                                  | D                                    | 5                                  | 40                                              |
| Nuttall saltbush                  | 5                                  | 5                                    | 5                                  | 50                                              |
| Greasewood                        | 5                                  | -                                    | -                                  | 60                                              |
| Western wheatgrass                | 5                                  | 55                                   | 5                                  | 30                                              |
| Threadleaf sedge                  | 5                                  | 5                                    | 5                                  | 25                                              |
| Rabbitbrush                       | <u>5</u>                           | <u>-</u>                             | <u>-</u>                           | <u>35</u>                                       |
| Total                             | 100                                | xxx                                  | 55                                 | xxx                                             |
| <u>1/ aristida longiseta</u>      |                                    |                                      |                                    |                                                 |
| <u>2/ oryzopsis hymenoides</u>    |                                    |                                      |                                    |                                                 |
| <u>3/ calamagrostis montana</u>   |                                    |                                      |                                    |                                                 |
| <u>4/ chrysothamnus nauseosus</u> |                                    |                                      |                                    |                                                 |

PAIR 7

Unit M

Unit N

6 miles west, of Melstone, Montana      Location      15 miles north, of Ingomar, Montana

Urolithiasis Incidence

1954-55

1954-55

Nine cases. Seven in Jan. and two in March.

None

1955-56

None

Cattle

Winter of 1954-55

Winter of 1954-55

Herefords calved May and April. 500 head in fair condition. Some apparently in low vigor due partly to lice infestation.

104 steers. Herefords and Angus, part calves and part yearlings. Apparently in good physical condition. Calves were castrated and branded about July 1. Calves 75% weaned by Jan. 1. Has a minimum of fences allowing cattle to move about the range at will. Winter range was all open.

Winter of 1955-56

900 Hereford steer yearlings and 350 Hereford steer calves. These were bought from small herds at the Billings and Lewistown sales yards.

Size of Unit

11,800 acres

16,000 acres

Soils

Parent materials almost entirely sedimentary from sandstone and shale. Sandy clay to clay. Zonal soils brown.

Grey to very light brown zonal soils. Residual mostly from shale, some sandstone. Immature soils. Sandy clay to dense clay.

Rainfall Belt

10 to 14 inches

10 to 14 inches

Sites

1. Clayey

Slope - 2 to 20%

Permeability - moderate

1. Clayey

Slope - 2 to 20%

Permeability-moderate to slow

2. Saline lowland

Slope - 2% to southeast

Permeability - slow

Vegetational Type

Ponderosa pine savannah-mixed grass

Site 1. Mixed grass-desert shrub transition. Nine-tenths of pasture  
Site 2. Desert shrub-saltbush. One-tenth of pasture.

Range Condition

Site 1 - 83 (excellent)

Site 1 - 60 (good)

Site 2 - 52 (low good)

Pasture- 59 (good)

PAIR 7 (continued)

Unit M

Unit N

Utilization

Pasture generally moderately used.  
Use moderate to heavy on threadleaf  
sedge.

Site 1. Pasture moderately used.  
Slightly heavier use on wheatgrass.  
Site 2. Utilization heavy on  
nuttall saltbush and western wheat-  
grass, moderate on greasewood,  
light on silver sagebrush and  
winterfat. Pasture not checked  
1955-56.

Supplemental Feed

Winter of 1954-55

Steers received 1 pound of barley  
per head per day or 1 pound of  
cottonseed cake per head per day.  
Cottonseed cake was 41% protein.

Winter of 1954-55  
None

Winter of 1955-56

900 steer yearlings and 350 steer  
calves were fed corn silage.  
Following two months (Sept. and  
Oct.) grazing in river bottom  
pastures consisted mostly of  
alfalfa hay aftermath, but includ-  
ing some wild grasses. They were  
put on straight corn silage ration  
by mid-Nov. and were still on this  
ration Feb. 25. Apparently in  
addition to the corn silage, the  
calves and steers had access to  
alfalfa hay in feeders.

Forage Analysis (per cent)

Unit M

Unit N

|            | Site 1 | alfalfa hay | Site 1 | Site 2 |
|------------|--------|-------------|--------|--------|
| Protein    | 3.7    | 12.7        | 6.7    | 9.9    |
| Phosphorus | .05    | .13         | .10    | .08    |
| Calcium    | .32    | 1.28        | .59    | 1.16   |
| Magnesium  | .14    | .44         | .29    | .80    |
| Potassium  | .17    | 2.42        | .58    | .90    |
| Silica     | 5.30   | 0.33        | 2.28   | 3.36   |

Water Analysis (per cent)

Unit M

Unit N

|            |         |         |
|------------|---------|---------|
| Calcium    | .0030   | .0095   |
| Phosphorus | .000006 | .000028 |
| Silica     | .00092  | .00093  |

PAIR 7 (continued)

Range Condition and Utilization:

|                      | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utiliza-</u><br><u>tion-%</u><br>Est. |
|----------------------|------------------------------------|--------------------------------------|------------------------------------|------------------------------------------|
| Unit M               |                                    |                                      |                                    |                                          |
| Needle-and-thread    | 35                                 | 30                                   | 30                                 | 30                                       |
| Western wheatgrass   | 25                                 | 35                                   | 25                                 | 35                                       |
| Bluebunch wheatgrass | 6                                  | D                                    | 6                                  | 30                                       |
| Blue grama           | 5                                  | 10                                   | 5                                  | 20                                       |
| Threadleaf sedge     | 5                                  | 5                                    | 5                                  | 45                                       |
| Sandberg bluegrass   | 5                                  | 5                                    | 5                                  | 25                                       |
| Fringed sagewort     | 5                                  | -                                    | -                                  | 5                                        |
| Junegrass            | 5                                  | 15                                   | 5                                  | 30                                       |
| Little bluestem      | 3                                  | D                                    | 3                                  | 20                                       |
| Silver sagebrush     | 2                                  | 5                                    | 2                                  | 10                                       |
| Invaders             | 2                                  | -                                    | -                                  | 5                                        |
| Forbs                | 2                                  | 2                                    | 2                                  | 5                                        |
| Total                | 100                                | xxx                                  | 83                                 | xxx                                      |
| Unit N - site 1      |                                    |                                      |                                    |                                          |
| Western wheatgrass   | 30                                 | 35                                   | 30                                 | 40                                       |
| Silver sagebrush     | 5                                  | 5                                    | 5                                  | 5                                        |
| Big sagebrush        | 10                                 | 5                                    | 5                                  | -                                        |
| Fringed sagewort     | 7                                  | -                                    | -                                  | -                                        |
| Needle-and-thread    | 13                                 | 30                                   | 8                                  | 25                                       |
| Greasewood           | 3                                  | -                                    | -                                  | 10                                       |
| Nuttall saltbush     | 5                                  | -                                    | -                                  | 45                                       |
| Saltgrass            | 5                                  | -                                    | -                                  | -                                        |
| Plains reedgrass     | 5                                  | 10                                   | 5                                  | -                                        |
| Prairie sandreed     | 5                                  | D                                    | 5                                  | 40                                       |
| Forb increasers      | 5                                  | 2                                    | 2                                  | 10                                       |
| Winterfat            | 3                                  | -                                    | -                                  | 40                                       |
| Annuals              | 5                                  | -                                    | -                                  | 10                                       |
| Total                | 100                                | xxx                                  | 60                                 | xxx                                      |
| Unit N - site 2      |                                    |                                      |                                    |                                          |
| Nuttall saltbush     | 40                                 | 10                                   | 10                                 | 60                                       |
| Big sagebrush        | 15                                 | 5                                    | 5                                  | -                                        |
| Western wheatgrass   | 10                                 | D                                    | 10                                 | 65                                       |
| Greasewood           | 10                                 | 10                                   | 10                                 | 40                                       |
| Silver sagebrush     | 5                                  | 5                                    | 5                                  | 20                                       |
| Winterfat            | 5                                  | 5                                    | 5                                  | 35                                       |
| Saltgrass            | 5                                  | 15                                   | 5                                  | 5                                        |
| Plains reedgrass     | 2                                  | 5                                    | 2                                  | 10                                       |
| Forb increasers      | 3                                  | -                                    | -                                  | 5                                        |
| Total                | 100                                | xxx                                  | 52                                 | xxx                                      |

PAIR 8

Unit O

15 miles northwest of Forsyth,  
Montana

Unit P

10 miles northwest of Forsyth,  
Montana

Urolithiasis Incidence

Winter of 1954-55

Nine cases. Three of these occurred Oct. 1 to Jan. 1, (while still on cows in pasture). Jan. 1 to Feb. 1, four cases (3 Herefords and 1 Angus). Feb. 1 to Mar. 1, two cases, both Herefords.

Winter of 1954-55

One case. This occurred April 3, following a severe storm.

Winter of 1955-56

None

Winter of 1955-56

Three cases. One of these cases occurred prior to Nov. 1 while calves were still on cows. The other two cases occurred between Dec. 1 and Jan. 1. One of the latter two was a Hereford calf, the other was a Aberdeen-Angus calf.

Cattle

Winter of 1954-55

106 Hereford and Aberdeen Angus steer calves. Calved between Apr. 1 and July 1. Castration date about June 20. Late calves castrated at about two weeks of age.

About the same number of calves kept during the 1955-56 winter. All cattle in good to excellent condition.

Winter of 1954-55

75 head of Hereford steer calves. Calved about Apr. and castrated at two weeks to two months of age.

Had about the same number of steer calves during the winter of 1955-56.

All calves in good to excellent condition.

Size of Unit

Approximately 7,500 acres

5,000 acres

Soils

Brown zonal soil of sedimentary sandstone and shale materials. Sandy clay loams.

Sedimentary parent materials of sandstone and shale. Brown zonal soil of sandy loam to sandy clay loam texture.

Rainfall Belt

11 to 14 inches

11 to 14 inches

Sites

1. Clayey

Slope - 2 to 6%

Permeability - moderate

1. Overflow

Slope - 3 to 5%

Permeability-moderate to slow

2. Clayey

Slope - 2 to 4%

Permeability-slow to moderate

PAIR 8 (continued)

Unit O

Unit P

Vegetational Type

Mixed grass

Mixed grass-desert shrub-saltbush type. (Introduced legumes)

Range Condition

Site 1 - 75 (high good)

Site 1 - 51 (low good)

Site 2 - 85 (excellent)

Pasture- 60

Utilization

Pastures grazed moderately with heaviest grazing on threadleaf sedge and needle-and-thread grass.

Heaviest utilization on shrubs including greasewood and willow. The use of leguminous plants also heavy (alfalfa and yellow blossom sweet clover).

Supplemental Feed

Winter of 1954-55

Calves grazed on site 1 with mothers from Oct. 1 to Jan. 1 and then were moved into the feed-lot and fed a ten-pound per day ration of western wheatgrass hay.

Winter of 1955-56

Calves were taken out of pasture of site 1 Nov. 1 and placed in a lowland pasture and fed a western wheatgrass hay. They grazed range in which there were some shrubs. Short grasses in this pasture were covered with snow nearly all the winter. There was a small amount of greasewood in the hay which was fed to these calves.

Winter of 1954-55 and 1955-56

Supplemental feeding programs very similar. Two-thirds of the steers were grazed on bottom land pasture late summer and fall up to Nov. 20, when they were moved to a bluejoint-alfalfa-sweet clover meadow, where they had access to willows and greasewood. From this pasture, they went into the corral about Dec. 15 and were fed a straight ration of alfalfa hay-western wheatgrass mixture.

The other one-third of steers were pastured in site 2 until Nov. 20th, when they were mixed with the main bunch in site 1. Site 2 of Unit P is very similar to site 1 of Unit O (adjoins it).

Forage Analysis (per cent)

|            | Unit O |              | Unit P |        |           |
|------------|--------|--------------|--------|--------|-----------|
|            | Site 1 | Bluestem hay | Site 1 | Site 2 | Mixed hay |
| Protein    | 4.3    | 8.6          | 5.3    | 6.3    | 7.6       |
| Phosphorus | .05    | .19          | .10    | .10    | .13       |
| Calcium    | .25    | .39          | .76    | .47    | .57       |
| Magnesium  | .14    | .23          | .23    | .21    | .25       |
| Potassium  | .08    | 1.50         | .70    | 1.22   | 1.93      |
| Silica     | 5.84   | 3.09         | 1.02   | 1.84   | 2.09      |

PAIR 8 (continued)

|            | <u>Water Analysis (per cent)</u> |                           |                 |
|------------|----------------------------------|---------------------------|-----------------|
|            | Unit O                           | Unit P                    |                 |
|            | Site 1                           | ranch well (headquarters) | pond in pasture |
| Calcium    | .0090                            | .0060                     | .0360           |
| Phosphorus | .000054                          | .000002                   | .000005         |
| Silica     | .00080                           | .00084                    | .00086          |

PAIR 8 (continued)

Range Condition and Utilization:

|                                 | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utiliza-</u><br><u>tion-%</u><br>Est. |
|---------------------------------|------------------------------------|--------------------------------------|------------------------------------|------------------------------------------|
| Unit O (borders Unit P)         |                                    |                                      |                                    |                                          |
| Western wheatgrass              | 25                                 | 35                                   | 25                                 | 30                                       |
| Needle-and-thread               | 20                                 | 25                                   | 20                                 | 35                                       |
| Big sagebrush                   | 10                                 | 5                                    | 5                                  | -                                        |
| Blue grama                      | 10                                 | 10                                   | 10                                 | 25                                       |
| Threadleaf sedge                | 7                                  | 5                                    | 5                                  | 50                                       |
| Sandberg bluegrass              | 5                                  | 5                                    | 5                                  | 30                                       |
| Bluebunch wheatgrass            | 5                                  | D                                    | 5                                  | 30                                       |
| Cheatgrass brome                | 5                                  | -                                    | -                                  | 40                                       |
| Junegrass                       | 5                                  | 15                                   | 5                                  | 45                                       |
| Sageworts                       | 5                                  | -                                    | -                                  | -                                        |
| Plains muhly                    | 3                                  | -                                    | -                                  | -                                        |
| Total                           | 100                                | xxx                                  | 75                                 | xxx                                      |
| Unit P - site 1                 |                                    |                                      |                                    |                                          |
| Western wheatgrass              | 22                                 | 25                                   | 22                                 | 65                                       |
| Greasewood                      | 14                                 | 5                                    | 5                                  | 25                                       |
| Yellow blossom sweet clover 1/  | 6                                  | -                                    | -                                  | 70                                       |
| Alfalfa                         | 7                                  | -                                    | -                                  | 80                                       |
| Silver sagebrush                | 7                                  | 5                                    | 5                                  | 10                                       |
| Needle-and-thread               | 5                                  | -                                    | -                                  | 40                                       |
| Junegrass                       | 5                                  | -                                    | -                                  | 30                                       |
| Willow                          | 4                                  | 5                                    | 4                                  | 5                                        |
| Bluebunch wheatgrass            | 3                                  | D                                    | 3                                  | 30                                       |
| Snowberry                       | 3                                  | -                                    | -                                  | 5                                        |
| Kentucky bluegrass              | 3                                  | -                                    | -                                  | 70                                       |
| Annuals                         | 5                                  | -                                    | -                                  | 20                                       |
| Red top 2/                      | 1                                  | -                                    | -                                  | 60                                       |
| Red three-awn                   | 1                                  | -                                    | -                                  | -                                        |
| Big sagebrush                   | 2                                  | -                                    | -                                  | -                                        |
| Rose                            | 1                                  | 1                                    | 1                                  | 5                                        |
| Canada wildrye                  | 2                                  | D                                    | 2                                  | 30                                       |
| Green needlegrass               | 2                                  | D                                    | 2                                  | 30                                       |
| Prairie sandreed                | 2                                  | D                                    | 2                                  | 20                                       |
| Other woody plants              | 5                                  | 5                                    | 5                                  | 5                                        |
| Total                           | 100                                | xxx                                  | 51                                 | xxx                                      |
| 1/ <u>Melilotus officinalis</u> |                                    |                                      |                                    |                                          |
| 2/ <u>Agrostis alba</u>         |                                    |                                      |                                    |                                          |
| 3/ <u>Elymus canadensis</u>     |                                    |                                      |                                    |                                          |

PAIR 8 (continued)

Range Condition and Utilization:

|                      | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utiliza-</u><br><u>tion-%</u><br>Est. |
|----------------------|------------------------------------|--------------------------------------|------------------------------------|------------------------------------------|
| Unit P - site 2      |                                    |                                      |                                    |                                          |
| Western wheatgrass   | 30                                 | 35                                   | 30                                 | 50                                       |
| Needle-and-thread    | 27                                 | 25                                   | 25                                 | 40                                       |
| Big sagebrush        | 8                                  | 5                                    | 5                                  | -                                        |
| Bluebunch wheatgrass | 8                                  | D                                    | 8                                  | 40                                       |
| Green needlegrass    | 5                                  | D                                    | 5                                  | 55                                       |
| Sandberg bluegrass   | 5                                  | 5                                    | 5                                  | 25                                       |
| Junegrass            | 5                                  | 15                                   | 5                                  | 30                                       |
| Silver sagebrush     | 3                                  | -                                    | -                                  | 5                                        |
| Cheatgrass brome     | 5                                  | -                                    | -                                  | 30                                       |
| Prairie sandreed     | 2                                  | D                                    | 2                                  | 60                                       |
| Greasewood           | <u>2</u>                           | <u>-</u>                             | <u>-</u>                           | <u>50</u>                                |
| Total                | 100                                | xxx                                  | 85                                 | xxx                                      |

PAIR 9

Unit Q

Unit R

|                                           |                                                          |
|-------------------------------------------|----------------------------------------------------------|
| 30 miles southwest of Forsyth,<br>Montana | <u>Location</u><br>10 miles south of Rosebud,<br>Montana |
|                                           | <u>Urolithiasis Incidence</u>                            |
| Winter of 1954-55<br>Six cases            | Winters of 1954-55 and 55-56<br>None                     |
| Winter of 1955-56<br>None                 |                                                          |

Cattle

|                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hereford-Shorthorn cross and Scotch<br>Highland cattle. Winters approximate-<br>ly 60 steers each year. Sells steers<br>in fall if the season is exceptionally<br>dry, but tries to keep steers to four<br>year olds. This rancher's experience<br>indicates, "Scotch Highland cattle<br>have water-belly too". | 1954-55, 55 steers.<br>1955-56 had 130 head of steer<br>calves (bought 80 and raised 50).<br>Cattle in excellent condition,<br>possibly slightly better condition<br>than on Unit Q. |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

Size of Unit

|             |                                               |
|-------------|-----------------------------------------------|
| 3,500 acres | Approximately 500 acres (no winter<br>range). |
|-------------|-----------------------------------------------|

Soils

|                                                                                                 |                                                                                     |
|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| Chestnut to brown, residual from<br>shale and sandstone. Fine sandy clay<br>loam to sandy clay. | Brown zonal soils. Residual from<br>sandstone and clay. Clay loam to<br>dense clay. |
|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|

Rainfall Belt

|                 |                 |
|-----------------|-----------------|
| 15 to 19 inches | 11 to 14 inches |
|-----------------|-----------------|

Sites

|          |                               |
|----------|-------------------------------|
| Savannah | Cattle not wintered on range. |
|----------|-------------------------------|

Vegetational Type

|                                      |                                                                                 |
|--------------------------------------|---------------------------------------------------------------------------------|
| Mixed grass-ponderosa pine, savannah | Cattle wintered on mixed alfalfa<br>and grass hay. Also grazed on<br>greasewood |
|--------------------------------------|---------------------------------------------------------------------------------|

Range Condition

|                |                              |
|----------------|------------------------------|
| 84 (excellent) | Cattle not wintered on range |
|----------------|------------------------------|

Utilization

|                                                                                                                             |                                          |
|-----------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| Pastures used lightly. Heaviest<br>grazing was on threadleaf sedge,<br>where utilization was only about<br>thirty per cent. | Cattle wintered on alfalfa-grass<br>hay. |
|-----------------------------------------------------------------------------------------------------------------------------|------------------------------------------|

PAIR 9 (continued)

Unit Q

Unit R

Supplemental Feed

|                                 |                                    |
|---------------------------------|------------------------------------|
| Winter of 1954-55               | Feeds full ration of alfalfa-grass |
| None except mineral feeds       | hay mixture beginning mid-Nov.     |
| Winter of 1955-56               | Cattle also get a variety of       |
| Had fewer dry, hot, dusty       | mineral feeds.                     |
| and more moisture late in the   |                                    |
| fall. Cattle remained on range  |                                    |
| with only about five days of    |                                    |
| supplemental feeding of alfalfa |                                    |
| hay. Snow has kept the short    |                                    |
| grasses covered most of the     |                                    |
| time throughout the winter.     |                                    |
| Range utilization light to      |                                    |
| moderate.                       |                                    |

Forage Analysis (per cent)

|            | Unit Q | Unit R            |
|------------|--------|-------------------|
|            |        | alfalfa-grass hay |
| Protein    | No     | 15.2              |
| Phosphorus | Sample | .18               |
| Calcium    |        | 1.09              |
| Magnesium  |        | .39               |
| Potassium  |        | .20               |
| Silica     |        | 0.21              |

Water Analysis (per cent)

|            | Unit Q | Unit R                  |
|------------|--------|-------------------------|
|            |        | Ranch headquarters well |
| Calcium    | No     | .0065                   |
| Phosphorus | Sample | .000003                 |
| Silica     |        | .00180                  |

PAIR 9 (continued)

Range Condition and Utilization:

|                       | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utiliza-</u><br><u>tion-%</u><br>Est. |
|-----------------------|------------------------------------|--------------------------------------|------------------------------------|------------------------------------------|
| Unit Q                |                                    |                                      |                                    |                                          |
| Western wheatgrass    | 20                                 | 35                                   | 20                                 | 20                                       |
| Needle-and-thread     | 15                                 | 20                                   | 15                                 | 25                                       |
| Bluebunch wheatgrass  | 15                                 | D                                    | 15                                 | 20                                       |
| Yarrow and other forb |                                    |                                      |                                    |                                          |
| increasers            | 10                                 | -                                    | -                                  | -                                        |
| Green needlegrass     | 5                                  | D                                    | 5                                  | 20                                       |
| Threadleaf sedge      | 5                                  | 10                                   | 5                                  | 30                                       |
| Blue grama            | 5                                  | 5                                    | 5                                  | 15                                       |
| Sageworts             | 5                                  | 3                                    | 3                                  | -                                        |
| Sandberg bluegrass    | 5                                  | 5                                    | 5                                  | 10                                       |
| Junegrass             | 5                                  | 15                                   | 5                                  | 15                                       |
| Cheatgrass brome      | 3                                  | -                                    | -                                  | 15                                       |
| Little bluestem       | 3                                  | D                                    | 3                                  | 15                                       |
| Prairie sandreed      | 3                                  | D                                    | 3                                  | 20                                       |
| Annuals               | <u>1</u>                           | <u>-</u>                             | <u>-</u>                           | <u>-</u>                                 |
| Total                 | 100                                | xxx                                  | 84                                 | xxx                                      |

Unit R

Cattle not wintered on range.

PAIR 10

Unit S

Unit T

|                                        |                                        |
|----------------------------------------|----------------------------------------|
|                                        | <u>Location</u>                        |
| 10 miles northwest of Ashland, Montana | 12 miles northwest of Ashland, Montana |

Urolithiasis Incidence

|                                                                                                                                                         |                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Winter of 1954-55<br>Six cases. Three of these occurred in Jan. and three occurred between Feb. 1 and Feb. 15, when they were taken out of the pasture. | Winters of 1954-55 and 1955-56<br>None. This rancher formerly wintered his steers on range east of Tongue River and had a ten per cent annual incidence of water-belly. |
| Winter of 1955-56<br>Two cases, both in late Nov. and early Dec.                                                                                        |                                                                                                                                                                         |

Cattle

|                                                                                      |                                            |
|--------------------------------------------------------------------------------------|--------------------------------------------|
| Winter of 1954-55<br>21 Herefords. Twenty steer calves and one three year old steer. | Hereford steer calves - 70 head each year. |
| Winter of 1955-56<br>15 steer calves.                                                |                                            |

Size of Unit

|                              |                                                                                 |
|------------------------------|---------------------------------------------------------------------------------|
| 5,000 acres plus leased land | Cattle not wintered on range except for short periods during winter of 1954-55. |
|------------------------------|---------------------------------------------------------------------------------|

Soils

|                                                                                                                         |                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Chestnut and brown. Parent material, sandstone, scoria cinders and shale. Soil textures, clay loams to sandy clay loam. | Soils in cultivated area where cattle grazed aftermath of alfalfa and small grains in the fall was of the brown soil group with texture of sandy clay loam. |
|-------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|

Rainfall Belt

|                 |                 |
|-----------------|-----------------|
| 15 to 19 inches | 15 to 19 inches |
|-----------------|-----------------|

Sites

|                                                                                                 |                                                                                                                                   |
|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| 1. Savannah<br>Slope - 2 to 30% and steep breaks<br>Permeability - moderately slow to moderate. | No site designation. Range used only for two weeks during fall and winter of 1954-55. This range was similar to site 1 of Unit S. |
|-------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|

Vegetational Type

|                                     |                                                     |
|-------------------------------------|-----------------------------------------------------|
| Mixed grass-ponderosa pine savannah | Cultivated ground, alfalfa and small grain stubble. |
|-------------------------------------|-----------------------------------------------------|

Range Condition

Site 1 - 87 (excellent)

--

PAIR 10 (continued)

Unit S

Unit T

Utilization

Range moderately used except western wheatgrass in coulees and threadleaf sedge and forbs on benches and side hills. Heavy use on these species and alfalfa. these sites. Utilization of threadleaf sedge was extremely heavy by steer cattle in winter time. Grazed principally on cultivated crops both winters. Crops consisted mostly of small grain stubble and alfalfa.

Supplemental Feed

Cattle received a commercial mineral mix throughout the fall and winter. Occasionally during the winter, they received one pound per day of cottonseed pellets per head.

Winter of 1954-55

Cattle were taken off range during the last week of Oct. and given a ration of 5 pounds of corn silage and 5 pounds of alfalfa hay per day up to Dec. 5. During the next month, they foraged on grass, alfalfa, clover, and small grain stubbles. From Jan. 1 to Mar. 1, they were given 5 pounds of hay and 2 pounds of commercial feed concentrate per day. Even while on range, they were receiving a daily ration of about 2.5 pounds of alfalfa hay per day.

Winter of 1955-56

Steers were taken off range Nov. 15 and fed a ration of 25 pounds of corn silage and 10 pounds of alfalfa hay per day throughout the winter.

Forage Analysis (per cent)

|            | Unit S | Unit T      |
|------------|--------|-------------|
|            | Site 1 | Alfalfa hay |
| Protein    | 7.0    | 16.9        |
| Phosphorus | .07    | .17         |
| Calcium    | .27    | 2.11        |
| Magnesium  | .14    | .58         |
| Potassium  | .22    | 2.62        |
| Silica     | 4.78   | 0.09        |

Water Analysis (per cent)

No Sample

PAIR 10 (continued)

Range Condition and Utilization:

|                           | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utilization</u><br><u>%</u><br>Est. | <u>By</u><br><u>Clipping*</u> |
|---------------------------|------------------------------------|--------------------------------------|------------------------------------|----------------------------------------|-------------------------------|
| Unit S                    |                                    |                                      |                                    |                                        |                               |
| Western wheatgrass        | 40                                 | 35                                   | 35                                 | 55                                     | 71                            |
| Needle-and-thread         | 20                                 | 25                                   | 20                                 | 30                                     | 26                            |
| Junegrass                 | 5                                  | D                                    | 5                                  | 25                                     | 49                            |
| Threadleaf sedge          | 5                                  | 10                                   | 5                                  | 55                                     | 66                            |
| Blue grama                | 5                                  | 5                                    | 5                                  | 25                                     | 33                            |
| Sandberg bluegrass        | 5                                  | 5                                    | 5                                  | 30                                     | 47                            |
| Green needlegrass         | 5                                  | D                                    | 5                                  | 25                                     | 27                            |
| Bluebunch wheat-<br>grass | 5                                  | D                                    | 5                                  | 20                                     | 24                            |
| Prairie sandreed          | 2                                  | D                                    | 2                                  | 20                                     | **                            |
| Forbs                     | 3                                  | -                                    | -                                  | 10                                     | 55                            |
| Cheatgrass brome          | 5                                  | -                                    | -                                  | 30                                     | 17                            |
| Total                     | 100                                | xxx                                  | 87                                 | xxx                                    | xxx                           |

Unit T

Cattle not winter-  
ed on range

\* As determined by clip quadrat method. Twelve quadrats were clipped.  
\*\* None in quadrats clipped.

PAIR 11

Unit S

Unit U

9 miles northwest of Ashland,  
Montana

Location

3 miles southwest of Colstrip,  
Montana on Castle Rock road

Urolithiasis Incidence

Winter of 1954-55

Six cases. Three of these  
occurred in Jan. and two oc-  
curred between Feb. 1 and Feb.  
15 when they were taken out of  
the pasture.

Winter of 1954-55

One case (a bull in early Dec.  
of 1954).

Winter of 1955-56

One case. A steer.

Winter of 1955-56

Two cases, both in late Nov.  
and early Dec.

Cattle

Winter of 1954-55

21 Herefords, Twenty steer  
calves and one three year old  
steer.

Herefords - high grade steer calves  
and bull calves. Had approximately  
60 bulls and 70 steers each year of  
1954-55 and 1955-56.

Winter of 1955-56

15 steer calves.

Size of Unit

5,000 acres plus leased land.

Approximately 7,000 acres.

Soils

Chestnut and brown. Parent material,  
sandstone, scoria cinders and shale.  
Soil textures, clay loams to sandy  
clay loams.

Zonal brown. Residual from shale  
and sandstone. Texture fine sandy  
clay to sandy clay.

Rainfall Belt

15 to 19 inches

15 to 19 inches

Sites

1. Savannah

Slope - 2 to 30% and steep  
breaks

Permeability - moderately slow  
to moderate

1. Savannah

Slope - 2 to 20%

Permeability - moderately slow  
to moderate

Vegetational Type

Mixed grass-ponderosa pine  
savannah

Mixed grass-ponderosa pine  
savannah

Range Condition

Site 1 - 87 (excellent)

85 - (excellent)

PAIR 11 (continued)

Unit S

Unit U

Utilization

Range moderately used except western wheatgrass in coulees and threadleaf sedge and forbs on benches and side hills. Heavy use on these species and these sites. Utilization of threadleaf sedge was extremely heavy by steer cattle in the winter time.

Pasture showed moderate use in 1955-56. There was a wide variety of grasses, forbs, and shrubs available and utilized by the stock. Considerably less threadleaf sedge on this site than on some of the other comparable units. Moderate grazing on silver sagebush, rosebush, ash, boxelder, and rabbitbrush.

Supplemental Feed

Cattle received a commercial mineral mix throughout the fall and winter. Occasionally during the winter, they received one pound per day of cottonseed pellets per head.

A supplemental feeding program of the winters of 1954-55 and 1955-56 was very similar. Steer calves and bull calves received supplemental forage and were allowed to graze nearby range. Steers received 5 to 6 pounds per head per day of a mixed alfalfa, corn, cheatgrass silage.

Forage Analysis (per cent)

|            | Unit S | Unit U                    |
|------------|--------|---------------------------|
|            | Site 1 | alfalfa-cheatgrass silage |
| Protein    | 7.0    | 7.1                       |
| Phosphorus | .07    | .16                       |
| Calcium    | .27    | 2.27                      |
| Magnesium  | .14    | .69                       |
| Potassium  | .22    | 2.85                      |
| Silica     | 4.78   | 0.25                      |

Water Analysis (per cent)

|            | Unit S | Unit U                      |
|------------|--------|-----------------------------|
|            | No     | well west pasture           |
| Calcium    | Sample | winter pasture and feed-lot |
| Phosphorus |        |                             |
| Silica     |        |                             |

PAIR 11 (continued)

Range Condition and Utilization:

|                                                | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utiliza-</u><br><u>tion-%</u><br>Est. |
|------------------------------------------------|------------------------------------|--------------------------------------|------------------------------------|------------------------------------------|
| Unit S (see tabulation for Unit S on page 117) |                                    |                                      |                                    |                                          |
| Unit U                                         |                                    |                                      |                                    |                                          |
| Western wheatgrass                             | 25                                 | D                                    | 25                                 | 25                                       |
| Bluebunch wheatgrass                           | 10                                 | D                                    | 10                                 | 10                                       |
| Silver sagebrush                               | 10                                 | 5                                    | 5                                  | 15                                       |
| Needle-and-thread                              | 10                                 | 25                                   | 10                                 | 30                                       |
| Green needlegrass                              | 5                                  | D                                    | 5                                  | 25                                       |
| Forb decreasers                                | 5                                  | D                                    | 5                                  | 30                                       |
| Threadleaf sedge                               | 5                                  | 10                                   | 5                                  | 40                                       |
| Big sagebrush                                  | 5                                  | -                                    | 5                                  | -                                        |
| Blue grama                                     | 5                                  | 5                                    | 5                                  | 10                                       |
| Sandberg bluegrass                             | 5                                  | 5                                    | 5                                  | 15                                       |
| Sageworts                                      | 5                                  | -                                    | -                                  | 10                                       |
| Forbs (yucca and yarrow)                       | 3                                  | 2                                    | 2                                  | -                                        |
| Other woody species                            | 2                                  | 2                                    | 2                                  | 15                                       |
| Annuals                                        | <u>3</u>                           | <u>-</u>                             | <u>-</u>                           | <u>10</u>                                |
| Total                                          | 100                                | xxx                                  | 84                                 | xxx                                      |

PAIR 12

Unit G

Unit V (one year record)

|                                                                |                                                        |
|----------------------------------------------------------------|--------------------------------------------------------|
| 20 miles southwest of Ekalaka,<br>Montana on Chalk Buttes road | <u>Location</u><br>5 miles south of Custer,<br>Montana |
|----------------------------------------------------------------|--------------------------------------------------------|

|                                                                                      |                                       |
|--------------------------------------------------------------------------------------|---------------------------------------|
| Winter of 1954-55<br>Seven cases. Started in Nov.<br>and last case occurred Feb. 15. | <u>Urolithiasis Incidence</u><br>None |
|--------------------------------------------------------------------------------------|---------------------------------------|

Winter of 1955-56  
Three cases. Two of these were  
Dec. 2 and one more Feb. 20.

|                                                                                                                                                                                                                                     |                                                                                                                                                                                          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Hereford steer calves, 30 head in<br>1954-55 and 1955-56, fair condition.<br>Usually brought in off summer range<br>to winter range Oct. 15 and weaned<br>about Christmas time. Calves Mar.<br>to May and castrates about mid-June. | <u>Cattle</u><br>Two owners run 18 and 30 head<br>respectively in one pasture during<br>the fall. All grade Herefords.<br>Steer calves and yearling steers<br>mixed about half and half. |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                                                                                                 |                                    |
|-----------------------------------------------------------------------------------------------------------------|------------------------------------|
| 1,250 acres in addition to several<br>thousand acres of Title III land<br>grazed in common with other ranchers. | <u>Size of Unit</u><br>1,200 acres |
|-----------------------------------------------------------------------------------------------------------------|------------------------------------|

|                                                                                                                                     |                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|
| Grey to brown. Parent material,<br>sedimentary. Residual from shale<br>and sandstone. Fine sandy clay with<br>clay loam in coulees. | <u>Soils</u><br>Grey from complex parent material,<br>mostly sandstone and clay. Soil<br>texture, sandy loam. |
|-------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|

|                 |                                         |
|-----------------|-----------------------------------------|
| 10 to 14 inches | <u>Rainfall Belt</u><br>14 to 19 inches |
|-----------------|-----------------------------------------|

|                                                                                     |                                               |
|-------------------------------------------------------------------------------------|-----------------------------------------------|
| 1. Clayey<br>Slope - general 5 to 8%<br>Permeability - slow to moderate-<br>ly slow | <u>Sites</u><br>1. Overflow<br>Slope 2 to 10% |
|-------------------------------------------------------------------------------------|-----------------------------------------------|

|                                     |                                                              |
|-------------------------------------|--------------------------------------------------------------|
| Desert shrub-mixed grass transition | <u>Vegetational Type</u><br>Mixed grass-savannah (deciduous) |
|-------------------------------------|--------------------------------------------------------------|

|           |                                         |
|-----------|-----------------------------------------|
| 55 (good) | <u>Range Condition</u><br>28 (low fair) |
|-----------|-----------------------------------------|

|                                                                                                                                                                                     |                                                                                                                                                                                                                                              |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Heaviest use made of western wheat-<br>grass and needle-and-thread. Moderate<br>use of short grasses. Coarse mid-<br>grasses (prairie sandreed and alkali<br>sacaton heavily used). | <u>Utilization</u><br>Pasture was used heavily. There<br>was extensive feeding on leguminous<br>plants, woody species including<br>silver sagebrush, rose, and willow.<br>Kochia furnished a substantial<br>amount of feed for these cattle. |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

PAIR 12 (continued)

Unit G

Unit V

Supplemental Feed

Winter of 1954-55

This winter was open and cattle could pick extensively on range. Fed 1/2 pound of barley, 1/2 pound of oats, 1/2 pound of cottonseed cake and white granulated salt.

Winter of 1955-56

Steer calves brought in from range about Christmas time and grazed on grain stubble, alfalfa and fed prairie hay for one month and then fed straight alfalfa hay. No mineral supplement fed either above years.

18 head removed to irrigated land Oct. 15 where cattle grazed aftermath, beet tops and small grain pasture. Small grain pasture was green until late fall. About Dec. 25, the 18 head were put in a corral and fed alfalfa at 20 pounds per day along with a heavy grain ration. 30 head were left in the pasture and, in addition, were allowed to graze out into other cultivated land including alfalfa aftermath, beet tops, and river bottom pasture. This 30 head of steers had received no supplemental forage or grain.

Forage Analysis (per cent)

|            | Unit G | Unit V |
|------------|--------|--------|
|            | Site 1 | Site 1 |
| Protein    | 4.0    | 6.2    |
| Phosphorus | .06    | .06    |
| Calcium    | .24    | .59    |
| Magnesium  | .17    | .34    |
| Potassium  | .22    | .63    |
| Silica     | 5.71   | 2.71   |

Water Analysis (per cent)

|            | Unit G  | Unit V |
|------------|---------|--------|
| Calcium    | .0065   | No     |
| Phosphorus | .000003 | Sample |
| Silica     | .00140  |        |

PAIR 12 (continued)

Range Condition and Utilization:

|  | <u>Volume In</u><br><u>Range-%</u> | <u>Maximum In</u><br><u>Climax-%</u> | <u>Condition</u><br><u>Score-%</u> | <u>Utiliza-</u><br><u>tion-%</u><br>Est. |
|--|------------------------------------|--------------------------------------|------------------------------------|------------------------------------------|
|--|------------------------------------|--------------------------------------|------------------------------------|------------------------------------------|

Unit G. (see tabulation of Unit G on page 96)

Unit V

|                             |     |     |    |     |
|-----------------------------|-----|-----|----|-----|
| Kentucky blue grass         | 15  | -   | -  | 70  |
| Yellow blossom sweet clover | 15  | -   | -  | 60  |
| Kochia                      | 15  | -   | -  | 70  |
| Silver sagebrush            | 12  | 5   | 5  | 5   |
| Cheatgrass brome            | 10  | -   | -  | 20  |
| Western wheatgrass          | 10  | D   | 10 | 7   |
| Broom snakeweed             | 5   | -   | -  | -   |
| Other annuals               | 5   | -   | -  | 10  |
| Bluebunch wheatgrass        | 3   | D   | 3  | 80  |
| Rose                        | 5   | 5   | 5  | -   |
| Buffalo berry               | 5   | 5   | 5  | -   |
| Total                       | 100 | xxx | 28 | xxx |

Additional Single Unit Description  
Number 1

Location:

Near Belltower, Montana

Urolithiasis Incidence:

Winter of 1954-55

13 cases. One of these cases appeared Nov. 15, the second case Nov. 17. The remaining 11 were distributed through the winter. All 13 cases were among 38 steer calves which had been grazed on "Muskrat Creek" range.

There were no water-belly cases among 37 additional steer calves wintered on this unit but which were grazed during the late fall and early winter on the "Hopkins" range. The "Muskrat" range was described, apparently authoritatively, as consisting of western wheatgrass, big sagebrush and cactus. The "Hopkins" range was described by the same person as having considerable amount of "sandgrass, winterfat, saltbush, sagebrush and alfalfa".

Winter of 1955-56

One case. All the cattle this year had been grazed on "Muskrat Creek" range described above.

Cattle:

Winter of 1954-55

Herefords - 75 steer calves. 38 from "Muskrat Creek" range and 37 from "Hopkins" range. All in good condition.

Winter of 1955-56

92 steer calves, Herefords. All moved from Muskrat range Nov. 15. This unit makes it a practice of castrating calves at about two weeks of age, and this was done in 1955-56. However, the previous year, 1954-55, the calves were not castrated until the last of July at the age of about three months.

Size of Unit:

Not known.

Soils:

Azonal and immature light grey soils of clay and sandstone parent material.

Rainfall Belt:

10 to 14 inches.

Site:

Clayey

Slope - 0 to 10%

Permeability - slow to moderately slow

Vegetational Type:

Desert shrub-mixed grass transition.

Range Condition:

Not known.

Utilization:

Range utilization not checked on account of snow cover.

Number 1 (continued)

Supplemental Feed:

Winter of 1954-55

All 75 head of steer cattle this year received a full feed of native grass hay beginning Dec. 15 and continued on through the winter. 38 head of these cattle, among which all 13 cases of water-belly occurred, had previously been grazed on "Muskrat Creek" range as described above. The remaining 37 were grazed during the fall and early winter on the "Hopkins" place described above. All 75 head from these two sources were moved to the unit number 1 during the latter part of Nov. and grazed on sagebrush, mixed grass range until Dec. 15 when feeding the native hay ration began.

Winter of 1955-56

All 92 steers were grazed during the fall on the "Muskrat Creek" range, where grass was reportedly tall but dry. Cattle were moved in from range Nov. 15 and grazed at the ranch headquarters until Dec. 1 on range that was covered with snow to a depth of about two to three inches. Calves were weaned Dec. 1 and placed on alfalfa, straw ration for nine days and then were changed to a ration of a commercial feed concentrate pelletized. They were allowed to graze out on pasture until Feb. 9 when a meadow hay consisting of grass and alfalfa was fed free choice. This hay was approximately two-thirds alfalfa.

Forage Analysis (per cent):

|            | Meadow hay (timothy) | Alfalfa-grass hay    |
|------------|----------------------|----------------------|
| Protein    | 9.1                  | mixture not sampled. |
| Phosphorus | .19                  |                      |
| Calcium    | .53                  |                      |
| Magnesium  | .34                  |                      |
| Potassium  | 2.00                 |                      |
| Silica     | 5.37                 |                      |

Number 2 (two year record)

Location:

4 miles south of Rosebud, Montana

Urolithiasis Incidence:

None

Cattle:

Herefords-average 25 steers per year. No water-belly among these in two years.

Size of Unit:

Approximately 600 acres.

Soils:

Brown alluviated residual material from shale and sandstone.  
Texture sandy clay loam.

Rainfall Belt:

10 to 14 inches.

Site:

Lowland

Vegetational Type:

Not grazed on range

Supplemental Feed:

Cattle are brought in off range mid-Oct. and allowed to graze in the alfalfa, small grain aftermath until Dec. 15, when they are then placed on a alfalfa hay ration for the winter. Calves normally castrated at about six weeks to two months of age.

Forage Analysis (per cent):

None

Water Analysis (per cent):

None

Number 3

Location:

Melville area, Montana

Urolithiasis Incidence:

Winter of 1953-54

30 cases. First case appeared in late Nov. Others occurred throughout the winter.

Winter of 1954-55

20 cases

Winter of 1955-56

4 cases. All cases occurred in late Nov. immediately after weaning.

Cattle:

All Herefords

Winter of 1953-54

350 head

Winter of 1954-55

300 head

Winter of 1955-56

300 head

Rainfall Belt:

10-14 inches

Site:

Not determined

Vegetational Type:

Mixed grassland

Range Condition:

Not checked due to snow cover

Utilization:

Winter of 1953-54

Cattle were on good, dry range Oct. 15 to late Nov., when calves were weaned. They were fed wild hay and allowed to graze in bottoms and on the benches covered with native range plants. During the short time when range was covered with snow, cattle received full feed of hay plus one pound per day of 20% protein pellets. Water was adequate.

Winter of 1954-55

Similar in most respects to previous winter.

Winter of 1955-56

Fall was dry and range was snow covered by mid-Nov. Cattle stayed on feed grounds more than previous two years, depending almost entirely upon hay.

The rancher indicated that the hay fed this year was of higher quality than previously because of fertilization with nitrogen. It contained about 10% legumes.

Forage Analysis (per cent):

None

Water Analysis (per cent):

None

TABLE XVIII. INCIDENCE OF UROLITHIASIS IN RELATION TO PLANT MINERALS. ANALYSIS OF VARIANCE <sup>1/</sup>

| Source of Variation           | Degrees of Freedom | MEAN SQUARES |              |              |              |              |
|-------------------------------|--------------------|--------------|--------------|--------------|--------------|--------------|
|                               |                    | Phosphorus   | Calcium      | Magnesium    | Potassium    | Silica       |
| All samples                   |                    |              |              |              |              |              |
| Due to regression             | 2                  | 497.086520** | 448.657970** | 329.522006** | 288.020304** | 384.459967** |
| Linear                        | 1                  | 413.361989** | 552.010794** | 535.044813** | 361.863756*  | 444.055581** |
| Quadratic                     | 1                  | 581.111051** | 345.305147** | 123.999198   | 216.176851   | 324.864353*  |
| Deviation about regression    | 35                 | 41.560970    | 44.328315    | 51.136085    | 53.450468    | 47.996773    |
| Questionable samples excluded |                    |              |              |              |              |              |
| Due to regression             | 2                  | 483.281563** | 489.415220** | 498.296788** | 472.659474** | 342.661640** |
| Linear                        | 1                  | 661.914491** | 516.344408** | 688.689111** | 489.377683** | 670.210816** |
| Quadratic                     | 1                  | 304.648635** | 462.486031** | 307.904466** | 455.941266** | 15.112464    |
| Deviation about regression    | 31                 | 38.233943    | 37.838223    | 37.265218    | 38.919239    | 47.306196    |

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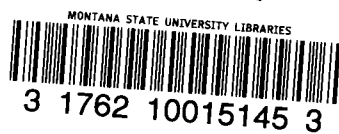
TABLE XIX. THE INCIDENCE OF UROLITHIASIS IN RELATION TO PLANT MINERALS. COEFFICIENTS OF CORRELATION<sup>1/</sup>

|                              | Incidence vs. Phosphorus | Incidence vs. Calcium | Incidence vs. Magnesium | Incidence vs. Potassium | Incidence vs. Silica |
|------------------------------|--------------------------|-----------------------|-------------------------|-------------------------|----------------------|
| All samples                  |                          |                       |                         |                         |                      |
| Linear                       | - .4109*                 | - .4748**             | - .4674**               | - .384*                 | .4258**              |
| Quadratic                    | .6373**                  | .6053**               | .5188**                 | .4858**                 | .5604**              |
| Questionable samples omitted |                          |                       |                         |                         |                      |
| Linear                       | - .5546**                | - .4899**             | - .5657**               | - .4769**               | .5581**              |
| Quadratic                    | .6702**                  | .6745**               | .6805**                 | .6628**                 | .5643**              |

\*\* Significant at .01 level

\* Significant at .05 level

<sup>1/</sup> Statistical analysis was conducted by the Montana State College Statistical Laboratory



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