



Soil water, nitrate, and site characteristics of Montana foothills range  
by June Gail Haigh

A thesis submitted in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE  
in Soil Science

Montana State University

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Abstract:

This study was undertaken "because of the importance of water as a resource and the current interest in the natural grassland ecosystem. It provides some climatic, soil and vegetation data for eight microsites in a restricted ectone of Montana Foothills Range. Soil water was determined gravimetrically in early spring of 1970 and in late summer at 20 sites, most of which were in good to excellent range condition.

Samples for moisture and nitrate were taken with a King tube sampler and from hand dug pits. Bulk density for soils containing a large amount of coarse fragments was determined by a sand-fill excavation method.

Mean summer soil temperature at 50 cm depth ranged from 14.5 C to 17.5 G which allows the soils to be classified as Gryborolls and Argiborolls. The study period precipitation ranged from 23.3 cm to 29.8 cm and was about normal for the general area over a 13 year period. Neither air temperature nor evaporation from a free water surface clearly stratified sites.

The growth season soil water depletion zone, and consumptive use rates varied markedly among the soils studied, but were quite similar among sites with similar soils and site factors. For all sites the consumptive use (precipitation plus soil depletion) ranged from 29.1 to 41.5 cm, or a difference of 12.4 cm. Three sites with similar deep silty soils had a range of only 2.9 cm. In these silty soils the water depletion was mainly from the upper 91 cm of soil while in soils containing many coarse fragments there was significant water depletion to 152 cm.

From these limited data it appears that soil nitrate is at a low level most of the year (less than 2 ppm). It may be in surplus for a short period in late June when the soils are both warm and moist, but is used rapidly by actively growing grasses before late July.

The average herbage production from clipped plots at the 20 sites was 1268 kg/ha (131 lb/a) ranging from 2167 kg/ha to 716 kg/ha.

Water use efficiency ranged from 20 to 58 kg/ha-cm of water used.

The highest producing site had the greatest water use efficiency and the least productive site had the lowest water use efficiency.

In the dissected upland Foothills Range of this study there is a complex of interacting soil and site factors that produce contrasting as well as intergrading micro-habitat types that need to be considered when assessing the alternative uses of these rangelands.

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Date

*May 25, 1976*

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A thesis submitted in partial fulfillment  
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ABSTRACT

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## INTRODUCTION

With the increasing demands on the water resources of the United States in recent years has come a closer look at the many and varied uses of water. No one has questioned the need of water for quenching human thirst but most other uses are coming under economic and environmental scrutiny.

About 70 percent (26 million hectares) of Montana is in rangeland or grazable woodland (Jackson 1970). Considering a minimum average precipitation of 30 cm, these lands receive about 7.8 million hectare meters of precipitation annually. What happens to this water, and this land, is of vital importance not only to the state's 250 million dollar livestock industry (Jackson 1970) but to the entire state economy and to the total environment. Montana State University Dean of Agriculture, writing of the Decade of the 70's. (Asleson 1970) expresses concern for rangelands:

"Being primarily a range-livestock state... Obviously we should look at range productivity... There are real opportunities for research to develop the knowledge which can substantially increase range production... It is imperative that improvements be made in our range productivity if our livestock producers are going to continue to compete."

The current market value and the continued public interest in land, especially the natural ecosystem, also point to the need for study of rangelands.

A common system of range analysis is the Ecological Site Method (Dyksterhuis 1958). By this method range condition is defined in

relation to its potential or its pristine state. Because man has so altered vast areas by farming, grazing, industrial activities and other uses it is often difficult to recognize this "pristine" state. At times the altered condition has even become accepted as the pristine and the real potential of the site is not realized. Over grazing has sometimes been cited to explain what is actually a limited site potential (Mason 1970). Many good documentations of pristine or near-pristine vegetation are reported in the literature of Branson and Miller (1965), Daubenmire (1942), Hulett and Tomanek (1969); Mueggler and Handl (1974), Ross et al. (1973) and others. Some of these studies have related soil and other site factors to the vegetative type. Yet, because of the complexity of natural systems and the difficulty of judging range condition without using criteria based on sound soil and plant data, Mason (1970) concludes that intensive studies of relict areas and areas with excellent vegetation condition are needed on all types of rangeland to determine range potential

The purpose of this study was to provide some benchmark data on the moisture and nitrate status of soils in native range and to document other site characteristics as a basis for predicting the environmental impact of management alternatives and to stratify sites of differing potential. More specifically, the goal of the study was to provide, for a number of near pristine range sites, specific infor-

mation on:

1. Physical soil characteristics
2. Precipitation
3. Evaporation
4. Soil temperature
5. Air temperature
6. Water stored and used from the soil
7. Soil nitrate status
8. Herbage production



## THE STUDY AREA

### Locations And Available Data

This study was carried out at two locations: 1. Red Bluff Ranch at Norris, Montana; and 2. North of Belgrade, Montana (Fig. 1). The Red Bluff Ranch was selected for the main part of this study because of the good condition of the range and the previous studies that have been done there.

In 1957 Van Dyne (1960-1) made a range survey of the Red Bluff Ranch by the ecological site method to evaluate the existing range condition and to determine the carrying capacity of the ranch. At that time approximately half of the nearly 400 hectare ranch was classified in good condition and about one fourth each in excellent and fair condition. In 1958, 70 locations were selected for line intercept studies (Van Dyne, 1960-2). These locations represented different range sites and varied range conditions of the ranch and were referred to as clusters. The sample area of each cluster was about one acre. Slope, aspect, elevation, and soil texture of the 5 to 46 cm layer were determined.

Ryerson et al. (1970) made soil moisture measurements in conjunction with studies of clubmoss control but no data specific to the Red Bluff Ranch was reported. Klages and Ryerson (1965) studied nitrogen and irrigating effects on yield and composition from 1959 to 1961.

In 1957 a standard Weather Bureau recording station was set up at the Red Bluff Ranch headquarters, designated as Norris 3ENE. Daily



























































































































































































































































































